Prediction of DC current flow between the Otjiwarongo and Katima Mulilo regions, Namibia

Mr. P. Share

As an additional opportunistic component to the Southern African Magnetotelluric Experiment (SAMTEX), audio-magnetotelluric (AMT) data were acquired during the most recent phase of the experiment (Phase IV) to investigate the local-scale conductivity substructure in the Otjiwarongo and Katima Mulilo regions (Namibia), as to aid in the installation of high-voltage direct current (HVDC) earth electrodes that has since taken place. Both of the AMT surveys are situated close to the edge of the orogenic Neo-Proterozoic Damara Mobile Belt (DMB). Previous studies all point to the existence of a highly conductive mid-crustal zone which correlates well with the spatial location of the DMB. Two-dimensional (2D) inverse modelling of the Otjiwarongo AMT data confirms the existence of the high conductive zone at mid-crustal depths (10-15 km). The high conductivity of the DMB is explained by the presence of interconnected graphite in the marble units present. The Katima Mulilo inversion results are characterized by a conductive upper crustal layer that does not form part of the DMB conductive belt. It is deduced that at the uppermost subsurface Kalahari sediments are responsible for the high conductivity observed while at greater depth it is due to ironstone within the Ghanzi Group. In contrast to the conductive DMB, the lithospheric structure of the neighbouring Archaean cratons, the Congo and Kalahari, are generally found to be electrically resistive. Therefore, it is hypothesized that ground return current, if present, will flow along a path between the Otjiwarongo and Katima Mulilo regions that lies either exclusively, or almost entirely within the DMB. The hypothesis is tested by inputting a three dimensional (3D) conductivity model (calculated using available magnetotelluric (MT) data and geological information) of the region into a DC resistivity forward modelling code. Forward modelling shows that the return current is only confined to, and follows regional trends characteristic of, the conductive DMB for approximately 200-300 km away from the injection point, after which there is no preferential flow.