3D imaging of electrical conductivity structures in the Eastern Cheb Basin across the Hartoušov molettes

Background:
The Hartoušov molettes field (Czech Republic) is one of the most prominent CD, degassing centres in Europe, which is located in a shallow Neogene intracratonic basin (the Cheb basin).
The region is also characterized by the NW–SE running Hanánský Láme Fault (HLF), the partially parallel Tachov Fault Zone (TFZ), and the N S oriented Poláky–Plasáni Zone (PPZ).
The massive degassing of CD, in the Cheb Basin, especially in the Mofette fields of Bubík and Hartoušov, originates from great depths. These mantles/cover residual derived fluids might use fault zones for their ascent.

Objectives:
- High resolution image of the electrical conductivity of the area surrounding the Bubík and Hartoušov molettes
- Investigation of possible correlations between CD degassing, fluids, aquifers, fault zones and swarm activity in the Cheb basin
- The assessment of the seismic hazards and mechanism of fluid-induced earthquake swarms
- Investigation of the geothermal potential of the Cheb Basin

Conclusion:
The extremely noisy MT data could be improved (except Ha) effectively through the application of remote-reference technique, Mahalanobis distance criterion, and Short Time average/Long Time average filter.
The low frequency data (<1 Hz) will be improved by applying Wiener filter which removes spikes and steps in the electromagnetic time series (Kappler, 2012 ; Kitterl & Weckmann, 2015).
Both 2D and 3D inversion results display similar structures, such as a near-surface anomaly beneath Bubík & Hartoušov molettes and a deep-reaching channel (north and east of 3D Model).

Data Processing:
The study area is heavily populated with power plants and, therefore severely affected by electromagnetic noise, which deteriorates the quality of the MT data.
The data were processed using the EMERALD software package (Ritter et al., 1998 ; Weckmann et al., 2005 ; Richter et al., 2015a).
We observed spikes and steps in the time series, were removed using a Short Time Average/Long Time average filter (STA/LTA) (Fig 1a; Kitterl & Weckmann 2015).
A notch filter (Kasanenbach, 1981; Hanasizadeh et al., 1996) is used to remove the noise from power lines and railways.
Two new processing criteria after Platz & Weckmann (2010). The Mahalanobis distance criterion removes data points that scatter around the desired MT distribution and reject data cluster originating from noise sources. In addition, we eliminated data points caused by a strongly polarized magnetic signal with the magnetic polarisation direction criterion (Figures 8b, Platz & Weckmann, 2010).
We used the permanent Reference Station in Wittstock (Germany), about 350 km from the study area, for processing (Figure 4b).

Field Experiment:
A dense grid of MT stations was measured in February-March 2016 in the region where the two profiles cross and the molettes are located. This grid has an approximate size of 5 x 10 km and includes 97 stations with an average site spacing of 500 m.
At all stations horizontal components of the electric field and all components of the magnetic field were measured in the frequency range of 10 kHz-0.001 Hz. We used the S.P.A.M. Hz, 3V magnetotelluric system, Rotronic induction coils and unispolisal Ag/AgCl electrodes from the Geophysical Instrument Pool Potsdam (GIPP).
The recording time at each station was approximately three days.

3D Inversion:
With the improved data quality, we are able to start with 3D inversion of the entire data. We can use data in the period range from 0.0001 s to 10 s.

Model grid:
- Background resistivity : 100 Ohm
- X: Direction: 100 cells x 70 m, 22 of pillow cells, increasing factor 1.3
- Y: Direction: 135 cells x 70 m, 22 of pillow cells, increasing factor 1.3
- Z: Direction: 55 layers, first layer thickness is 22 m, increasing factor 1.1, max. depth 300 m
- Zep: 5% of [Zep], Zec: 5% of [Zec], 3% of Zep and 34% of [Zep]

Smoothing parameters: 0.2 in all directions.

Figure 8: 3D model slices from the first 3D model of the MT data. A near-surface anomaly at depth in depth seems to be a likely cause of the Hartoušov molettes field.

References:

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