

TELLUS-EXPLORA S.A.S.
CAPABILITY STATEMENT



(March 2024)

SUMMARY

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1) COMPANY PROFILE

Tellus-Explora s.a.s. is an independent geophysical private company, established in 2009 in Genova (Italy). Its personnel include experienced geophysicists with a broad background, acquired through professional and research works accomplished worldwide.

The mission of the company is the provision of high-quality consultancies and services, among which on-site and office geophysical training. The services are delivered in the most flexible way, in order to suit the Client's needs at best.

A constant professional update guarantees the application of state-of-art methods. The company is also devoted to carry out applied geophysical research, as witnessed by many publications disclosed by international scientific conferences and papers.

Since 2010 Tellus-Explora's work has been fundamental to characterise complex geological settings. From then, the company has increasingly reached international visibility, carrying out studies over Asian/Pacific and African prospects.

Tellus-Explora's key staff is composed by licensed geologists with a cumulative experience of fifty years in the field of Applied Geophysics. Their expertise has been matured both in the professional and academic and research worlds, and includes:

- geothermal field exploration and well targeting;
- regional geophysical surveys and geological interpretation;
- geophysical modelling and inversion;
- geophysical code development.

2) GEOPHYSICAL SERVICES

Tellus-Explora's activity can virtually cover all the various phases of a geophysical survey. For the geophysical surveys to be accomplished out of the EU, the collaboration of local geophysical crews can be pursued for an optimal efficiency. Our capabilities are:

- Survey planning
- Survey execution
- Third-party QA/QC (also remote)
- Geophysical modelling and interpretation
- Advise for geothermal well siting
- Data processing/reviewing
- On-site and office training

3) TECHNICAL EXPERTISE

Tellus-Explora's personnel gained experience with many geophysical methods. Its knowledge includes both the good practice standards and the theoretical foundations, allowing to optimize both the data acquisition and the subsequent modelling and interpretation. The range spans many geophysical techniques covering both shallow and deep targets:

- EM methods
 - ✓ MT (Magnetotellurics)
 - ✓ TDEM (Time-Domain Electromagnetics)
 - ✓ FEM (Frequency-Domain Electromagnetics)
 - ✓ GPR (Ground Probing Radar)
- Potential methods
 - ✓ Gravity
 - ✓ Magnetometry
- DC methods
 - ✓ VES (Vertical Electric Soundings)
 - ✓ 2D/3D ERT (Electrical Resistivity Tomography)
 - ✓ Induced Polarization – IP
- Seismics
 - ✓ Refraction tomography
 - ✓ MASW (Multichannel analysis of Surface Waves)
 - ✓ ReMi (Refraction Microtremor)

4) AREAS OF APPLICATION

Our activity has been so far involved to tackle many present-day challenges, including renewable energies and environmental threats. The geophysical methods we routinely apply are however suitable for the geological characterisation needed in a broad range of applications, including hydrocarbon and mineral researches.

4.a) Geothermal exploration

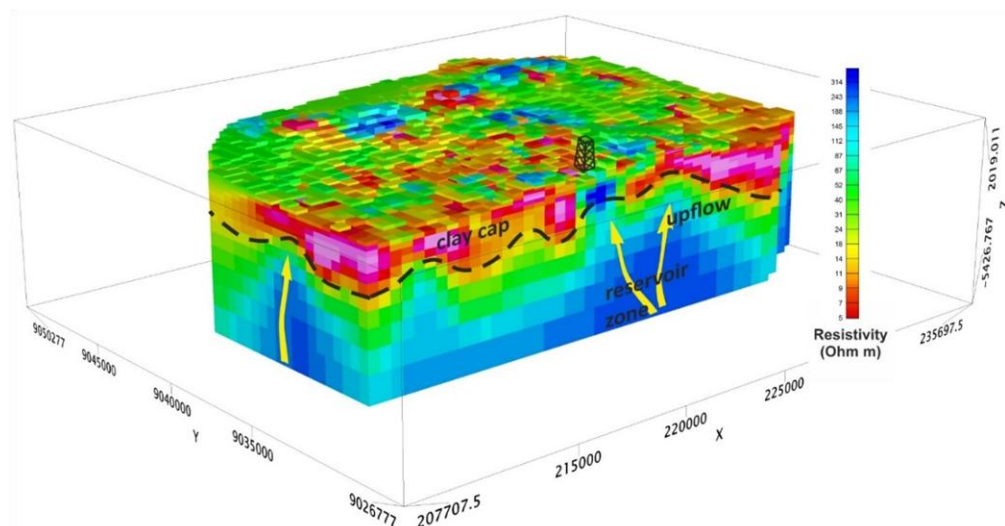
The proper assessment of geothermal fields relies upon a good understanding of their complex geology. Geophysics can effectively tackle this challenging task, allowing for a remarkable reduction of drilling risk and a suitable exploitation planning. In this field, the services include:

- Identification of the geothermal field features (clay cap, upflow/outflow zones, reservoir) by MT/TDEM 1D/2D/3D resistivity modelling
- Location of permeable faults/ lineaments by gravity 2D/3D density modelling
- Underground temperature assessment through iso-resistive surface analysis
- Alteration assessment by resistivity/geochemical modelling (computation of the CEC – Cation Exchange Capacity)
- Identification of hydrothermally de-magnetised zones by magnetometry
- Geological interpretation and advising for well siting

Case studies

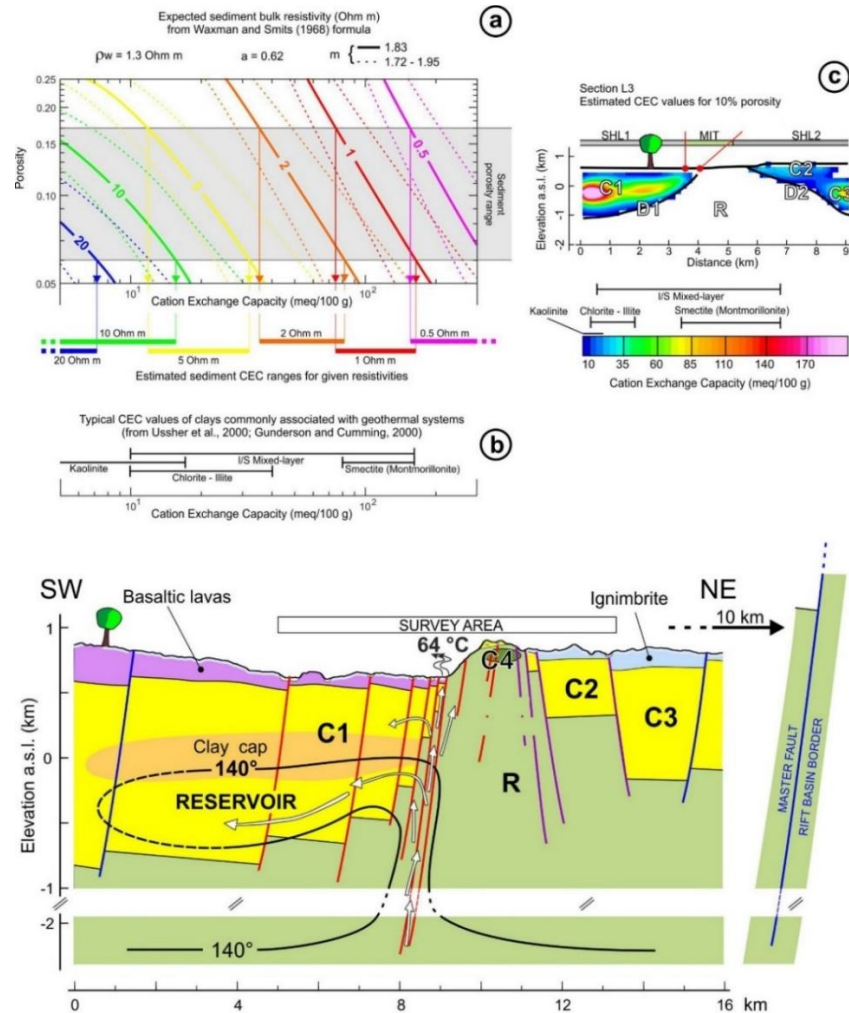
Three-dimensional resistivity imaging of a geothermal field (Indonesia).

- 80 broadband MT stations
- 259,200 FD model cells, Z + Tz joint inversion
- Resistivity structure for well siting



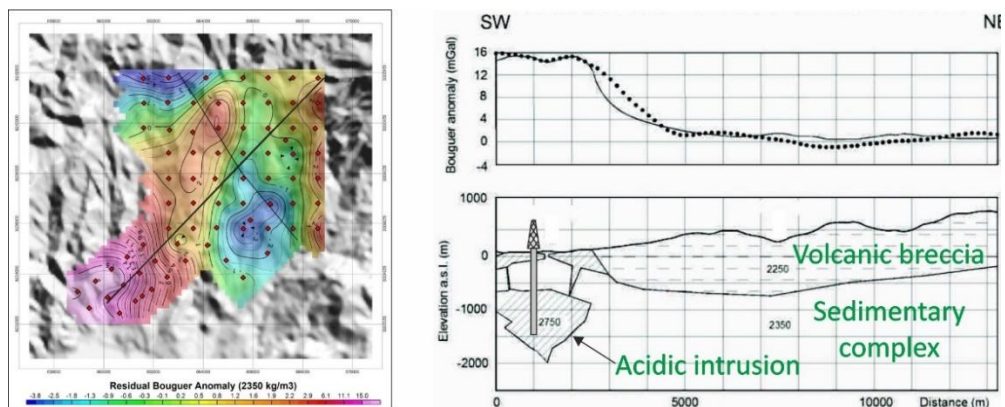
Definition of a geothermal conceptual model (Tanzania).

- 2D gravity modelling/MT 3D modelling
- Geochemical data integration (reservoir estimated temperature and water chemistry)
- Clay cap identification by CEC estimation by Waxman-Smits equation



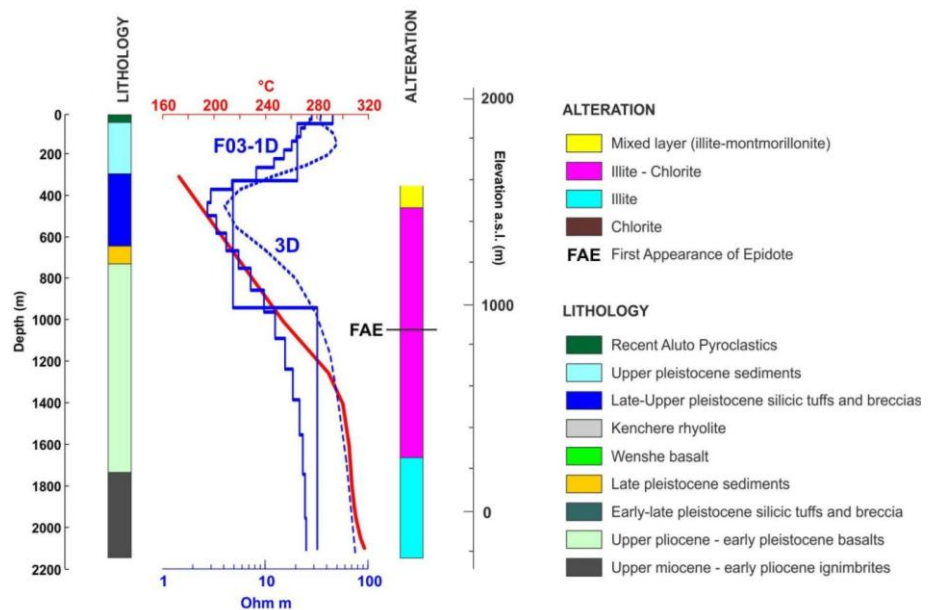
Geological interpretation of a 2D density model of a volcanic area (Indonesia).

- 71 gravity stations
- 2D prism gravity modelling
- Geophysical interpretation constraint by one deep borehole and rock samples



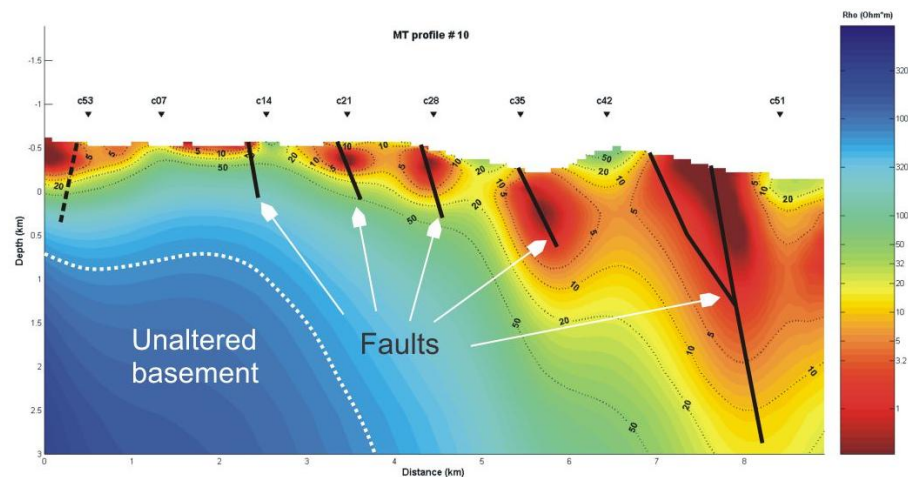
Correlation between MT modelling and well logs (Ethiopia).

- 1D smooth/blocky and 3D MT resistivity modelling
- Lithology, temperature and alteration logs
- Assessment of resistivity and hydrothermal alteration dependence



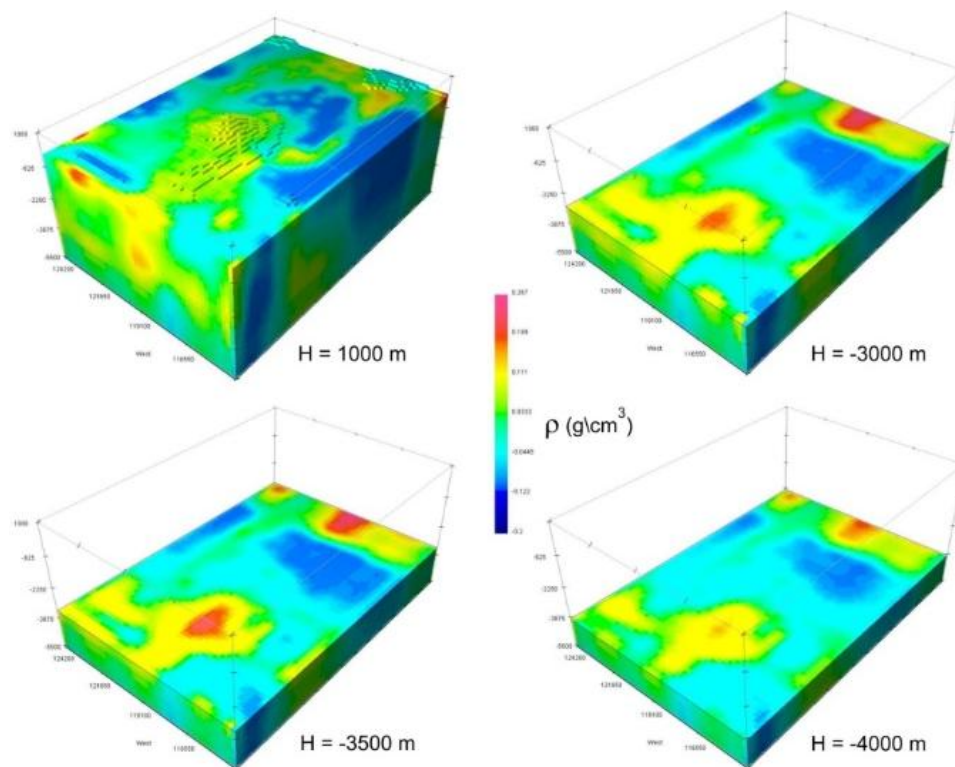
Structural interpretation of 2D resistivity model from MT data (Indonesia).

- 8 broadband MT stations
- 2478 FE cells, TE+TM joint inversion
- Fault-driven brine/alteration resistivity signature



3D density modelling of a volcanic system (Indonesia).

- 80 gravity stations
- 305000 cells
- Deep-rooted dense intrusion



4.b) Engineering Geophysics

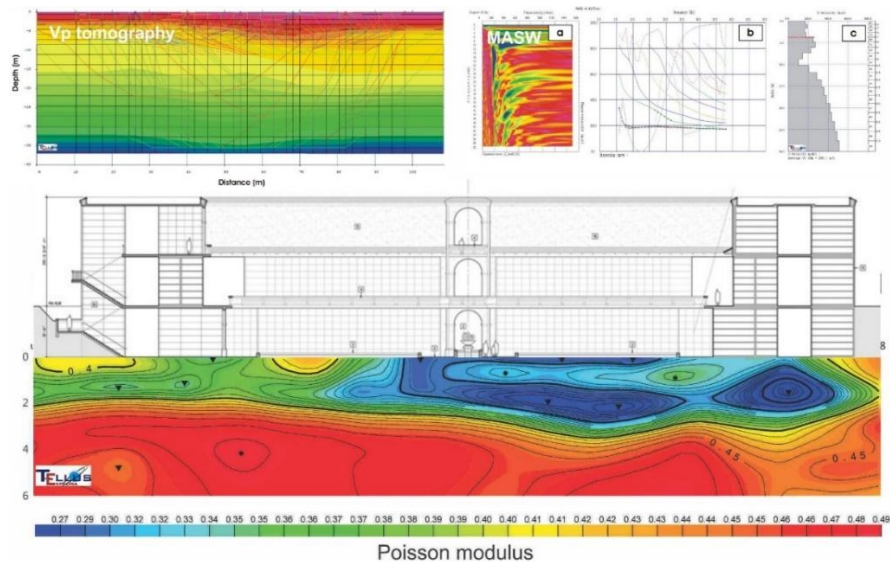
Building design requires the accurate characterisation of the subsoil, including the identification of pre-existing structures and the evaluation of the seismic site effects. Landslides are very common natural hazards on Earth, and their mitigation relies upon their correct characterisation (slip surface, geometry, groundwater level). In this field, our services include:

- Reconstruction of subsoil geometry and mechanical properties by:
 - I. Refraction/surface wave seismics
 - II. Geoelectrical methods
 - III. GPR (Ground Probing Radar)
- Seismic site classification by
 - I. MASW (Multichannel Analysis of Surface Waves)
 - II. ReMi (Refraction Microtremor)
- Location of buried structures and underground utilities by:
 - i. GPR

Case studies

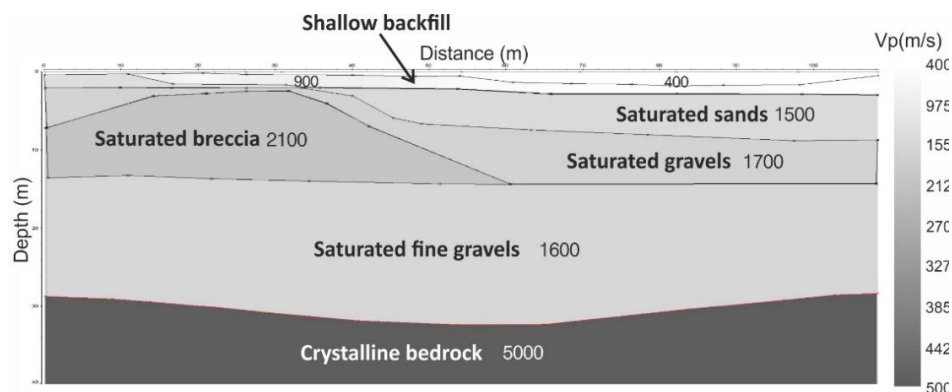
Assessment of subsoil stiffness by seismic investigations (Italy).

- One 24-channels refraction seismic line, 3.5 m spacing; refraction tomography + wavefront inversion
- Five 28-channel MASW lines, 1.75m spacing; non-linear LSQ inversion of Rayleigh waves
- Poisson's modulus computation from V_p/V_s ratio



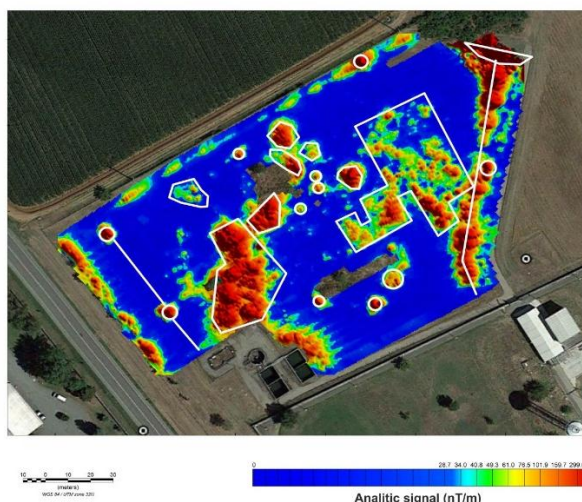
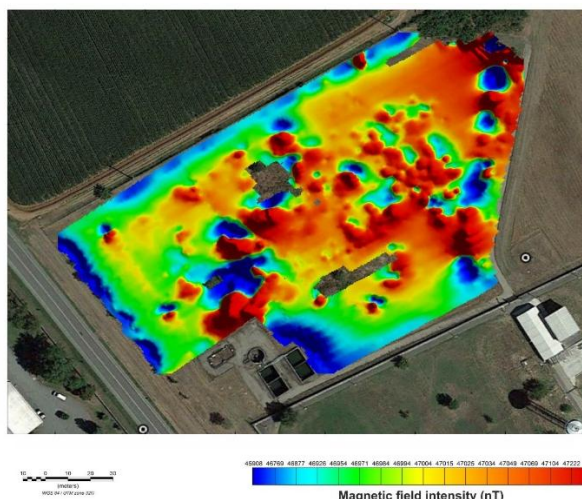
Stratigraphy reconstruction by refraction seismics

- 24-channels refraction seismics, 3.5 m spacing
- wavefront inversion for initial model
- Stratigraphy by forward modelling constraint by three boreholes



Location of buried metallic structure by magnetometry (Italy).

- 9148 gradiometric MAG measurements; 1m spacing, 0.1 nT accuracy
- GNSS MAG point positioning
- Analytic signal for structure identification



4.c) Environmental and water Geophysics

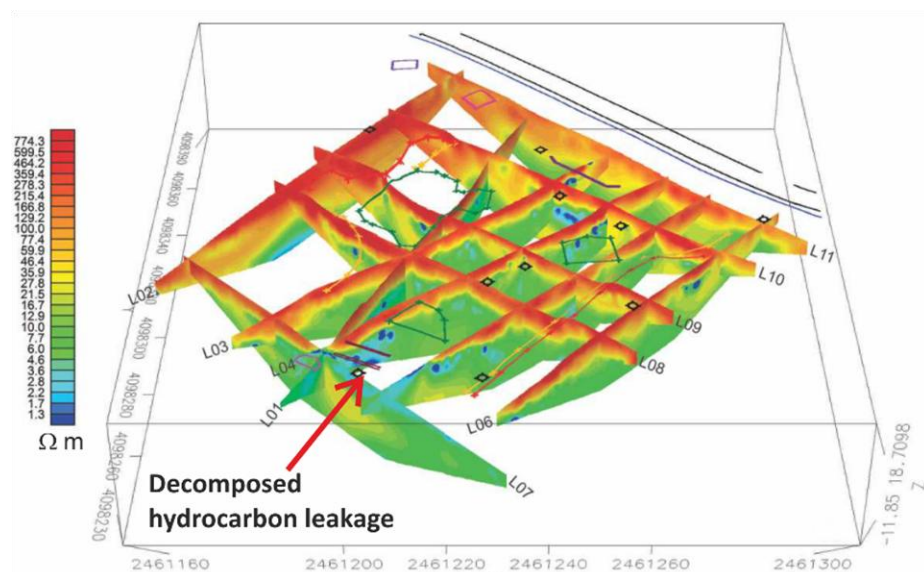
The characterisation of major environmental hazards such as waste disposal sites and brownfields is fundamental for the implementation of remediation projects. Geophysics can provide accurate information about the waste and contaminant nature, location and extension. Geophysical methods can be as well applied to water researches and evaluation of salty water intrusion in coastal environments. In this field, our services include:

- Waste volume assessment
 - i. Refraction seismics/MASW
 - ii. ERT measurements
- LNAPL/DNAPL plume delineation
 - i. ERT measurements
- Groundwater researches
 - i. Refraction seismics/MASW
 - ii. ERT measurements
- Assessment of coastal salty wedge intrusion
 - i. Refraction seismics/MASW
 - ii. ERT measurements

Case studies

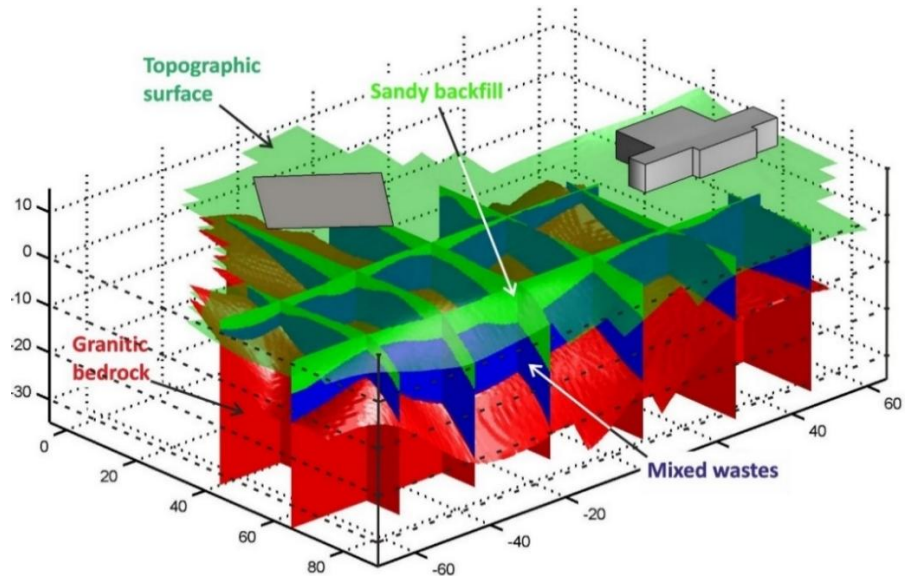
Identification of a hydrocarbon contamination plume by ERT (Italy).

- Eleven 48-channel ERT lines, 2/2.5 m spacing;
- Wenner-Schlumberger arrays, RHO/IP measurements
- GNSS topographic survey
- Low-resistivity signature of decomposed hydrocarbons



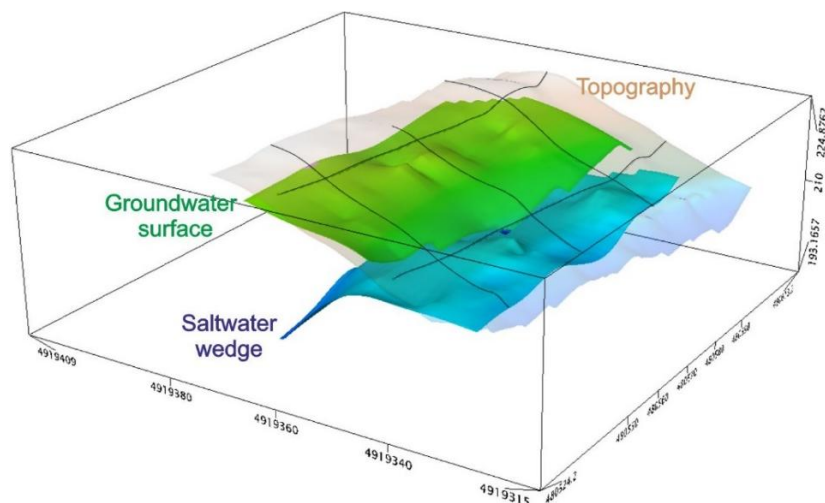
Landfill investigations (Italy).

- Six 48-channel ERT lines, 2/3 m spacing, profiling Wenner-Schlumberger array, RHO/IP measurements.
- Two 24-channel refraction seismic lines, 2.5 m spacing
- GNSS topographic survey
- Waste volume estimation



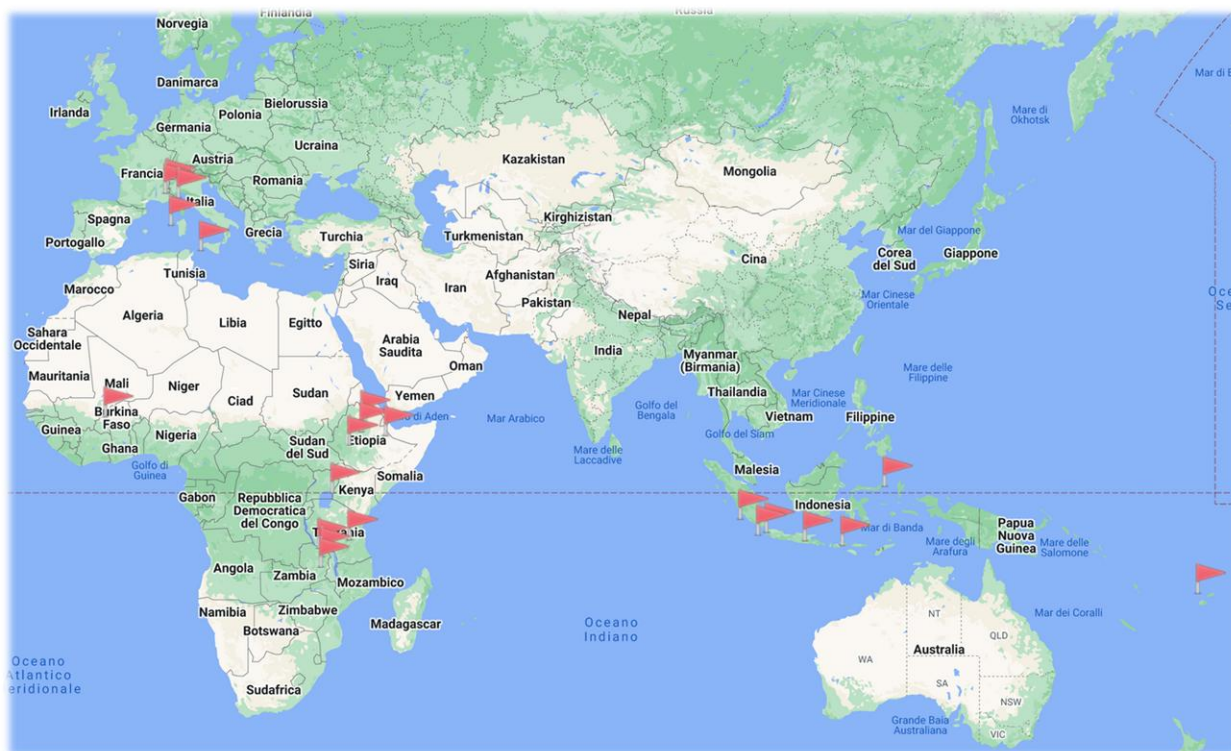
3D resistivity model of saltwater wedge intrusion (Italy).

- Five 48/72 - channel ERT lines, 0.5/1 m spacing; Wenner-Schlumberger array, RHO/IP measurements
- GNSS topographic survey
- Salt wedge delineation for coastal groundwater management



5) MAIN PROJECTS

Through the years, TE's personnel have been involved in many projects across the world. The following list spans a period of about 17 years, and it has to be understood as a cumulative list of professional assignments.



2023/2024 OSI Forward Modelling Capacity for Non-Seismic Geophysical Techniques.

November 2023 – August 2024. Customer: UN – CTBTO (Wien).

- Development of 3D forward modelling software for GRAV, MAG, FDEM, TDEM and ERT simulations.
- Simulations of forward response for a series of given 3D models related to UNE studies.

2023 S. Lucia (The Caribbeans): Exploration Management Consultant for the Management of an Exploration Drilling Program – EMC.

September-October. Customer: ELC-Electroconsult S.p.a. (Italy).

- Reprocessing of 120 MT (Magnetotellurics) station data
- MT 1D inverse modelling
- Rendering of resistivity maps and profiles
- Interpretation of the results in terms of geothermal resources

Updated Feasibility Study and Detailed Design of Dudhkoshi storage hydroelectric project (Nepal) - Final Detailed Design Headrace tunnel AMT survey.

February-May. Customer: ELC-Electroconsult S.p.a. (Italy).

- Reprocessing of 58 AMT (Audio-Magnetotellurics) station data

- AMT 2D inverse modelling along the trace of a hydroelectric tunnel
 - Sensitivity 2D forward AMT tests
 - Discussion of the geoelectrical model against the geological observations
- 2022 **New assessment of electrical resistivity and geothermal alteration vs. temperature relationships at Mt. Aluto volcano geothermal field, Ethiopia.**
Ongoing. Customer: ELC-Electroconsult S.p.a. (Italy).
- Three-dimensional re-interpretation of a MT (Magnetotellurics) dataset (160 stations)
 - Analysis of the relationship between electrical conductivity and temperature distribution retrieved from 13 geothermal deep wells
 - Advise for the definition of the updated geothermal conceptual model
- Servicio de Consultoria para Estudios Superficiales en el Campo Geotérmico Empexa, Bolivia.**
April-August. Customer: ELC-Electroconsult S.p.a. (Italy).
- Gravimetric and GNSS survey supervision, data QC and processing
 - MT survey supervision, QC and data processing
 - MT and MT 1D/3D forward/inverse modelling
 - Gravity 2D/3D forward/inverse modelling
 - Tectonic lineament detection
 - Geophysical modelling/interpretation
 - Advising for the geothermal conceptual model definition and well siting
- 2021 **Assessment of Ground Water Sources Potential and Possibility of Surface Water Sources for Hargeisa City, Hargeisa Water Agency.**
November 2021-May 2022. Customer: Sari Ltd (UK).
- Literature review
 - Hydrogeological survey
 - VES and ERT survey design
 - VES and ERT forward/inverse modelling
 - Geophysical data interpretation/modelling for aquifer characterization
- 2019 **Labasa and Savusavu geothermal field geophysical survey (Fiji).**
March-July. Customer: ELC-Electroconsult S.p.a. (Italy).
- TDEM survey planning
 - Data acquisition processing
 - TDEM 1D forward/inverse modelling
 - Resistivity mapping and profiling
 - Tectonic lineament detection
 - Geoelectrical model interpretation
 - Advising for the geothermal conceptual model definition
 - Geophysical training
- 2018 **Meteka geothermal field geophysical survey (Ethiopia).**
January-February. Customer: ELC-Electroconsult S.p.a. (Italy).
- Gravity/GNSS data acquisition and processing
 - TDEM and MT surveys supervision and QC
 - MT/TDEM data processing and 1D forward/inverse modelling
 - Gravity 2D/3D forward/inverse modelling
 - Tectonic lineament detection
 - Geoelectrical and gravimetric model interpretation

- Geophysical training

2017 Kasitu geothermal field geophysical survey (Malawi).

June-July. Customer: ELC-Electroconsult S.p.a. (Italy).

- Gravimetric and GNSS data acquisition and processing
- MT/TDEM survey supervision and quality control (QC)
- MT/TDEM data processing and 1D forward/inverse modelling
- MT 3D inverse modelling
- Gravity 2D/3D forward/inverse modelling
- Tectonic lineament detection
- Geoelectrical and gravimetric modelling/interpretation
- Advising for the geothermal conceptual model definition and well siting
- Geophysical training

Chiweta geothermal field geophysical survey (Malawi).

May-June. Customer: ELC-Electroconsult S.p.a. (Italy).

- Gravimetric / GNSS data acquisition and processing
- MT/TDEM supervision and QC
- MT/TDEM data processing and 1D forward/inverse modelling
- MT 3D inverse modelling
- Gravity 2D/3D forward/inverse modelling
- Tectonic lineament detection
- Geoelectrical and gravimetric modelling/interpretation
- Advising for the geothermal conceptual model definition and well siting
- Geophysical training

Ulumbu-Mataloko geothermal field (Indonesia).

February-March. Customer: ELC-Electroconsult S.p.a. (Italy).

- Review of MT data
- MT 3D inverse modelling
- Resistivity mapping and profiling
- Tectonic lineament detection
- Geoelectrical model interpretation
- Advising for the geothermal conceptual model refinement and well siting

Luhoi geothermal field geophysical survey (Tanzania).

January-March. Customer: ELC-Electroconsult S.p.a. (Italy).

- Gravimetric/GNSS data acquisition and processing
- TDEM and MT survey supervision and quality control (QC)
- MT/TDEM data processing and 1D forward/inverse modelling
- MT 3D inverse modelling
- Gravity 2D/3D forward/inverse modelling
- Tectonic lineament detection
- Geoelectrical and gravimetric modelling/interpretation
- Advising for the geothermal conceptual model definition and well siting
- Field/office geophysical training

2016 Kiejo-Mbaka geothermal field geophysical survey (Tanzania).

September-October. Customer: ELC-Electroconsult S.p.a. (Italy).

- Gravimetric and GNSS data acquisition and processing

- TDEM and MT survey supervision and quality control (QC)
- MT/TDEM data processing and 1D forward/inverse modelling
- MT 3D inverse modelling
- Gravity 2D/3D forward/inverse modelling
- Tectonic lineament detection
- Geoelectrical and gravimetric modelling/interpretation
- Advising for the geothermal conceptual model definition and well siting
- Field and office geophysical training

Aluto-Langano geothermal field geophysical survey (Ethiopia).

June. Customer: ELC-Electroconsult S.p.a. (Italy).

- Supplemental TDEM data acquisition and data processing
- TDEM 1D forward/inverse modelling
- Field and office geophysical training

2015 Aluto-Langano geothermal field geophysical survey (Ethiopia).

June-July. Customer: ELC-Electroconsult S.p.a. (Italy).

- Gravimetric and GNSS data acquisition and processing
- TDEM/MT supervision and quality control (QC)
- MT/TDEM data processing and 1D forward/inverse modelling
- MT 3D inverse modelling
- Gravity 2D/3D forward/inverse modelling
- Tectonic lineament detection
- Geoelectrical and gravimetric model implementation/interpretation
- Advising for the geothermal conceptual model definition and well siting
- Field and office geophysical training

2014 Alalobeda geothermal field geophysical survey (Ethiopia).

December, 2014 - March, 2015. Customer: ELC-Electroconsult S.p.a. (Italy).

- Gravimetric and GNSS data acquisition and processing
- TDEM and MT survey supervision and quality control (QC)
- MT/TDEM data processing and 1D forward/inverse modelling
- MT 3D inverse modelling
- Gravity 2D/3D forward/inverse modelling
- Tectonic lineament detection
- Geoelectrical and gravimetric modelling/interpretation
- Advising for the geothermal conceptual model definition and well siting
- Field and office geophysical training

Tendaho geothermal field geophysical survey (Ethiopia).

January-March. Customer: UNEP

- TDEM/MT data processing and 1D forward/inverse modelling
- MT 2D inverse modelling
- Advising for the definition of the geothermal conceptual model

Bosco Marengo (Italy).

September. Customer: GEAMB s.r.l. (Italy)

- FDEM and MAG measurements for location of buried objects in a waste-disposal site

2012 Menengai geothermal field geophysical survey (Kenya).

December. Customer: ELC-Electroconsult S.p.a. (Italy).

- Review of TDEM and MT data
- MT 2D forward/inverse modelling
- Geoelectrical model interpretation
- Advising for the refinement of the geothermal conceptual model and well siting

Lumut-Balai geothermal field geophysical survey (Indonesia).

March. Customer: ELC-Electroconsult S.p.a. (Italy).

- Review and 2D forward/inverse modelling of MT data
- Geoelectrical model interpretation
- Tectonic lineament detection
- Advising for the refinement of the geothermal conceptual model and well siting

Blawan-Ijen geothermal field geophysical survey (Indonesia).

October. Customer: ELC-Electroconsult S.p.a. (Italy).

- MT, TDEM and GNSS survey supervision and QC
- Review and 2D forward/inverse modelling of MT data
- Tectonic lineament detection
- Geoelectrical model interpretation
- Advising for the definition of the geothermal conceptual model and well siting

2011 “Biviere di Gela” hydrocarbon waste site geophysical surveys (Gela, Italy).

September. Customer: SEA s.r.l. (Italy).

- Electrical Tomography (ERT) data acquisition
- ERT 2D forward/inverse modelling
- Geoelectrical model interpretation for hydrocarbon detection

Cisolok-Cisukarame geothermal field geophysical survey (Indonesia).

January. Customer: ELC-Electroconsult s.p.a (Italy).

- Review and 2D inverse modelling of MT data
- Geoelectrical model interpretation
- Tectonic lineament detection
- Advising for the refinement of the geothermal conceptual model and well siting

Ouagadougou (Burkina Faso).

January-February. Customer: Water for life NGO (Italy).

- Geophysical integrated surveys (VLF/VES) for water research and groundwater well siting

2010 Tampomas geothermal field geophysical survey (Indonesia).

May-June. Customer: ELC-Electroconsult S.p.a. (Italy).

- GNSS and TDEM data acquisition and processing
- MT and gravity survey supervision and quality control (QC)
- MT 2D forward/inverse modelling
- Gravity 2D/3D forward/inverse modelling
- Tectonic lineament detection
- Geoelectrical and gravimetric model interpretation
- Advising for the geothermal conceptual model definition and well siting

Jailolo geothermal field geophysical survey (Indonesia).*March-June. Customer: ELC-Electroconsult S.p.a. (Italy).*

- GNSS and TDEM data acquisition and processing
- MT and gravity survey supervision and quality control (QC)
- MT 1D/2D forward/inverse modelling.
- Gravity 2D/3D forward/inverse modelling
- Tectonic lineament detection
- Geoelectrical and gravimetric model interpretation
- Advising for the geothermal conceptual model definition and well siting
- Field and office geophysical training

2009 Zeri eolic plant design (Massa, Italy).*October. Customer: FERA s.r.l. (Italy).*

- Refraction and surface waves seismic surveys for the characterisation of foundations
- Seismic site classification

Santa Luce eolic plant design (Pisa, Italy).*June. Customer: FERA s.r.l. (Italy).*

- Refraction and surface waves seismic surveys for the characterisation of a wind turbine plant foundations
- Seismic site classification

2008 ADF S.p.a. highway (Italy).*November. Customer: ADF S.p.a. (Italy).*

- Refraction and surface waves seismic surveys for the subsoil characterisation and seismic site assessment for a highway adjustment design.

2007 Waste site geophysical surveys (Nuoro, Italy).*September. Customer: TEI S.p.a. (Italy).*

- Refraction seismic and ERT data acquisition
- Modelling and interpretation for waste-disposal site characterization

2006 Pisa (Italy).*October. Customer: Coalpa S.p.a. (Italy).*

- Refraction and SW seismic surveys for the subsoil characterisation
- Seismic site classification for noise barriers design

2005 Massa (Italy).*May. Customer: SINA S.p.a. (Italy).*

- Refraction and surface waves seismic surveys for the subsoil characterisation for a highway adjustment design
- Seismic site assessment

Alessandria (Italy).*January-April. Customer: SINA S.p.a. (Italy).*

- Refraction seismic surveys for the subsoil characterisation for “Terzo Valico” railroad design

6) SCIENTIFIC PUBLICATIONS

- 2024 *"Some evidence of a wide rotational extension in East Antarctica preceding Gondwana breakup"*, Egidio Armadillo, Daniele Rizzello, Pietro Balbi, Alessandro Ghirotto, Davide Scafidi, Guy Paxman, Andrea Zunino, Fausto Ferraccioli, Laura Crispini, Andreas Läufer, Frank Lisker, Antonia Ruppel, Danilo Morelli, and Martin Siegert, EGU 2024 General Assembly, Wien. Oral presentation.
- "New MT surveys and 3D resistivity imaging beneath the Ngozi-Rungwe volcanoes at the triple rift junction of the East African Rift System in SW Tanzania: Support for integrated interpretations of geothermal conceptual models"*, Makoye M. Didas, Egidio Armadillo, Gylfi Páll Hersir, William Cumming, Ásdís Benediktsdóttir, Daniele Rizzello, Halldór Geirsson, *Geothermics*, Vol. 118, March 2024.
- 2023 *"Smooth magnetotelluric impedance estimation by optimization"*, Rizzello, D., Armadillo, E., *Journal of Applied Geophysics*, Volume 210, March 2023, 104952.
- 2022 *"Assessment of the Kiejo-Mbaka geothermal field by three-dimensional geophysical modelling"*. Rizzello, D., Armadillo, E., Pasqua, C., Balsotti, R., Pisani, P., Principe, C. Lelli, M., Didas, M. Giordan, V., Mnjokava, T., Kabaka, K., Tumbu, L. Marini, L. *Geomech. Geophys. Geo-energ. Geo-resour.* (2022) 8:143.
- "Regional thermal anomalies derived from magnetic spectral analysis and 3D gravity inversion: Implications for potential geothermal sites in Tanzania"*. Didas, M, Armadillo, E., Hersir, G. P., Cumming, W., Rizzello, D. *Geothermics*, 103, July 2022.
- 2021 *"The geophysical recognition of a vapor-cored geothermal system in divergent plate tectonics: the Alalobeda (Alalobad) field, Ethiopia"*. Rizzello, D., Armadillo, E., Pasqua, C., Pisani, P., Balsotti, R., Solomon Kebede, S., Mengiste, A., Kebede, Y., Hailegiorgis, G., Mengesha, K. *Tectonophysics*, 813 (2021) 228933.
- 2020 *"Geophysical constraints on the Luhoi (Tanzania) geothermal conceptual model"*. Armadillo, E., Rizzello, D., Pasqua, C., Pisani, P., Ghirotto, A., Kabaka, K., Mnjokava, T., Mwano, J., Didas, M., Tumbu, L., *Geothermics*, 87, September 2020.
- 2019 *"Relationships between CO₂ soil degassing and regional/local fault systems in the Kiejo-Mbaka geothermal prospect (Tanzania)"*. Lelli, M., Taramaeli, M., Ariph, K., Sadock, J., Pisani, P., Pasqua, C., Principe, C., Mnzava, F., Armadillo, E., Rizzello, D., Mkangala, A. *SIMP-SGI-SOGEI Congress, Parma 2019 (Italy)*. Oral presentation by Lelli M.
- 2018 *"Three-dimensional geophysical modelling of Kiejo-Mbaka geothermal field, Tanzania "*. Rizzello, D., Armadillo, E., Pasqua, C., Pisani P., Mnjokava, T., Mwano, J., Makoye, D., Tumbu, L. *Argeo C7 (7th African Rift Geothermal Conference, Kigali, Rwanda, 31st October – 2nd November 2018)*. Oral presentation.
- "Geophysical imaging of the Luhoi geothermal field, Tanzania"*. Armadillo, E., Rizzello, D., Pasqua, C., Pisani, P., Mnjokava, T., Mwano, J., Makoye, D., Tumbu, L. *Argeo C7 (7th African Rift Geothermal Conference, Kigali, Rwanda, 31st October – 2nd November 2018)*. Oral presentation.
- "Focused Inversion of Gravimetric and Magnetotelluric Data for Geothermal Investigations"*. Armadillo E., Rizzello, D., Pasqua, C., Pisani, P., Mnjokava, T., Mwano, J., Makoye, D., Tumbu, L. *Argeo C7 (7th African Rift Geothermal Conference, Kigali, Rwanda, 31st October – 2nd November 2018)*. Oral presentation.
- "New magnetic anomaly map of the Antarctic"*. Golynsky, A.V., Ferraccioli, F., Hong, J.K., Golynsky, D.A., von Frese, R.R.B., (...), Armadillo, E., ... (2018). *Geophysical Research Letters* 45 (13), 6437-6449.
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