**Multidimensional inversion of transient electromagnetic data for the exploration of clay pans in the Atacama Desert, Chile**

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## Abstract

The Atacama Desert along the Chilean Coastal Cordillera is a unique landscape to understand the evolution of the Earth in hyper-arid and arid environments. Clay pans are crucial to understand the surface and subsurface processes in areas limited by water availability. This work aims to provide the sedimentary architecture and bedrock topography of selected clay pans through multidimensional inversion and interpretation of loop source transient EM data. The investigated sites are study areas of the *CRC 1211- Earth evolution at the dry limit*, established at the University of Cologne, Bonn and Aachen. In this context, our work contributes to a better comprehension of the investigated sites.

A total of 116 soundings were carried out on a 3D grid in the Paranal clay pan during December 2019. The TEM data were processed, analyzed, and inverted to investigate the resistivity distribution of the site. The resulting models show a maximum thickness of about 160 ± 10 m, interpreted as layers of colluvial and fluvial sediments. The major stratigraphy and the basement depth were confirmed with a drill core carried out in February this year. The shape of the conductive sediments suggests the presence of a former channel that might be part of the main drainage network in the surrounding study zone. However, multidimensional effects can lead to misinterpretations of TEM data if the subsurface is not 1D. In those cases, the quasi-2D resistivity distribution might be influenced. Therefore, a 2D inversion of the TEM data using the recently developed TEM3DInv code is performed to derive a more accurate geometry of the clay pan.

The TEM3DInv code is suitable for the time domain and is based on 3D Finite-Volume. The algorithm uses a Gauss-Newton inversion scheme coupled with a preconditioned conjugate gradient method to avoid explicit Jacobian calculation in each iteration. The performance and accuracy were tested using synthetic models that are representative of the PAR clay pan. Since the code is implemented for 3D, a very large smoothing in the y-direction is used to force a 2D subsurface reconstruction. Typically, the inversion converges in around six iterations, and the data is fitted well with a RMS of about 2. The derived 2D models are consistent and resolve the basement of around ~160 m depth. Thus, the 2D inversion provides an independent and improved solution compared to the 1D models. Finally, a 3D inversion of the whole 3D grid TEM shall be derived, although the computational resources are significant.

**Keywords:** Transient electromagnetic method, clay pans, sedimentary deposits, electrical conductivity.