New insights into the DeepEarthShape project (Chile) by comparison of 2D and 3D inversion results of RMT data using different inversion codes

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SUMMARY

As part of the DeepEarthShape project, electromagnetic and seismic methods were conducted in 2020 at specific study areas along the north-south trending Coastal Cordillera of Chile to investigate the controlling physical, biological and chemical processes of weathering. The long-stretched Chilean subduction system provides an ideal natural laboratory since the geological formations are quite similar while the climate and weathering changes with latitude. Within this project, at three out of four locations (La Campana, Nahuelbuta, Santa Gracia and Pan d' Azucar) the high-frequency variant Radio-Magnetotellurics (RMT) was used together with a horizontal magnetic dipole transmitter. Using a controlled source method was necessary, as radio and VLF installations along the coast have all the same incidence direction.

The main focus of the RMT data evaluation is laid on imaging the depth of the weathering zone and the presence of fluids in faults and fluid pathways.

For this purpose, a variety of 2D and 3D inversion codes based on finite differences (ModEM, WingLink) and finite elements (Mare2DEM, GoFEM, FEMTIC) are applied. The resulting inversion models are subsequently compared to illustrate the different behaviour and challenges in the inversion of RMT data and to study the resolution power towards more conductive near-surface structures and faults within a high resistive regime. In this context, special attention is paid to the four main aspects of (1) defining an appropriate starting model, especially in the first tens of meters, (2) resolving structural properties that are known from nearby boreholes (geophysical logging and core samples) in 2D and 3D inversions, (3) inverting RMT data in combination with MT data from an additional station and (4) evaluating the efficiency of the different inversion codes in dealing with the high-frequency RMT data.

The RMT inversion results allow to better assess the horizontal variability next to the boreholes and to support the overall interpretation of the borehole results and the validity of the geomorphological models.

Keywords: 2D & 3D Inversion, Adaptive Finite-Element Method, Controlled-Source Radio-Magnetotellurics, Inversion Code Efficiency Test, Weathering Zone