Prediction of DC return current flow in northern Namibia and Botwana

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SUMMARY

SAMTEX (Southern African Magnetotelluric Experiment) is a multinational project initiated in 2003 to study the regional-scale electrical conductivity substructure of southern Africa and to infer from it the tectonic processes involved in the formation and deformation of the southern African subcontinental lithosphere. As an additional opportunistic component to SAMTEX, audio-magnetotelluric (AMT) data were acquired during the most recent phase of the experiment (Phase IV) to investigate the local-scale conductivity structure of the upper and middle crust in the Otjiwarongo and Katima Mulilo regions (northern and north-eastern Namibia), where in future the installation of high-voltage direct current (HVDC) earth electrodes will commence. Both of the AMT surveys were sited close to the edge of the orogenic Neo-Proterozoic Ghanzi-Chobe/Damara belts (collectively termed the Damara Mobile Belt, DMB). Previous studies using magnetotellurics (MT), magnetometer arrays and geomagnetic observatory data 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) inversions of AMT and broad-band magnetotelluric (BBMT) data recorded during SAMTEX confirm the findings of previous conductivity studies. In addition the high resolution models also show the conductive belt to be discontinuous across strike, in turn leading to speculation regarding its continuity along strike. An accurate three-dimensional (3D) conductivity model of northern Namibia and Botswana is constructed from the existing 2D models from five N-S profiles. In achieving the best 3D model that is both consistent with our data and the understanding of conductivity variations within the Earth, different interpolation scenarios are tested. The 3D model is then used as input to a 3D DC forward modeling code to try to predict the ground return path that DC current will follow between the Otjiwarongo and Katima Mulilo regions.

Keywords: SAMTEX, audio-magnetotelluric, Damara Mobile Belt, 3D DC forward modeling