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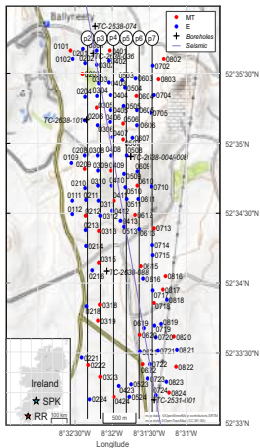
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# Magnetotelluric exploration of critical raw materials in central Europe

## Zn/Pb deposit, Stonepark / Ireland

Hybrid surveying setup speeds up data acquisition



In total, magnetotelluric (MT) data were collected at 108 locations at the end of 2022 using two types of site setups: 33 broadband MT stations (red symbols) and 75 telluric-only (E-field) stations (blue symbols). A reference station was installed 100 km to the SW.

Telluric-only stations are quick and easy to install, allowing efficient data collection with dense site spacing.

The E-field stations were processed by combining the local electric fields with the magnetic fields of a nearby MT-station, which (i) record data at the same time and (ii) has good data quality.

Quality of full MT and E-field stations is the same demonstrating the applicability of the hybrid surveying approach also in noisy environments.

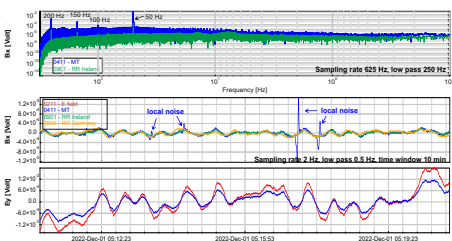
Reliable data despite high noise levels

The data were processed using the EMERALD processing suite (Ritter et al., 1998; Weckmann et al. 2005). Key steps to get high quality transfer functions:

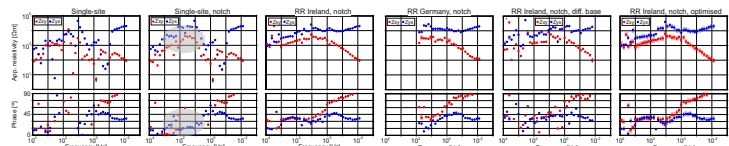
**Removal of 50 Hz signal and harmonics**  
Strong 50 Hz signals of the local power grid caused by the proximity of settlements can be removed from the time series by applying a notch filter to the base frequency and several harmonics. This improves the data at 1000-10 Hz.

**Remote reference (RR)**  
Single-site processing does not result in reasonable transfer functions due to very high local noise levels. For RR processing, we used (i) a station installed in Ireland ~100 km SW of the study area and (ii) for the lower frequencies the permanent remote station of GFZ in Wittstock/Germany at a distance of ~1400 km.

**Pre-selection and parameter tests**  
Results can be further improved by a variety of pre-selection criteria (e.g. coherence threshold, Mahalanobis distance criterion) as well as testing robust stacking parameters.



Data were recorded with sampling rates of 25KHz (5min each hour, HF mode) and 625Hz (continuously, LF mode) using S.P.A.M. Mk IV (and ELMAR data loggers), Metronix induction coils, and non-polarisable Ag/AgCl electrodes supplied by the Geophysical Instrument Pool Potsdam (GIPP).

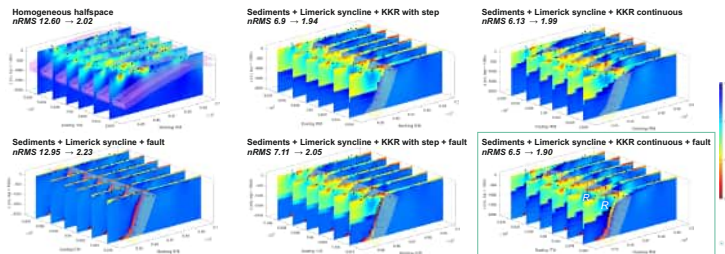


Constrained 3D inversion reveals fluidized fault

Integration of the MT results with the drill hole data, a detailed 3D geological model of the Stonepark mineral system, and a reprocessed seismic profile allowed the continuation of the horizons to the south where they are sparsely documented by drill holes.

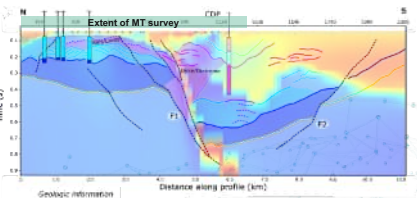
In particular, the MT data revealed a subvertical conductive feature that is spatially coincident with a hidden fault zone inferred from the seismic data (see map for location of seismic profile), suggesting that the fault may be fluid enriched.

The resistive feature (marked with R in preferred model) south of the fault zone correlates spatially with a volcanic intrusion suggested by seismic interpretation (see profile to the right). KKR = Knockree Volcanic Suite.



Excellent agreement with measurements on drill core samples and P-wave velocities for preferred model

The electrical conductivity structure at Stonepark revealed by 3D inversion shows the mineral-bearing unit as high resistivity material (500 to 5000 Ωm) typical for limestones, with little lateral variations in resistivity across the survey area. While the MT models do not provide a direct image of economically relevant mineralized zones, they are in excellent agreement with resistivity measurements on rock samples. MT models show variable resistivities for the Knockree Volcanic suite, which reflect the initial variability and varying degree of alteration of the volcanic rocks. The alteration changes the porosity of the rocks and the observations are supported by coinciding variations of P-wave velocity (Susin et al. 2025).



## Kupferschiefer, Spremberg / Germany

MT survey

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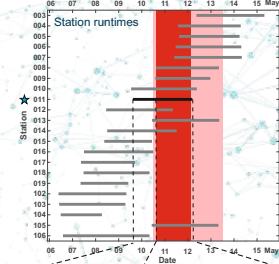
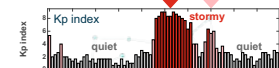
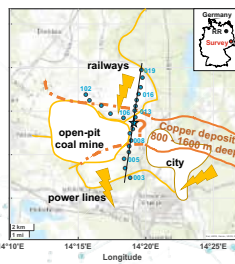
Geomagnetic storm

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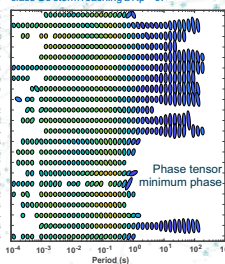
2 decades more of MT data

MT model constrains geometry of major units

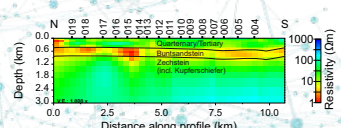
In May 2024, a magnetotelluric (MT) survey with 22 sites was carried out in the German Kupferschiefer district, a region with strong electromagnetic noise sources. Key components of the processing were the same as for the Stonepark data set (above).



At the time of fieldwork, a series of powerful solar storms (Kp 5-9) hit our planet and brought parts of human infrastructure such as power grids in Europe close to failure. The 11-12 May event was classified as the highest class G5 storm reaching a Kp=9.



3D inversion of the MT data agrees well with legacy results along 4 profiles located 3-15 km to the east. Legacy data overlap with 3D seismic and a detailed geological model. The new MT model could be used to infer geometries of major horizons, in particular the Buntsandstein, and extend the geological model to the west.



## VECTOR

Vectors to Accessible Critical Raw Material Resources in Sedimentary Basins [www.vectorproject.eu](http://www.vectorproject.eu)

1. To meet the objectives of the EU Green Deal we require a sharp increase in the supply of raw materials.
2. To extract these materials responsibly and sustainably we must understand the complex social, environmental and technical challenges and how they interact.
3. VECTOR will assess these challenges and integrate them to produce human centered solutions to current supply issues.

