Magnetotelluric profile across the Zimbabwe craton

Marion P. Miensopust[1,2], Alan G. Jones[1], Mark R. Muller[1], Mark P. Hamilton[1,3], Jessica E. Spratt[1], Xavier Garcia[1], Rob L. Evans[4], Shane F. Evans[5], Andy Mountford[6], Wayne Pettit[7], Patrick Cole[8], Tiyapo Ngwisanyi[9], Dave Hutchins[10], C.J.S. Fourie[11], and the SAMTEX Team[12]

1. Dublin Institute for Advanced Studies, 5 Merrion Square, Dublin 2, Ireland, *marion@cp.dias.ie, alan@cp.dias.ie*, *xavi@cp.dias.ie*, *mark.muller@dias.ie*, *mh@cp.dias.ie*, *jsp@cp.dias.ie*
2. National Unisversity of Ireland, Galway, Ireland, *marion@cp.dias.ie*
3. University of the Witwatersrand, School of Geosciences, Johannesburg 2050, South Africa, *mh@cp.dias.ie*
4. Woods Hole Oceanographic Institution, Department of Geology and Geophysics, Clark South 172, 360 Woods Hole Road, Woods Hole, Massachusetts, 02543-1542, U.S.A., *revans@whoi.edu*
5. De Beers Group Services, Private Bag X01, Southdale 2135, South Africa, *Shane.Evans@au.debeersgroup.com*
6. Rio Tinto Mineral Exploration Inc., PO Box 695, 7th Floor Castlemead, Lower Castle Street, Bristol BS99 1FS, U.K., *Andy.Mountford@riotinto.com*
7. BHP Billiton, 6 Hollard Street, Johannesburg 2001, South Africa, *Wayne.Pettit@bhpbilliton.com*
8. Council for Geoscience, 280 Pretoria Street, Silverton, Pretoria 0001, South Africa, *pcole@geoscience.org.za*
9. Geological Survey of Botswana, Private Bag 14, Lobatse, Botswana, *tngwisanyi@gov.bw*
10. Geological Survey of Namibia, 1 Aviation Road, Windhoek, Namibia, *dhutchins@mme.gov.na*
11. Council for Scientific and Industrial Research, Address, *sfourie@csir.co.za*
12. Other members of the SAMTEX team are: Louise Collins, Clare Horan, Gerry Wallace (Dublin Institute for Advanced Studies); Alan D. Chave (Woods Hole Oceanographic Institution); Marisa Adlem, Kobus Raath, Raimund Stettler (Council for Geoscience); Susan J. Webb (University of the Witwatersrand).

ABSTRACT

The understanding of the geology and early Earth processes is the main aim of the Southern African MagnetoTelluric EXperiment (SAMTEX). Within this project, magnetotelluric data were collected over a large area which included parts of South Africa, Namibia and nearly the whole of Botswana. The most northeastern profile (ZIM line) is crossing the Zimbabwe Craton and will be topic of the here presented work.
So far the extent of the Zimbabwe Craton and its surrounding mobile belts (Limpopo Belt, Magondi Mobile Belt and Damara Mobile Belt) are estimated from surface geology and magnetic and gravity data. The intention is to verify or to modify these boundaries at lithospheric depths using the results of modelling SAMTEX magnetotelluric data.

Key words: SAMTEX, magnetotellurics, Zimbabwe craton.

INTRODUCTION

The question how far back the plate tectonic paradigm applies to describe the Earth's dominant tectonic processes is coupled with the uncertainty of the formation process of Archean-age cratonic lithosphere. Primarily passive seismology has been used to obtain this information, but over the last eight years deep-probing magnetotellurics (MT) has been developed and applied to this problem, and has demonstrated that MT data, combined with other geoscientific information, provides significant constraints on formation processes (Davis et al., 2003). Therefore in South Africa the world's largest-ever teleseismic study (Kaapvaal Seismic Experiment) was followed by the world's largest-ever land-based MT project (Southern Africa MagnetoTelluric EXperiment, SAMTEX). The physical properties and the geometries of Archean and Proterozoic lithosphere will become as well-known as its extensive geochemical framework. With such an enormous data set about the current status of the geology, a good base will be build up for studies of

processes in the Earth's history as far back as the MesoArchean.

Studies of magnetic and gravity data, as well as surface geology, generated maps of outlines of the main geological features of southern Africa. The magneto-telluric data will be used to verify or modify these boundaries, and extend them into the lithosphere, based on their resistivity structure.

The processing of magnetotelluric data is not a one-step procedure and some of the intermediate steps might give already useful additional information; for example the analysis of the strike angle.

THE ZIM LINE

The profile considered here is the so called 'ZIM line'. In Figure 1 the ZIM line stations are highlighted in red whereas all other SAMTEX magnetotelluric sites are shown in light blue.

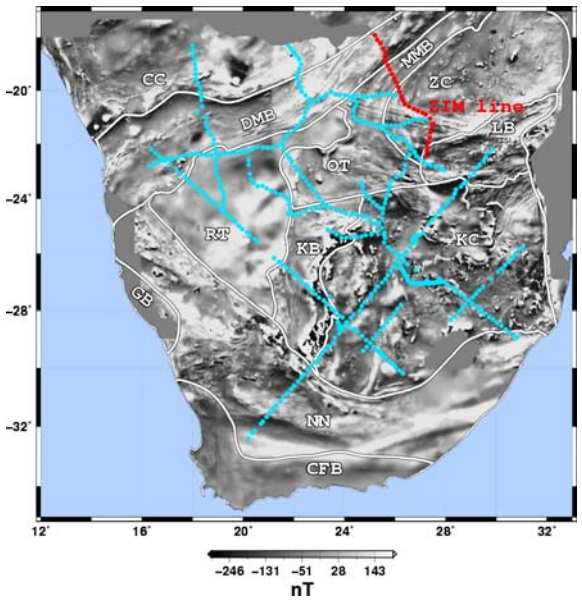

Figure 1. Map of site locations of all SAMTEX MT sites – highlighted in red the ZIM line crossing the Zimbabwe craton. In greyscale as background the map of the magnetic data, which, together with the gravity data, is the basis for the tectonic terrane division of Sue Webb and shown here as the white lines.
(CC – Congo Craton, DMB – Damara Mobile Belt, MMB – Magondi Mobile Belt, ZC – Zimbabwe Craton, LB – Limpopo Belt, OT – Okwa Terrane, RT – Rehoboth Terrane, GB – Gariep Belt, KB – Kheis Belt, KC – Kaapvaal Craton, NN – Namaqua-Natal Mobile Belt, CFB – Cape Fold Belt)

The ZIM line is located in northeastern Botswana running nearly parallel to the Zimbabwe boarder for most of the profile. With its 31 MT stations, it crosses not only the Zimbabwe craton but also the surrounding Damara and Magondi mobile belts in the north and parts of the Limpopo Belt in the south. Figure 2 shows a close-up of the ZIM line and its site locations in relation to the boundaries of the geolocial structures.

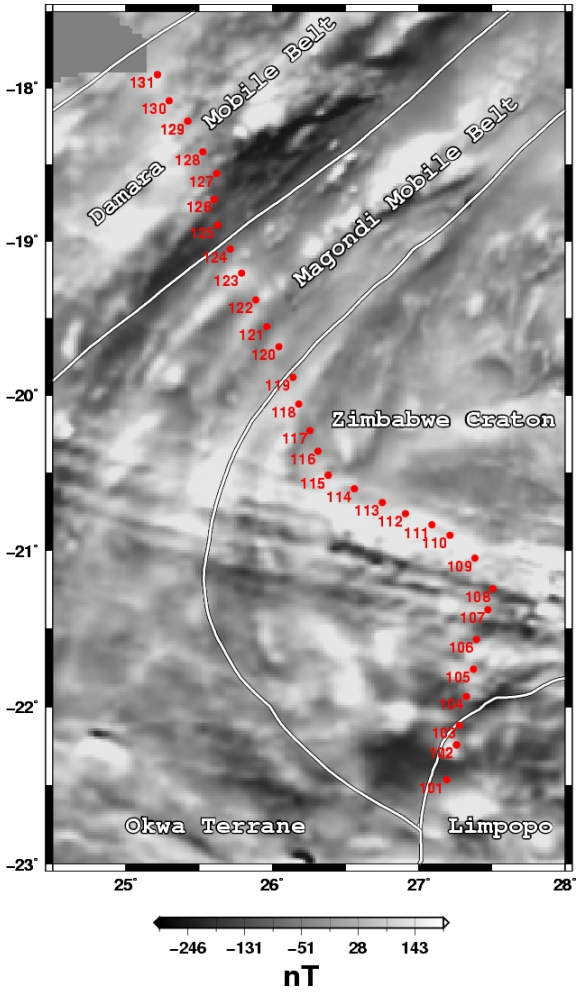

Figure 2. Map of site locations of the ZIM profile. In greyscale as background map the magnetic data image which is together with the gravity data the base of the geological outline done by Sue Webb and shown here as the white lines.

GEOELECTRIC STRIKE ANALYSIS

The geoelectric strike analysis for the ZIM line shows variation of strike angle along the profile but also with frequency (which is related to the penetration depth). This gives hints of changing geology laterally and also

in the vertical direction. Some of these strike angles and their changes can be correlated with geological features indicated on the magnetic map (background of Figure 1 and 2).
Having changing strike angles along the profile and with depth the profile has to be divided in smaller areas having the same strike angle for the further modelling, such as 2D inversion.
The most current strike angle maps and models will be shown.

CONCLUSION

The SAMTEX project provides additional knowledge about the lithospheric mantle in geophysically and geochemically well-known areas (predominantly South Africa) and new knowledge in Botswana and Namibia where a next to nothing is known. The primary result to date is the identification of thin and thick lithosphere transition from the mobile belt onto the craton, and that the diamondiferous kimberlites occur primarily at the transition. To improve the understanding of the Archean processes the final 3D model for southern Africa will be integrated with existing geochemistry, petrology, geology and other geophysics.

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http://www.dias.ie/~mh/samtex_html/participants.html

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