

IEAGHG Maria Laach 2010

# Characterization of a Magmatic Diffuse CO<sub>2</sub> Degassing Structure by Combining Resistivity Tomography with Sedimentologic and Soil Gas Measurements: The Hartoušov Mofette Field (Western Eger Rift/Czech Republic)

## Introduction/Motivation

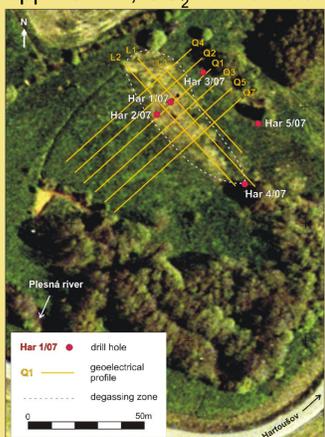
The western Eger Rift, W-Bohemia/Czech Republic, with its large number of mofette fields and mineral springs, is also characterised by Quaternary volcanoes, anomalies of mantle derived He and the periodic occurrence of earthquake swarms. Geochemical study indicates, that the recent active magmatic processes in the earth's crust may have an influence on the degassing behaviour and the generation of swarm earthquakes. One of the main research questions is to understand the transport processes of CO<sub>2</sub> from the active magma reservoir in the subcrustal mantle through the earth's crust to the surface. We have selected a CO<sub>2</sub> gas emission site, the Mofette field Hartoušov in the Cheb Basin, for investigations with the aim to get an insight into the near surface structural and lithological control of the diffuse degassing and the patterns of fluid movements down to a depth of 20 m.

The central degassing vent in the Hartoušov mofette field



## Methods

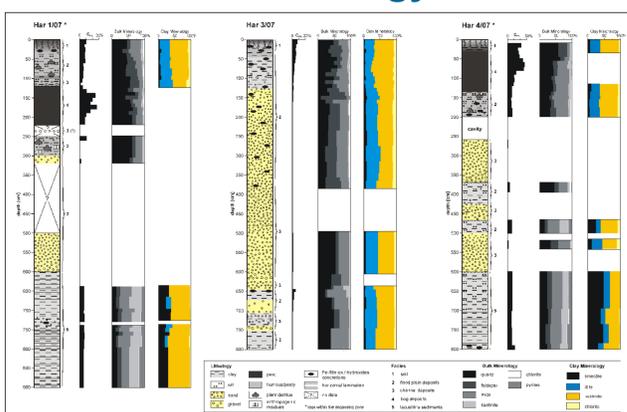
- Combination of 3-D Electrical Resistivity Tomography (ERT) and measurements of the natural electrical field (self-potential), supplemented by CO<sub>2</sub> data and sedimentological investigations of core probes from five drill sites (depth 8 – 9 m).
- Geoelectrical investigations:** Electrical Resistivity Tomography on 75 m profiles with 1 m electrode spacing (configurations: Wenner- $\alpha$  and - $\beta$ , dipole-dipole) and measurements of the self-potential.
- Sedimentological investigations:** content of organic material C<sub>org</sub>, mineralogical composition and clay mineralogy of the core probes.
- Soil gas measurements:** CO<sub>2</sub> concentration in depth of appr. 0.8 m, CO<sub>2</sub> flux rates at the surface.



Aerial view of the study area, the southern part of the Hartoušov mofette field with nine ERT-profiles respectively the self-potential mapping profiles, the five drill sites (Har1/07-Har5/07) and the central mofette near drill site Har 1/07.

Within the white dashed line the pale colour of the vegetation due to the influence of CO<sub>2</sub> is evident!

## Results Sedimentology

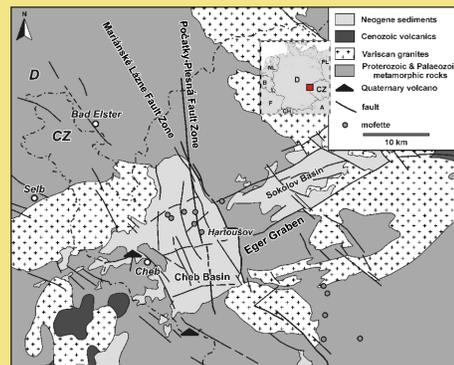


Lithological logs of the core drills Har 1/07, Har 3/07 and Har 4/07 with the content of organic material C<sub>org</sub> (based on LOI<sub>550</sub>), mineralogical composition, clay mineralogy and sedimentological interpretation. The logs Har 1/07 and Har 4/07 are located within the botanically marked degassing zone, Har 3/07 outside.

- Dispersed quartz pebbles were found intercalated into fine-grained sediments at sites with intense degassing, possible transported upward by gas lift.

## Geological setting

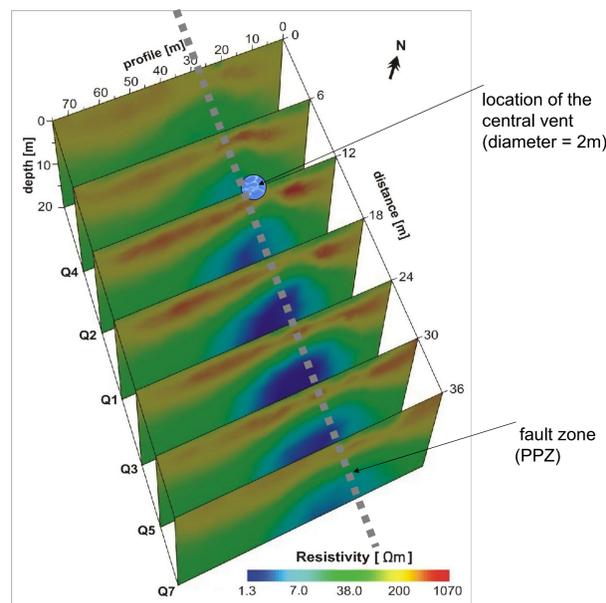
The north-eastern part of the Cheb Basin is one of the seismically most active regions of Central Europe. The Hartoušov mofette field is located 10 km south of the epicenters in the flood plain of the Plesná river, in siliciclastic and in part peaty sediments of Cenozoic age. The degassing vents (up to 99 % CO<sub>2</sub>) are located in close proximity to the main fault zones of the Cheb Basin, especially the N-S striking Počátky-Plesná Zone (PPZ).



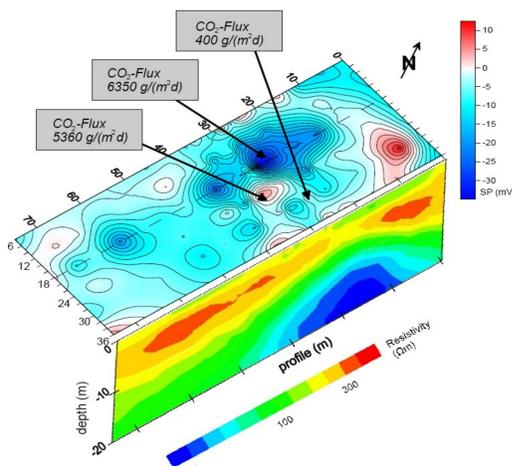
Geological sketch map of the Cheb Basin and its surrounding

## Results Geoelectrics

The resistivity signatures define the quasi-static image of the subsurface structures and of the state of dynamic. Distribution of SP anomalies give a dynamic information of flow processes in the subsurface (groundwater, ascending and/ or descending fluids).



3-D resistivity image of the mofette area (inversion code BERT) with vertical slices through the model at 0, 6, 12, 18, 24, 30 and 36 m; ERT lines: Q1-Q7. The bulged zone of low resistivities, elongated in NW-SE direction, is confirmed by the occurrence of clay in depth up to 5 m below surface and correlates with the area of high CO<sub>2</sub> degassing.

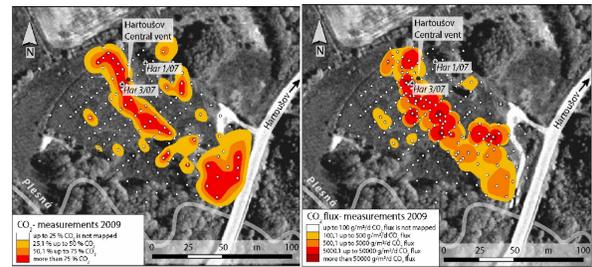


Comparison between the self-potential map of the investigation site, the inverted electrical resistivity section on profile Q1 and CO<sub>2</sub> flux data at selected locations.

- Elevated contents of C<sub>org</sub> and pyrite in areas of high CO<sub>2</sub> gas concentrations could be caused by a higher preservation potential of organic material attributable to a retarded bacterial decay and due to reducing conditions.
- Increasing concentration of smectite and decreasing concentration of chlorite and illite with the depth could be caused by influence of elevated CO<sub>2</sub> concentration on clay formation.

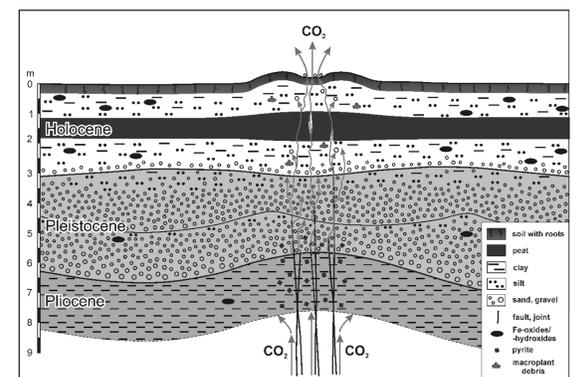
## Results Soil Gas Data

An oval shaped, NW-SE striking Diffuse Degassing Structure (DDS) was detected.



Result of CO<sub>2</sub> soil gas concentration measurements (depth appr. 80 cm) and CO<sub>2</sub> flux mapping at the Hartoušov mofette field

Internal structure of the DDS exhibits smaller scale anomalies, marked by CO<sub>2</sub> concentration in 0.8 m depth up to more than 75% CO<sub>2</sub>. The maximum of the gas flow rate of the anomalies reaches up to > 50 kg/m<sup>2</sup>/d close to the central vent of the mofette field and at dot-shaped small structures of intense degassing.



Conceptual model of sedimentation at the central vent of the Hartoušov mofette field

The location of the Hartoušov mofette field seems to be linked to a deep-reaching fault zone (PPZ). The fault and joints serve as deep-seated conduits for the CO<sub>2</sub>. The pre-Quaternary basal clay-rich unit most probably forms a domal feature below the most active mofette. The driving force behind the updoming of the clays below the mofette might be the high pressure of uprising CO<sub>2</sub>. Micro-channels, gas vents, cavities and upward inflow of sand caused by high pressure degassing were documented in the Pliocene (Vildštejn) Formation. High pressured CO<sub>2</sub> might thus be able to deform and uplift the pre-Quaternary clays, either in a brittle and/or ductile manner, probably depending largely on their water content

## Conclusion

The investigations reveal a positive correlation between areas of high soil gas CO<sub>2</sub> concentration and flux with geophysical anomalies (negative self potential, positive structures of low electrical resistivity) as well as with specific sediment properties (content of pyrite and organic material, occurrence of dispersed pebbles, uplifted clay layer). These features are thought to be directly or indirectly related to the magmatic caused CO<sub>2</sub> flow and a high gas pressure.

A causal mechanism for the updoming of the clay layer might be hefty gas pressure, possibly in combination with fluidisation of the clay layer and/or swelling of smectite minerals due to intensified water circulation on cracks caused by the CO<sub>2</sub> pressure. Soil gas measurements indicate areas of high CO<sub>2</sub> content to be marked by anomalous vegetation patterns. These anomalies spread out with a linear trend, suggesting a fault control on gas ascent.

## Contact

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