Solid Earth Discuss., 3, C143–C155, 2011
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Solid Earth
Discussions

SED
3, C143–C155, 2011

Interactive
Comment

Interactive comment on "Geophysical characterisation of two segments of the Møre-Trøndelag Fault Complex, Mid-Norway" *by* A. Nasuti et al.

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We would like to thank Dr. Gerald Gabriel and Prof. Hermann Zeyen for their constructive comments and suggestions that have really helped us to prepare a new and improved version of our work. In the following, we ïňĄrst list the major changes made to the manuscript and second we reply point-by-point to the reviewers' comments.

Note: All page and line references refer to the new manuscript for reviewers. Changes come in blue in revised Ms and here the Answered comes after A:

1-New information about the processing of gravity and magnetic data has been added to the text. We agree with both reviewers that quoting extensively two reports from the

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Geological Survey of Norway (NGU) and a MSc thesis, in order to reduce a too-lengthy description of data and methods in the Ms, could appear somewhat cryptic. However, we would like to emphasize that the two reports (Nasuti et al. 2009, 2010) and the MSc thesis of A. Biedermann are completely open to anyone and can be downloaded from the net. The reader can get access to far more detailed information than it is common in traditional peer-review literature. We apologize for not having been more specific on this critical point in the original version of the Ms. We now indicate the precise web links for these documents. 2- Figures 1, 2, 3, 6, 8 have been modified. 3- A model based on geophysical data was added to figure 6. 4- A synthetic model has been attached to the document in order to show the magnetic anomaly of a dipping structure. This figure is not included in the Manuscript. 5- Mean values of petrophysical measurements replaced by Median values. 6- The reference list has been updated.

Replies point-by-point (reviewer 2: Dr. Gerald Gabriel):

A) Geology The authors give a short introduction into the geology of the study area. For me it would have been helpful having a figure available, which images the geological interpretation of the apatite fission track data after Redfield et al. (2004, 2006) and Redfield and Osmundson (2009).

A new figure adapted from Redfield et al. (2005) has been added.

Name the faults that are plotted in Fig. 2.

The bedrock map is based on Tveten et al. (1998) and after checking again we found that there are no official names for these possible faults. We also modified the legend of Fig. 2 and added the assumed fault shown as a solid line.

B) Gravimetry Because the observed gravity anomalies are rather small, e.g. only about 1 mGal along profile PP', some more information about the error budget of the anomaly data might be required. The authors write (page 163, line 25) that the measuring accuracy was in the order of 0.01 to 0.02 mGal. But with respect to the small

SED
3, C143–C155, 2011
Interactive Comment

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Interactive Discussion
Discussion Paper

anomalies it would be interesting to read also something about the accuracy and values of the terrain reduction. How did the authors handle the bathymetric data? The reference to some (internal?) reports is not helpful. I suggest shifting the information from chapter 3.3 'Petrophysical data and Bouguer corrections' to chapters 3.1 and 3.2. When discussing the densities, the authors should refer to Table 1 and the sample locations in Fig. 5.

The reports are available online and all the details can be found there (see also reply to the first point of reviewer 1). Nevertheless, new information has been added to the text (p.4 line 80 and p. 7 line 164). http://www.ngu.no/upload/Publikasjoner/Rapporter/2009/2009_037.pdf http://www.ngu.no/upload/Publikasjoner/Rapporter/2010/2010_049.pdf On page 168, line 15, the authors write, that the observed gravity anomaly along profile PP' displays a steep gradient that cannot be explained by the relief only. What is meant? The relief in the sense of the topography should be corrected in the gravity data, because the authors discuss Bouguer anomalies. We agree with Dr. Gabriel's argument and consequently emphasize now that the data has been corrected for topography (p 4.line 80). The text has been modified and this sentence has been removed.

The density of the Quaternary overburden is rather high (2590 kg/m3). Does any evidence exist for this assumption? If the density can be even lower, than the gradient in the Bouguer anomalies along profile PP' (Fig. 7) might be simply explained be the density contrast between the Quaternary and the hard rocks, i.e between density contrasts above sea level.

We agree that the overburden should normally present lower densities. However, we need to point out that (1) we unfortunately have no measurements on overburden properties and, more importantly, that (2) even if reduce the overburden density in our modeling we still need to introduce a low density body with high susceptibilities in order to fit both gravity and magnetic data. In conclusion, the density of the overburden does not affect significantly our model, especially because this layer is thin as demonstrated

SED

3, C143–C155, 2011

by our own field observations and the seismic and resistivity measurements.

C) Magnetics Regarding the location of the magnetic surveys the authors should refer also to Fig. 2 (page 164, line 4). Furthermore, I miss some information about the data quality - again, only an internal report is given as reference.

As mentioned previously full (and even more than usually found in traditional peer-review literature) can be found in the reports that are fully accessible on the web (see answer to point B).

Also the work of Biedermann (2010) is unpublished. Therefore, some more information about the variations in the petrophysical data and its interpretation should be given in this paper. Is any information available about remanent magnetization of the rocks? Or is there any evidence that no remanent magnetization must be considered in the forward models also?

The remanent magnetization has also been measured by Biedermann (2010). This latter study indicates that magnetic anomalies are dominated by the induced magnetization, therefore the effect of remanent magnetization could be neglected in the modeling (see Biederman 2010 p. 19) this has been added to the text (p.10 line 233). The work of Biedermann (2010) is fully accessible at http://e-collection.library.ethz.ch/view/eth:1986

Are the magnetic anomalies pole reduced; I guess they are not? The authors describe the shape of the magnetic anomalies along profile QQ' (Fig. 6) with "up and downs" (better: alternating positive and negative anomalies) which are expected to image contacts between different rocks. I am not really aware of the typical shape of only induced magnetic anomalies at these latitudes. For a better correlation between the magnetic signature and the discussed structures a forward model is required. The proposed correlation of the magnetic anomaly M3 with the seismic anomaly S3 and the resistivity anomaly R3 is - with respect to their locations along the profile – not convincing.

In this specific region the RTP does not affect the shape of the anomalies (inclination is 75 degrees and declination 0.3 degrees). We anyway modified our statement about the magnetization of the fault zone and use" positive and negative" instead of "up and down" (P.9 line 206). Also the locations of M1 and M3 have been reconsidered. As mentioned previously (answer to point 3 of Prof. Zeyen), the dip of the magnetic body together with the orientation of the profile most probably create the observed shape of the anomaly. New information has been added to the text (p.9 line 216)

Also regarding the discussion of the spatial correlation between the resistivity anomalies A1 (and A2?) along profile ZZ' and the magnetic anomaly U a forward model is required. Are the positive and negative parts of the anomaly U related to one source body, or do they origin from two different rock types? Another magnetic survey was performed about one kilometer west of profile ZZ'. Does this profile also image the anomaly U like along profile ZZ'?

Indeed, yes, anomaly U is seen also along profile ZZ', but because this latter profile was not acquired at the same location than the one shown in the Ms, the anomaly appears shifted 200 m towards the south. This is fully consistent with the strike of the inferred fault (see anomaly (1) on profile 15 in Nasuti et al., 2010, p. 38).

D) Seismic profiling The interpretation of the seismic surveys suffers from a lack of information regarding the "field data". I expect the reader wants to see at least a representative seismogram / graph of traveltimes that was used to estimate the velocities.

We agree with the reviewer and put some more information about the data interpretation but as mentioned previously all details about the seismic data are available and published by the Geology Survey of Norway and it is fully accessible at http://www.ngu.no/upload/Publikasjoner/Rapporter/2009/2009_037.pdf

Please also note the supplement to this comment:
http://www.solid-earth-discuss.net/3/C143/2011/sed-3-C143-2011-supplement.pdf

SED

3, C143–C155, 2011

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Interactive comment on Solid Earth Discuss., 3, 159, 2011.

SED

3, C143–C155, 2011

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Interactive Discussion

Discussion Paper

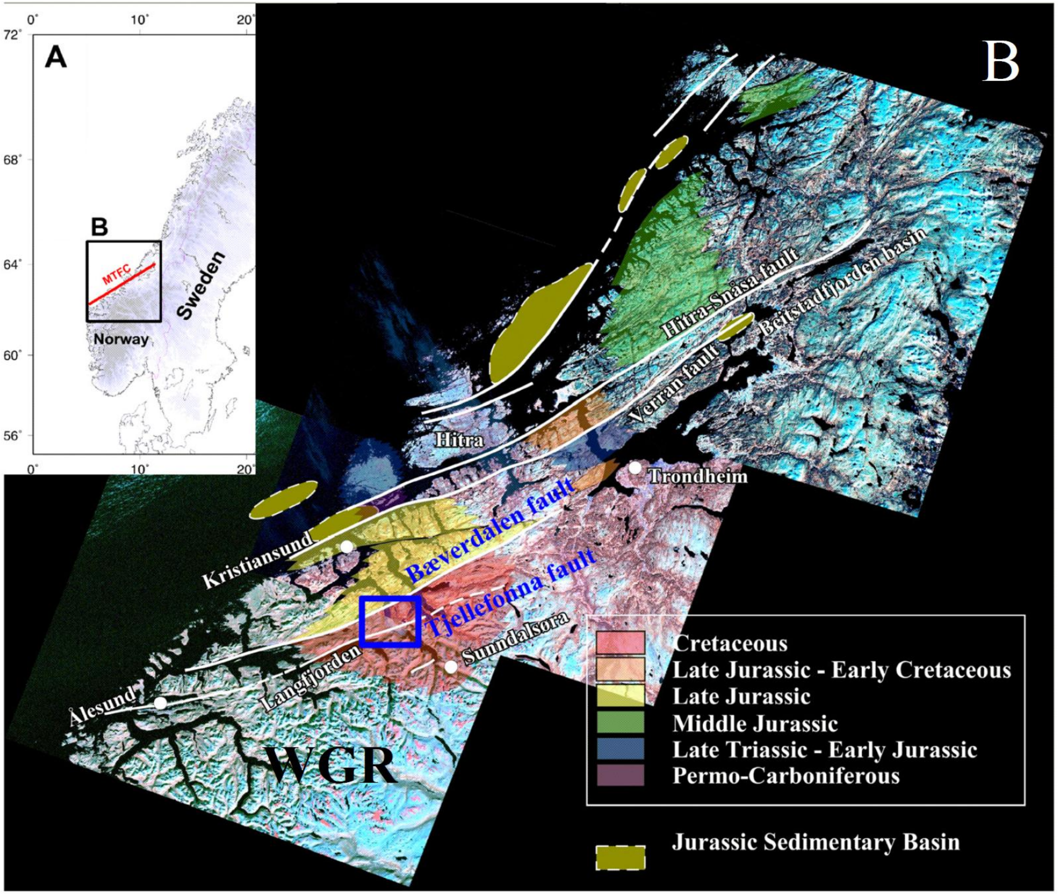

Fig. 1. Fig. 1

SED
3, C143–C155, 2011

Interactive Comment

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Interactive Discussion
Discussion Paper

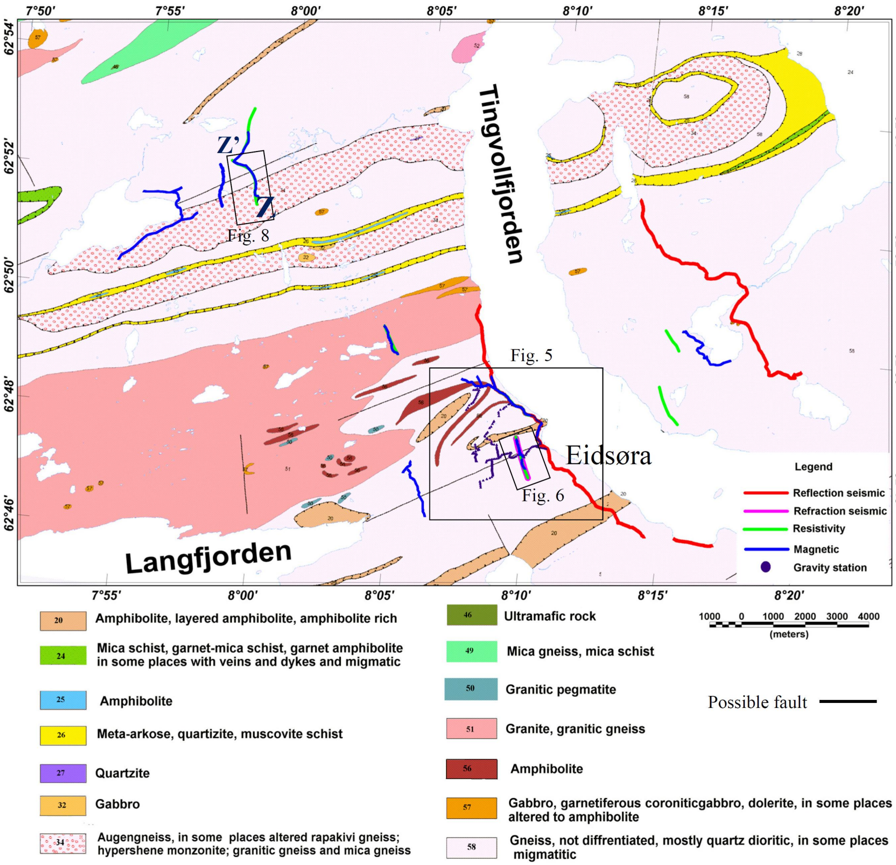

Fig. 2. Fig. 2

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Interactive Discussion
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3, C143–C155, 2011

Interactive Comment

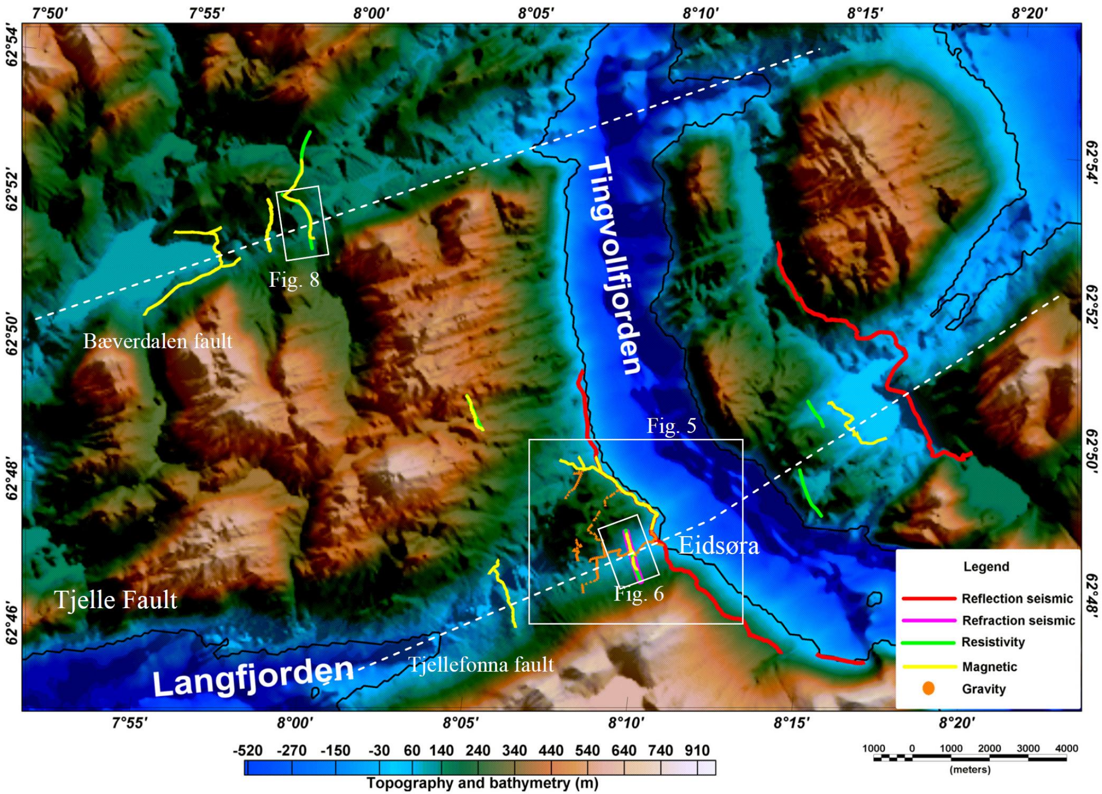

Fig. 3. Fig. 3

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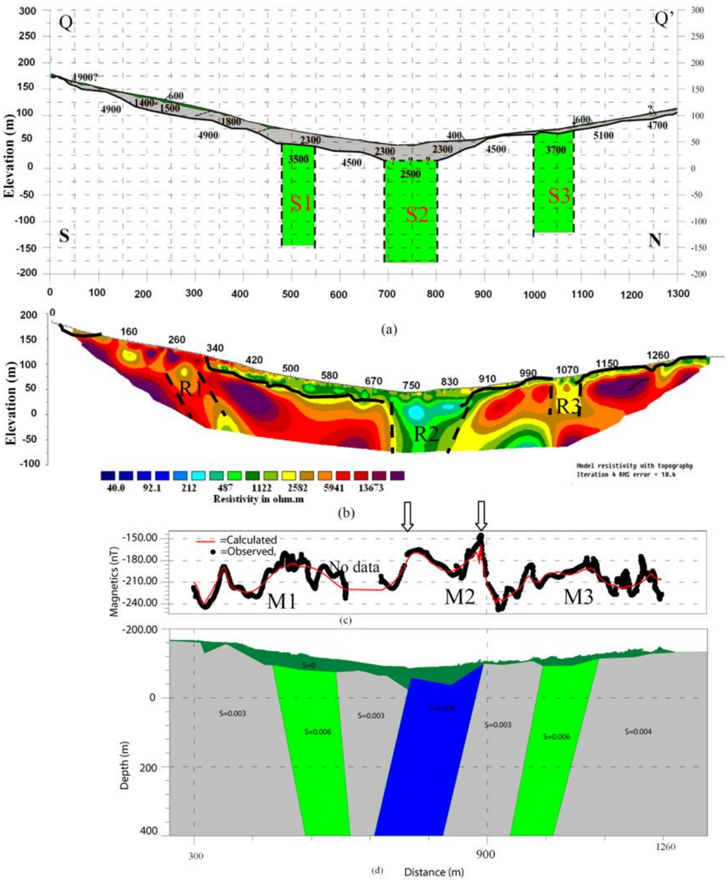

Q
Q'
S
N
S1
S2
S3
Elevation (m)
Distance (m)
(a)
R1
R2
R3
Resistivity in ohm.m
Model resistivity with topography
(b)
=Calculated
=Observed,
No data
M1
M2
M3
Magnetics (nT)
(c)
Depth (m)
(d)

Fig. 4. Fig. 6

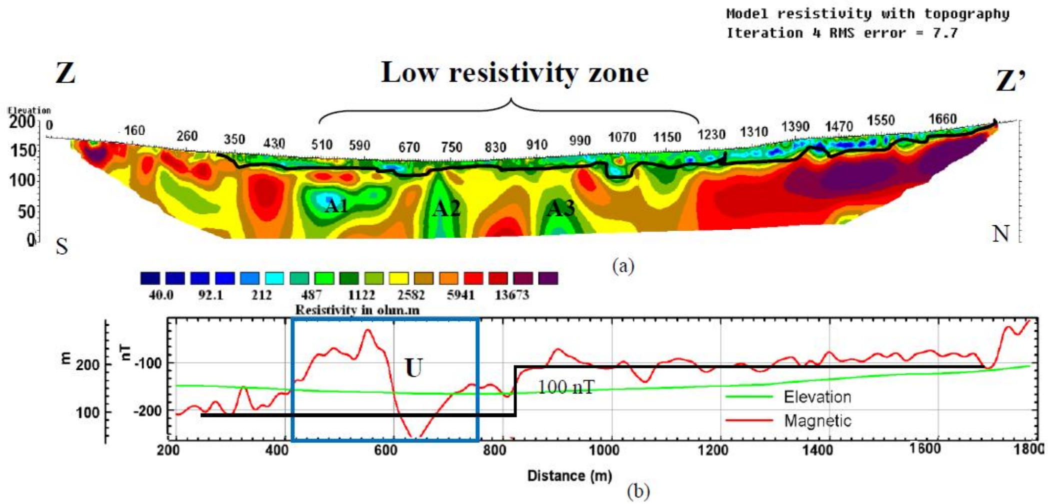


Fig. 5. Fig. 8

SED
3, C143–C155, 2011

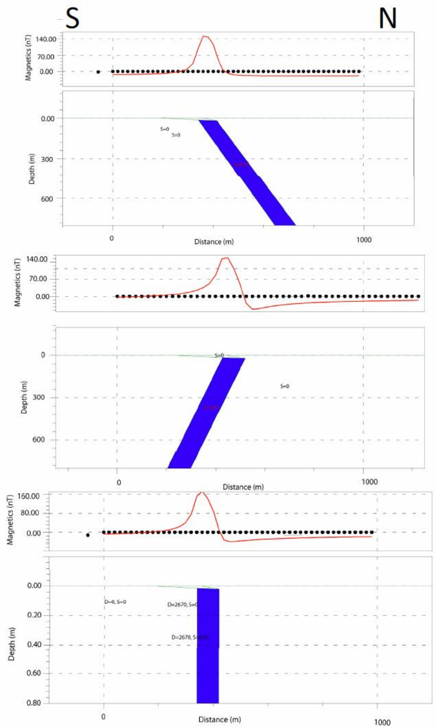
Interactive Comment

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

SED

3, C143–C155, 2011

Interactive Comment



Synthetic model for a dipping magnetized body. The Earth field has 75 deg with 0.3 declinations. The magnetized body has susceptibility of 0.01 SI. The profile has Azimuth of 340.

Fig. 6. Synthetic Model

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Interactive Discussion

Discussion Paper

Figure and Table captions

Fig. 1 Principal structural features of the Møre-Trøndelag Fault Complex (MTFC) and surrounding regions. (A) Location of the Møre-Trøndelag Fault Complex (MTFC) onshore Norway. (B) Composition of three LandSat scenes showing the major lineaments of the MTFC (after Redfield et al. 2005). The blue frame depicts the study area. WGR- Western Gneiss Region.

Fig. 1 Simplified bedrock map of the study area (after Tveten et al. 1998). The respective locations of the different geophysical profiles are shown. The black boxes outline some of the geophysical profiles shown in Figs. 5, 6 and 8.

Fig. 2 Several geophysical data sets have been acquired in the study area (blue box in Fig. 1). The background map depicts topography and bathymetry. The white boxes outline geophysical profiles whose corresponding results are shown in Figs. 5, 6 and 8. dashed white lines show the proposed Tjellefonna and Bæverdalen faults.

Fig. 3 Determination of the bulk density of the studied domain using the Nettleton Method. (a) Computed Bouguer anomalies along NN' using different densities. The location of this profile is shown in Fig. 5. (b) Topography of the profile with location of the gravity points.

Fig. 5 Bouguer anomalies calculated using a reduction density of 2790 kg/m3 and superposed on the geological map (Tveten et al. 1998). NN' is the traverse used to determine the reduction density (Fig. 4). PP' and QQ' are profiles shown in figures 7 and 8 respectively. Letters in black represent petrophysical sampling sites (Biedermann 2010).

Fig. 6 Geophysical profiling across the "Tjellefonna Fault". (a) The refraction seismic profile shows three low-velocity zones (S1, S2 and S3); velocities in m/s. (b) Depth-inverted 2D resistivity profile showing three low-resistivity zones (R1, R2 and R3). Continuous and dashed lines represent the interpreted top bedrock and the edges of the interpreted main fault zone respectively. (c) Magnetic

Fig. 7. Figures and table captions

SED

3, C143–C155, 2011