Multidimensional inversion of sedimentary sequences in the Atacama Desert, Chile, using transient electromagnetic data

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Abstract
The Atacama Desert along the Chilean Coastal Cordillera is a unique landscape to understand the Earth's evolution in hyper-arid and arid environments. The Paranal clay pan has studied by the CRC 1211 project to recover a continuous climate record for paleoclimate research. The goal is to provide the sedimentary architecture and bedrock topography of the Paranal site by interpreting multidimensional inversion of loop source transient electromagnetic (TEM) data. A total of 133 TEM soundings were carried out using a central loop configuration, with a transmitter loop size of 40×40 m^2 and a receiver of about 10×10 m^2. The TEM data was processed and analyzed, exhibiting high-quality data, with an average of noise level of about $\eta_{noi} = 3 \cdot 10^{-10} V/Am^2$. The 1D Occam inversion results exhibits a clear three-layered resistivity-depth structure with a second conductive layer of roughly 20 Ωm. The clay pan's resistivity distribution is well-resolved with a global misfit of around 1.1. However, the study site showed 2D effects that were stronlgy visible at the edges of the clay pan, leading to misinterpretations of the TEM data. This was confirmed based on 2D forward modelling. In this manner, to better deal with the observed 2D distortions in the TEM data and to derive a more accurate geometry of the clay pan, the recently developed Julia Package (3DTEMinv) for time-domain 3D inversion and modeling data was performed. The resulting 3D inversion presents a high convergence rate, and acceptable solutions are obtained after ten iterations with a good misfit of about 1.6. The 3D model exhibits a well-resolved geometry of the clay pan, with a high resolution of the derived conductive body. The drill core results confirm the 1D and 3D TEM models at the center of the clay pan, which is in good agreement with the resulting lithology with a maximum thickness of about 171 m depth and a weathered granodioritic bedrock below. These results agree with the local and regional geological context, improving the understanding of sediment deposition and transportation in this hilly and arid environment.

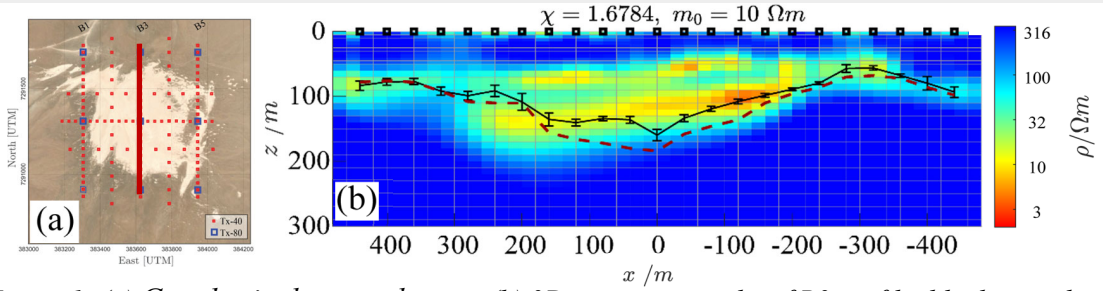

Figure 1: (a) Geophysical survey layout. (b) 3D inversion results of B3 profile, black error bars are the conductive bottom depths based on 1D models. Black squares denote the sources and receivers. Red dashed line indicate the conductive basement derived by the 2D forward modeling.

Reference / more information
Liu, Y., Yogeshwar, P., Peng, R., Hu, X., Han, B., & Blanco-Arrué, B. (2024). Three-Dimensional Inversion of Time-Domain Electromagnetic Data Using Various Loop Source Configurations. IEEE Transactions on Geoscience and Remote Sensing.