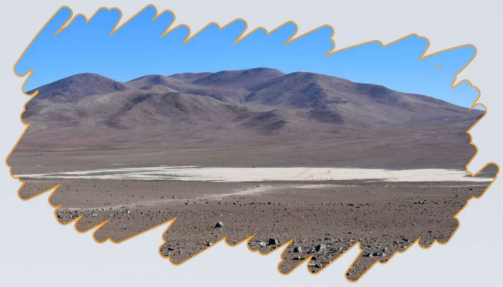
University of Cologne

Earth – Evolution at the dry limit

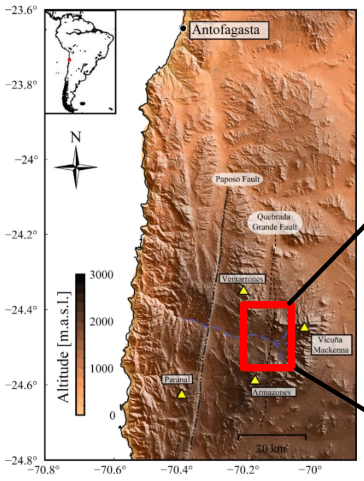
Integrated geophysical investigation of sedimentary deposits for paleoclimate research in the Atacama Desert, Chile



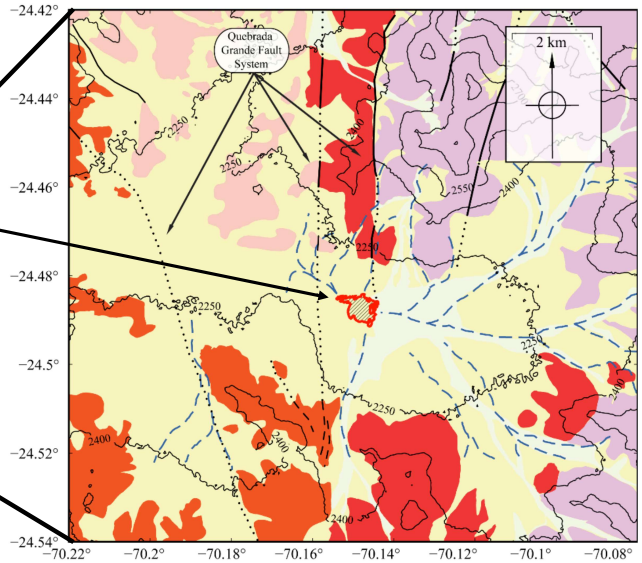
B. Blanco-Arrué, P. Yogeshwar, V. Wennrich, B. Tezkan, D. Diaz, W. Mörbe, B. Farah, J. Pawel, S. Buske, L. Ninnemann

EMTF – 28th of September

Introduction to the Paranal clay pan



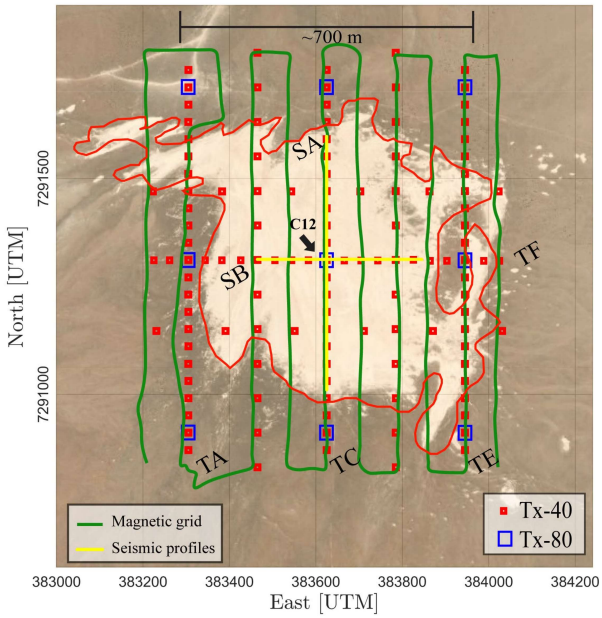
Topographic image from NASA, 2020

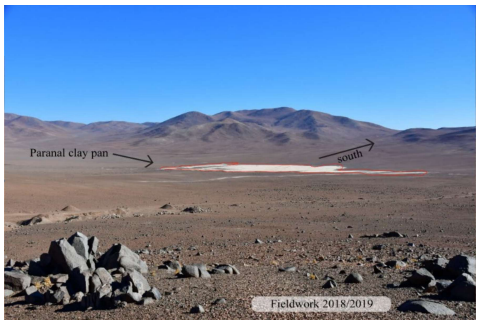


Modified from Geological Map, Sernageomin (Domagala, J. et al. 2016).

- Provide detailed information about the **sedimentary architecture and bedrock topography** of selected clay pans.
- Derive **suitable drilling locations** for paleoclimatic research.

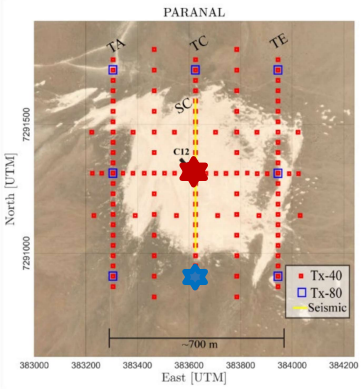
Field survey design

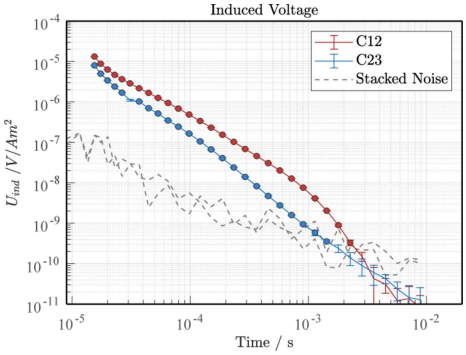




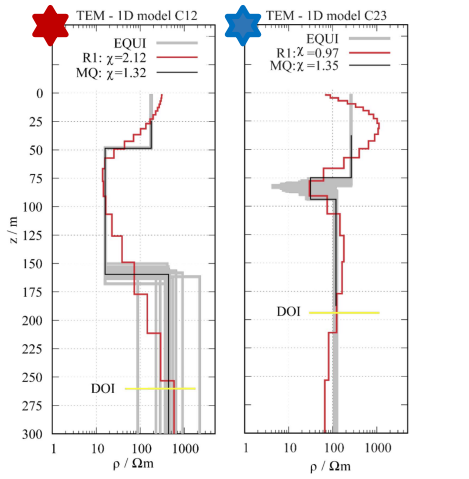
- In total 116 TEM soundings (Nov. 18'and Dec. 19)
- Two different Transmitter sizes: 40x40 m and 80x80 m.
- Central loop configuration. $\Delta d_{Tx} = 0,40\ m$
- Two seismic profiles
- Magnetics

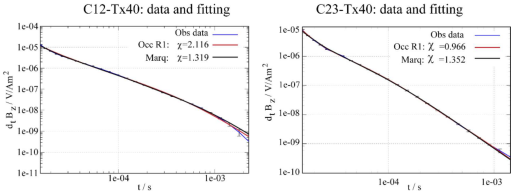
TEM data: Induced voltages and 1D models



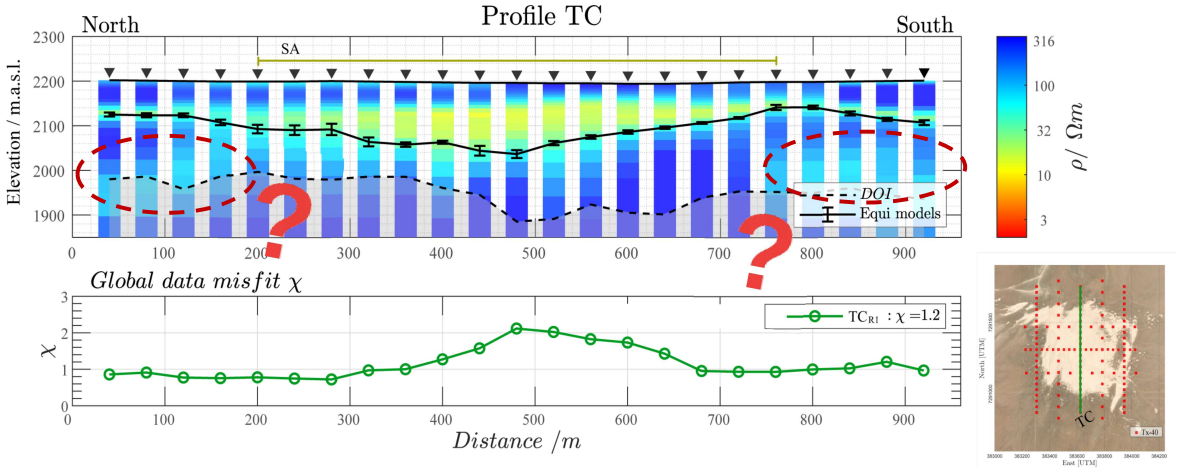


1D inversion of TEM data:
Marquardt – Levenberg (Levenberg, 1944; Meju, 1994)
Occam R1 and R2 (Constable, 1987)





TEM 1D models: Profile TC

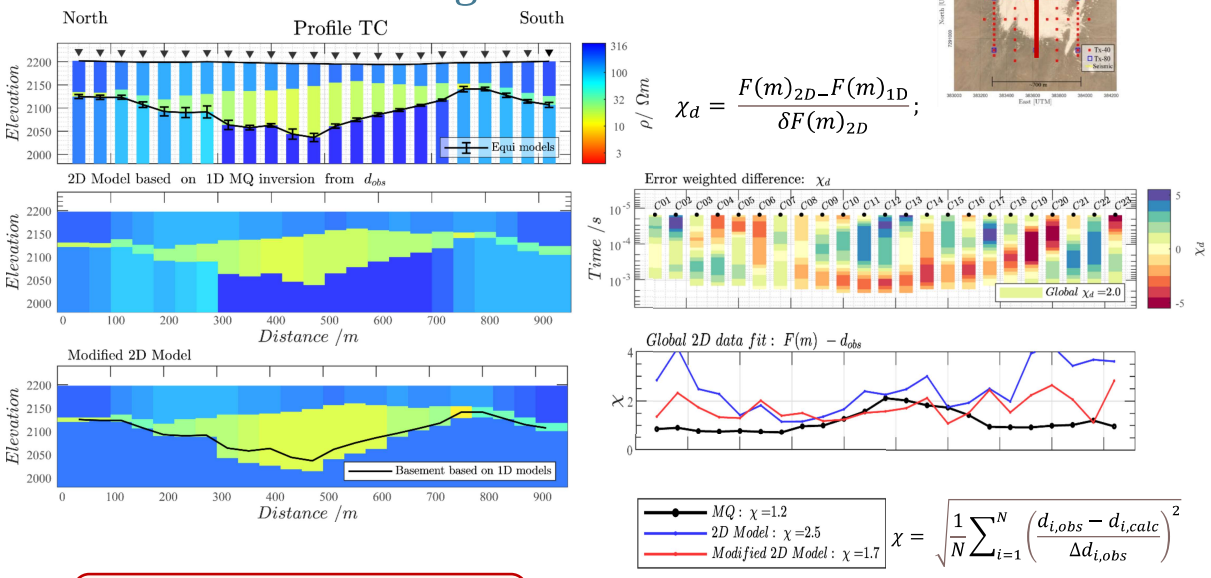


2D forward modeling study is required!

2D forward modeling study
Validate possible 2D effects using Finite Difference (FD) algorithm SLDMem3t (Druskin & Knizhnermann, 1988, 1994, 1999).

$$DOI\colon \delta_{meju} = \frac{\sqrt{2t\bar{\rho}/\mu_0}}{2.3} \qquad \chi = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(\frac{d_{i,obs} - d_{i,calc}}{\Delta d_{i,obs}}\right)^2}$$

2D forward modeling: Profile TC

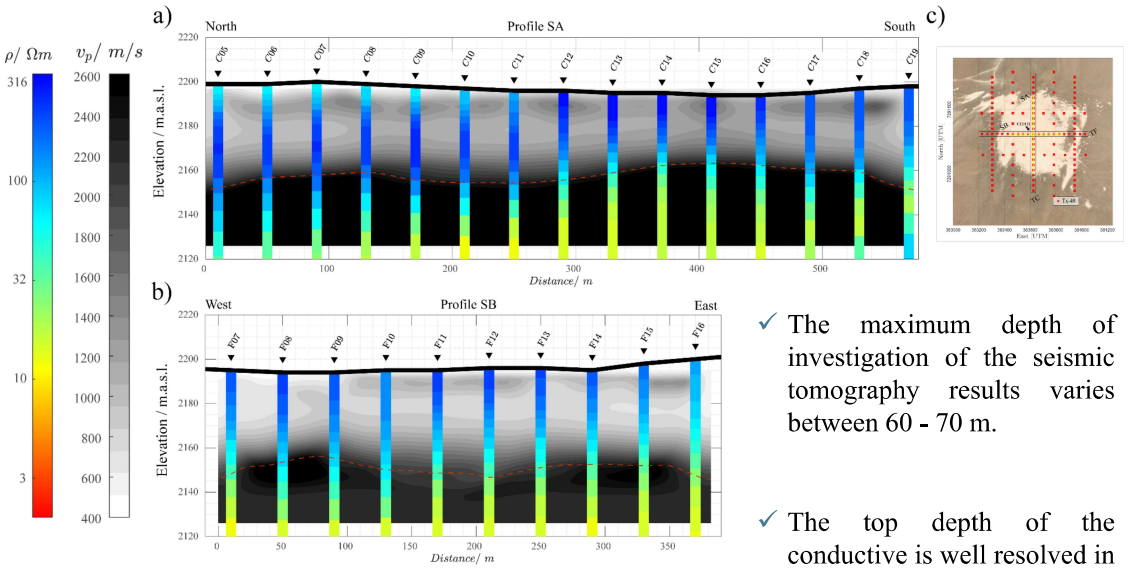


$$\chi_d = \frac{F(m)_{2D} - F(m)_{1D}}{\delta F(m)_{2D}};$$

$$\chi = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(\frac{d_{i,obs} - d_{i,calc}}{\Delta d_{i,obs}}\right)^2}$$

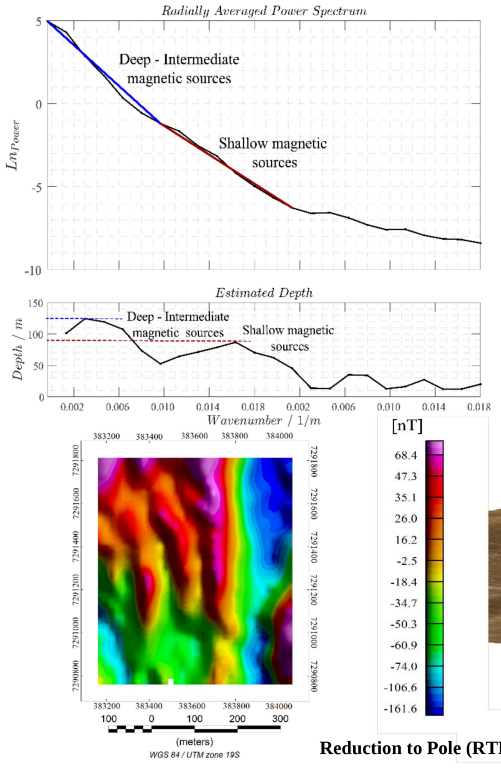
2D forward modeling reveals a thicker conductive layer → 2D/3D inversion is required

Integrated geophysical study: TEM 1D models + seismics

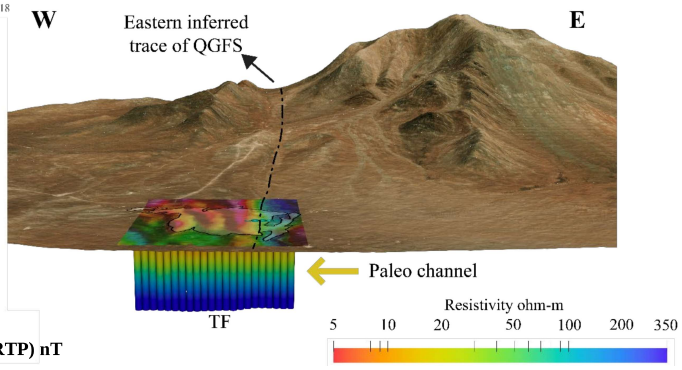


- ✓ The maximum depth of investigation of the seismic tomography results varies between 60 - 70 m.
- ✓ The top depth of the conductive is well resolved in both methods.
- ✓ High p-wave velocities correlate with high electrical conductivity layers and are interpreted as lacustrine sediments.

Integrated geophysical study: TEM 1D models and magnetics

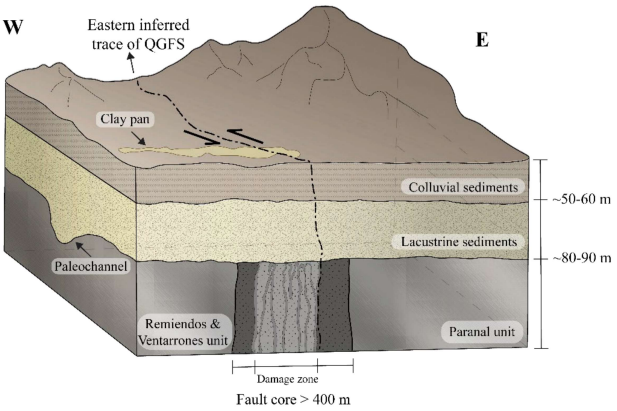


- ✓ The estimate depths by magnetics are in good agreement with the layers derived by the TEM 1D models.
- ✓ The RTP filter response is consistent with the transition of the Eastern inferred trace of the QGFS, and the different intrusive in the surrounding of the clay pan.



Summary & outlook

- Lake sediments and basement clearly detected. A maximum sedimentary thickness 160 ± 10 m.
- 2D effects are identified in the Paranal clay pans and reveals a deeper basement.
- First resistivity contrast is consistent with the tomography results (colluvial and lacustrine sediments).
- The estimated depths of magnetic sources are consistent with the derived TEM 1D models.



Outlook: 2D/3D inversion of the TEM data (EM3DANI algorithm code, Liu et al., 2020).

Institute of Geophysics and Meteorology | EMTF | Blanco, B. et al. | September 2021

Universität zu Köln

University of Cologne

Earth – Evolution at the dry limit A2 D7

Thanks for your attention!






IGM Geophysics Cologne · fcfm Facultad de Ciencias Físicas y Matemáticas Universidad de Chile · TU Bergakademie Freiberg · DAAD · Agencia Nacional de Investigación y Desarrollo, Gobierno de Chile