

Electrical conductivity of the Cape Fold Belt, South Africa.

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ABSTRACT

Within the framework of the German - South African geo-scientific research initiative *Inkaba yeAfrica* several geophysical field experiments were conducted along the Agulhas-Karoo Transect in South Africa. This 600km long transect crosses the Cape Fold Belt (CFB) with the Kango and Oudtshoorn Basins, the Namaqua-Natal Mobile Belt, the Karoo Basin and the transition into the Kaapvaal Craton. Magnetotelluric imaging reveals structural details of the CFB and its collision zone with the Namaqua Natal Mobile Belt (NNMB) at a scale of the entire crust.

The CFB is generally characterized by similarly high electrical conductivities as observed in the NNMB. Exceptionally high electrical conductivities are found in the Mesozoic/Cenozoic inliers, the Kango and Oudtshoorn Basins, whereas the Swartberg and the Outeniekwa Mountain ranges seem to have mid crustal resistive roots.

Key words: Magnetotellurics, Southern Cape Conductive Belt, Namaqua Natal Mobile Belt, crustal structure, Kango Basin

INTRODUCTION

Within the framework of the German - South African geo-scientific research initiative *Inkaba yeAfrica* several geophysical field experiments were conducted along the Agulhas-Karoo Transect in South Africa. This 600km long transect crosses the Cape Fold Belt (CFB) with the Kango and Oudtshoorn Basin, the Namaqua-Natal Mobile Belt, the Karoo Basin and the transition into the Kaapvaal Craton. The transect also crosses the Beattie Magnetic Anomaly (BMA) and the Southern Cape Conductive Belt (SCCB), two of Earth's largest continental geophysical anomalies, that extend across the southern African continent in east-west direction. Here we focus on the CFB which was initiated in the late Permian by a collision of allochthonous terranes. Thereby, the development of the CFB and the evolution of the Karoo basin as an intercontinental foreland basin were strongly coupled.

The deformation associated with the CFB dominates the geology in the area and compressional structures are evident as either thrust faults that crop out at the surface, or as folds associated with blind thrust faults (de Wit, 1992; Paton, 2002). During the break-up of Gondwana and the subsequent rifting of the South Atlantic, the Cape Fold Belt is thought to have undergone negative inversion, resulting in the development of a series of extensional Mesozoic basins and inliers (de Wit & Ransome, 1992, and references therein).

METHOD AND RESULTS

The MT data were collected in 2005 along a profile between Prince Albert and Mossel Bay, crossing the Swartberg and the Outeniekwa mountain ranges and the Kango and Oudtshoorn Basins (Fig. 1 and Fig. 2). Data analysis and inversion strategies which are applied to the data set MT2 are comparable to other MT data sets along the Agulhas-Karoo transect (MT1 and MT4) and are described in detail in Weckmann et al. (2007a, 2007b). We acquired 5-component MT data at 31 broadband stations in a period range from 0.001 s to 1000 s using GPS synchronized S.P.A.M. MkIII (Ritter et al., 1998) and CASTLE broadband instruments. Metronix MFS05/06 induction coil magnetometers and non-polarizable Ag/AgCl telluric electrodes were used to record natural magnetic and electric field variations. The data were processed according to Ritter et al. (1998) and Weckmann et al. (2005).

In order to evaluate if the MT data are compatible with a 2D interpretation, the dimensionality of the electromagnetic fields and the geo-electric strike direction were determined. Different tensor decomposition schemes confirmed a predominantly east-west strike direction and that a two-dimensional interpretation of the data is adequate to explain the most relevant features.

For two-dimensional (2D) joint inversion of the MT data and the vertical magnetic field we used the inversion algorithm after Rodi and Mackie (2001), starting from a homogeneous half space of 100 Ωm and

in a coordinate system which was rotated by -90° . The obtained electrical conductivity sections along the profile provide an image of the electrical conductivity distribution of the CFB on a crustal scale.

The most prominent feature within the 2D conductivity section is a triangular shaped zone of low resistivities ($< 2 \Omega\text{m}$), which spatially coincides with the Kango and Oudtshoorn basins. These conductive zones seem to extend further north beneath the Rooiberge. Farther to the south, data misfits are above average indicating poorly resolved structures. Alternating resistive and highly conductive zones in the upper crust could be caused by electrical anisotropy in this area.

The high resistivities associated with the Swartberg and the Outeniekwa mountains reach mid-crustal depths.

CONCLUSIONS

Our magnetotelluric results provide an image of the electrical conductivity distribution of the Cape Fold Belt on a crustal scale which can be correlated with structures known from regional geology and other geophysical deep sounding techniques.

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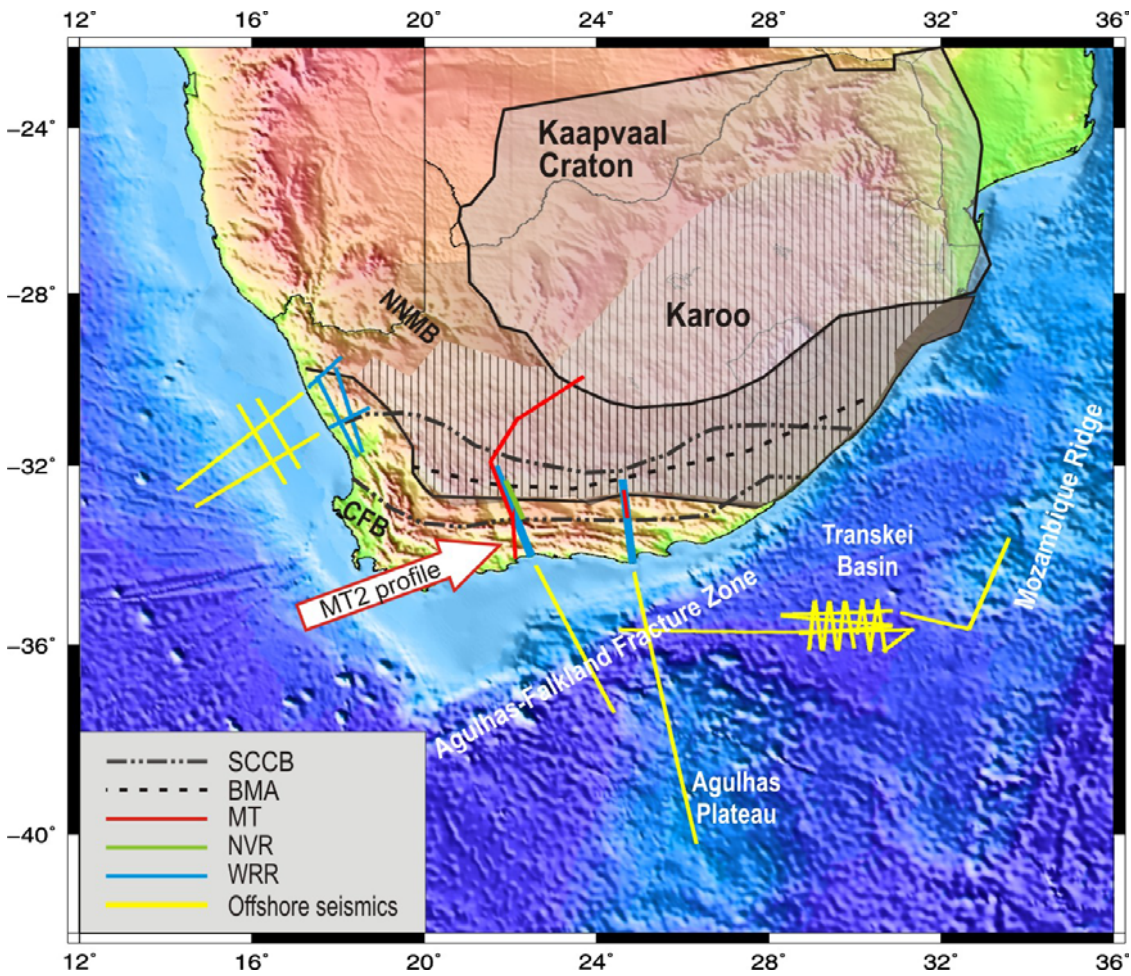


Figure 1: Simplified terrane map of southern Africa showing the Archean Kaapvaal Craton, the Mesoproterozoic Namaqua Natal Mobile Belt (NNMB) and the upper Paleozoic Cape Fold Belt (CFB). A large region is covered by Paleozoic-Mesozoic sediments and igneous rocks of the Karoo Basin (shaded). The axis of the Beattie Magnetic Anomaly (BMA) and the boundaries of the Southern Cape Conductive Belt (SCCB; Fig. 12 in de Beer et al. (1982)) are marked by a dashed line and a dot-dashed line, respectively.

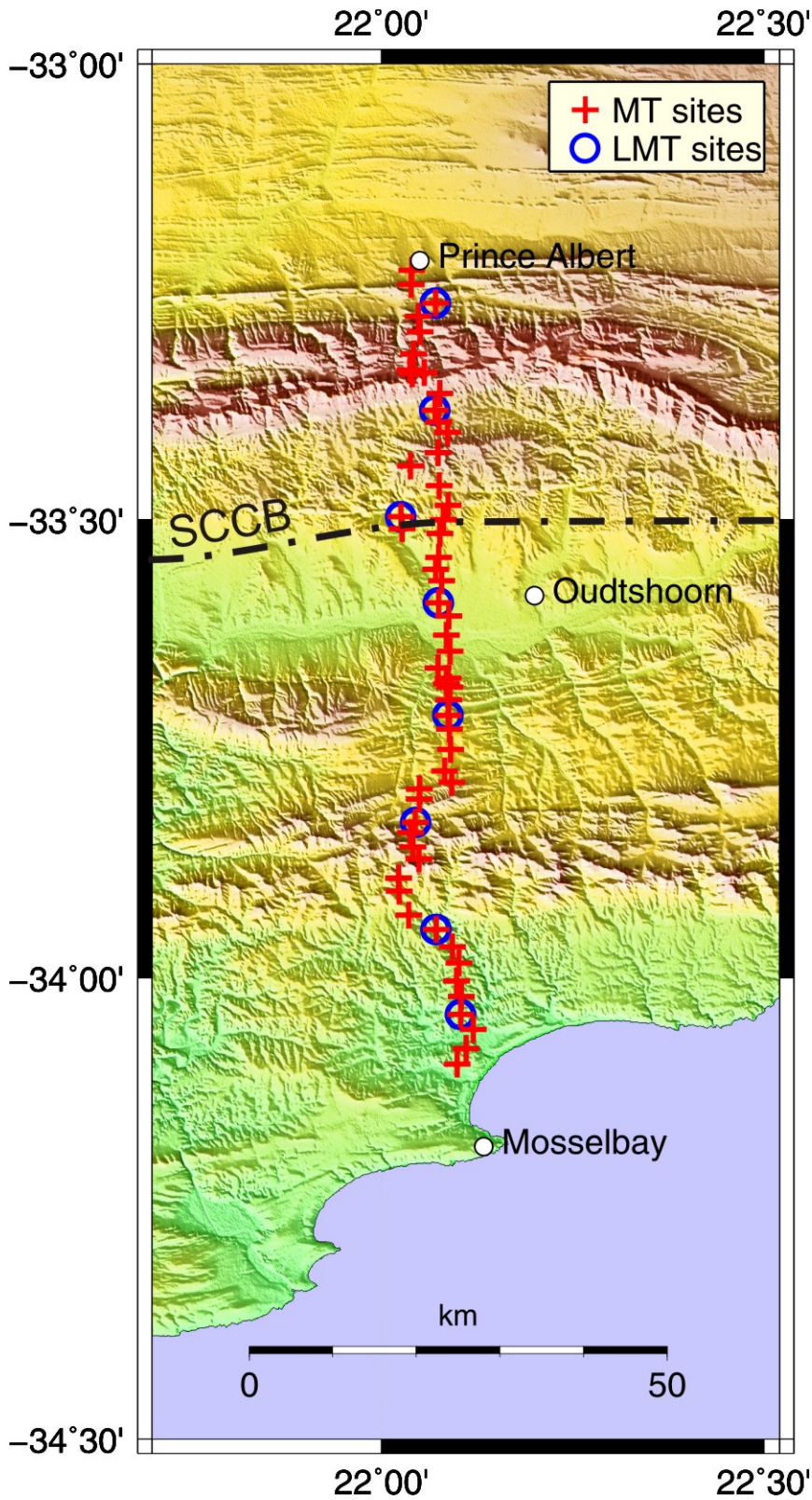


Figure 2: Location of 55 MT sites deployed along a 100 km long profile from Mossel Bay in the South to Prince Albert in the North. Blue circles mark LMT stations, which extend the frequency range to 0.05 mHz.