REPORT ON A MAGNETOTELLURIC STUDY IN KANGERLUSSUAQ, WEST GREENLAND

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Despite a well-mapped, interesting surface geology, deep sounding geophysical studies like seismics or magnetotellurics have been used very rarely in Greenland. The aim of this article is to present the preliminary results of a magnetotelluric study performed in the area of Kangerlussuaq, West Greenland. The estimated transfer functions will be used in the future for 2-D and 3-D modelling of subsurface resistivity structures, the influence of the electrically conductive ocean, as well as the source geometry in the auroral oval.

1. The MT-survey

We report on a magnetotelluric (MT) investigation in the Kangerlussuaq area performed in the period from 5*th* of August 2010 to 17*th* of September 2010. Five recording stations were evenly distributed along a 40 km profile with an approximate WSW-ENE orientation between Kellyville (SRI Incoherent Scatter Radar; DTU Space magnetometer station), station A, and the Greenland Ice Sheet (Fig. 1), station E. The telluric field variations were measured using Ag/AgCl electrodes (Junge, 1990) at all five stations, and magnetic field variations were recorded with 3-component fluxgate magnetometers at stations A and E. The sampling frequency was 4 Hz and standard robust processing (Löwer, 2010) was applied to the data to estimate MT transfer functions such as impedance tensors and tipper vectors.

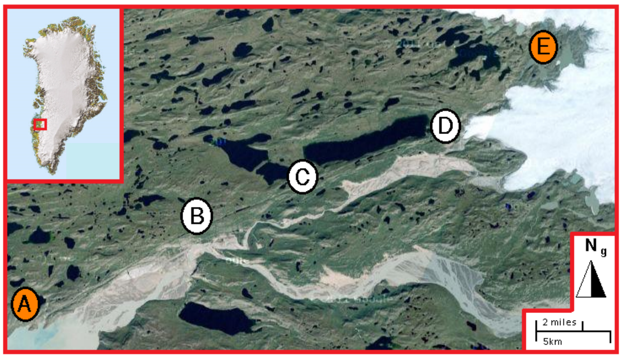

Figure 1: Map of Greenland (upper left panel) and detailed map of the Kangerlussuaq region including the locations of the five measurement stations. At stations A and E the three components of the magnetic field and the horizontal components of the telluric field were observed (orange circles), whereas at stations B, C and D only the telluric field was recorded (white circles). Source: www.google.com

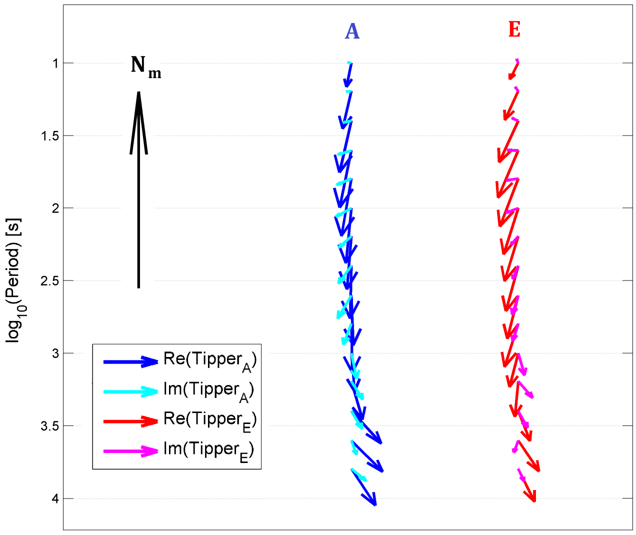

Figure 2: Tipper arrows for stations A (blue) and E (red). The corresponding calculations are due to the Wiese convention, thus the real tipper arrows point away from a good conductor. The local magnetic north points upwards. The black arrow indicates the unity arrow pointing towards local magnetic nord.

2. Data processing

Unstable transfer functions were observed during magnetic active periods. The survey period was therefore divided into halfdays and data from half days with a mean k-index value above 2 were excluded.

Comparing the measured tipper arrows (Fig. 2) and phase tensor bar orientations (Fig. 3) (Häuserer and Junge, 2011), the determined phase values could be assigned to the polarisation modes TE and TM (Fig. 4), under assumption of two-dimensionality. This is necessary before a 2-D subsurface resistivity model can be created.

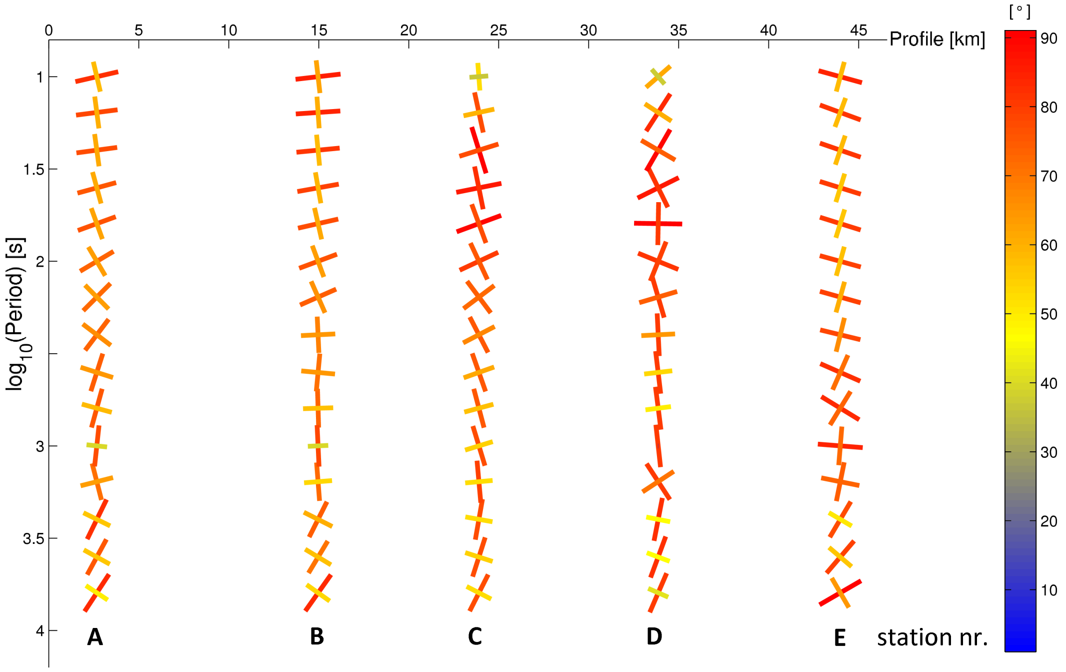

Figure 3: Phase tensor bars along the measurement profile, orientated in the local magnetic coordinate system. The bar colours and lengths correspond to the phase values.

3. Results

The orientation of the estimated tipper arrows in Fig. 2 is shown in the local magnetic coordinate system. Taking the westerly magnetic declination of 32 degrees into account, the real part of the tipper arrows points approximately towards geographic southeast.

The estimated phase tensor bar values (Fig. 4) show a distinctive split-up between the two polarisation modes as well as a cross over at periods around 100 sec. The measurements of station E differ from the general phase behaviour seen at the other stations. We suggest that this could be caused by a pronounced 3-D conductivity structure and/or anisotropy.

4. Discussion

The observed tipper orientations suggest a large and well conducting structure northwest to the measurement profile. Other magnetotelluric investigations from Finland (Korja et al., 1989) and Canada (Evans et al., 2005) reveal also good conducting structures of approximately $5\Omega m$ between 10 km and 40 km surface depth. The Kangerlussuaq area might be linked to the other two areas through a 1.9 Ga old foldbelt (Johansson, 2009), which encourages further investigations of our data set. In Greenland, this fold belt is called the Nagssugtoqidian orogen (e.g. Marker et al. (1995)).

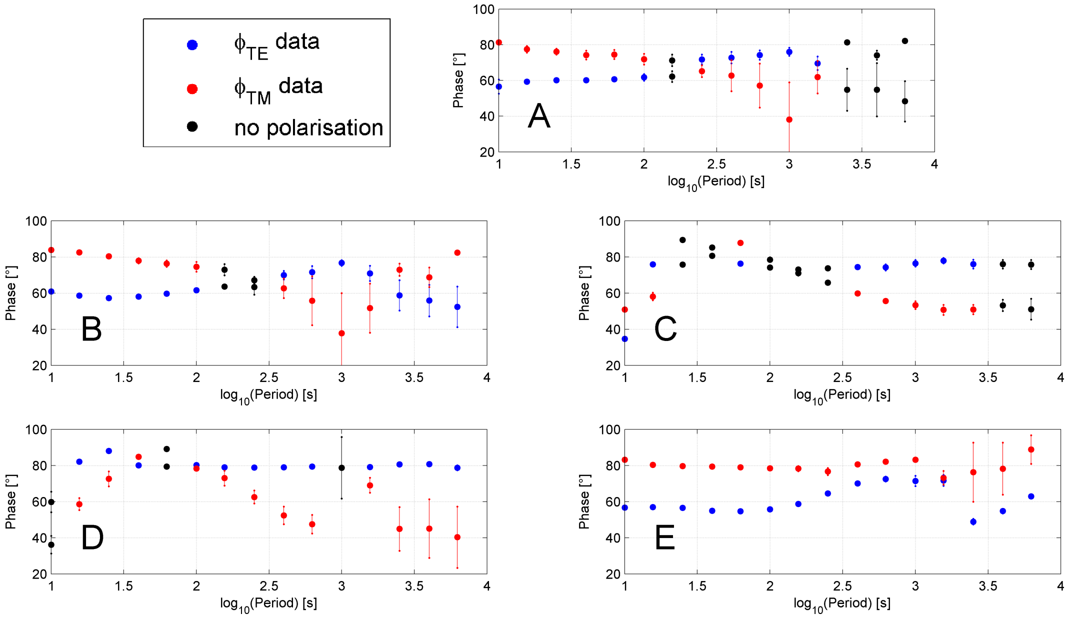

Figure 4: The estimated phase tensor bar values for stations A to E are illustrated with their corresponding polarisation mode affiliation for TE (blue) and TM (red). Black data points represent the measurements where a polarisation mode association was not possible.

5. Conclusion

The current study investigates the subsurface resistivity structure in the area around Kangerlussuaq, West Greenland. Magnetotelluric measurements were performed at five stations along a 40km WSW-ENE profile. As a first step, the corresponding transfer functions were estimated and are presented here. The orientation of the tipper vectors suggests a large and well conducting structure to the northwest, with a strike direction of similar orientation as the measurement profile. Future surveys should therefore aim at locations along a profile perpendicular to the strike direction identified here. Such studies could then be compared to similar MT-studies, especially from Canada, and reveal conductivity structures across the proterozoic orogen.

Further data treatment, including 2-D as well as 3-D inversion modelling, is already in progress.

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