MT image of an orogenic copper-gold deposit at the edge of Kongo craton, Namibia

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SUMMARY

Orogenic copper gold deposits have been widely found to be associated with lithospheric electrical conductors. Recent work has suggested that precipitation of graphite during mantle-sourced fluid ascent represents the genetic link between lower crustal conductors and surface mineralizations. This renders the magnetotelluric (MT) method a valuable tool to characterize orogenic copper-gold mineral systems.

Here, we present the results of a 50 km MT profile across the edge of the Kongo craton near Khorixas, Namibia. The area is currently being explored for gold and auxiliary minerals using geological mapping and rock sample analysis and has shown to host significant concentrations of gold up to 2-50 g/t. However, questions remained to as the type of mineral system responsible for enhanced gold concentrations. MT was used in this context to test for the existence of lower crustal conductivity anomalies and crustal pathways.

We recorded broad-band MT data using 4 permanent five-component MT stations distributed along the profile and mobile telluric-only receivers with a site spacing of 3 km. The profile was complemented with a dense grid of audio-MT recordings targeted at near-surface features of the exposed mineralization zone. The data were processed into high-quality inter-station transfer functions between local electric fields and the magnetic field components recorded at the base sites. For the inversion of transfer functions into a 3D model of electrical conductivity distribution, we used the FEMALY code, a recently presented finite element 3D EM modelling and inversion toolbox entirely written in Matlab. The code was adjusted to handle the type of inter-station transfer functions obtained in this survey. Overall, we achieved an excellent data fit of the four impedance elements.

The final model displays a pronounced conductivity anomaly with conductivities in excess of 1 S/m at mid-to-lower crustal levels, reaching to depths of about 10 km below the mineralization zone. Individual pathways connecting the deep conductivity anomaly with the surface mineralization cannot be imaged, but the audio-MT grid data reveal localized, moderate near-surface conductors, possibly associated with alteration zones. The model is thus overall consistent with MT images of orogenic copper-gold deposits elsewhere, suggesting that the gold occurrences encountered in the study area belong to this type of mineral system.

In our contribution, we present the data and the model, and we compare the results achieved with the FEMALY code with independent inversion results using ModEM.

Keywords: Mineral systems, 3D inversion, inter-station transfer functions