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An Integrative Geoelectric, Sedimentologic and Soil Gas Investigation of a Magmatic CO_2 Degassing Structure in the Cheb Basin/Czech Republic: A Natural Analogue Study to Understand Transport Processes in the Near Surface

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The mofette field of Hartoušov is located in the Cheb Basin, a shallow Neogene intracontinental basin in Central Europe. The north-eastern part of the Cheb Basin is one of the most seismically active regions of Central Europe. Seismic activity in the Cheb Basin has mainly a swarm-like character. The numerous cold CO_2 emanations ($>$99 Vol.% CO_2) at the surface of the basin are supposed to be generally connected to the seismic activity and to stem from the upper mantle. The Hartoušov mofette field has been investigated by combining geophysical measurements (geoelectrical resistivity tomography, self potential) with sedimentological studies (grain size, C_org, mineralogy) and soil gas (CO_2 flux and CO_2 concentration) data. Key question of the research was to evaluate the structural and sedimentological control at a CO_2 degassing location. The investigations reveal a positive correlation between areas of high soil gas (CO_2) 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_2 flow. Soil gas (CO_2) measurements indicate areas of high CO_2 content to be marked by anomalous vegetation patterns. These anomalies spread out with a linear trend, suggesting a fault control on gas ascent. Places of highest gas flow form small hummocks, with minor depressions on top. Negative geoelectrical self potentials at such locations were interpreted considering as having been caused by a downward movement of the meteoric water balancing the upward CO_2 flux. The top of a pre-Quaternary clay-rich unit with a high content of smectite is highest in the location nearest to the mofette showing the most intense CO_2 emanation. Most probably the clays form a domal feature below this mofette, as confirmed by the 3-D geoelectric measurements by low electrical resistivities. The driving force behind the updoming of the clays might be the pressure of uprising CO_2. Additionally, the more intense swelling of smectite due to higher rates of fluid flow at these locations might also contribute to this phenomenon. Isolated quartz pebbles dispersed in fine-grained sediments could have been transported upward by gas jets bonded to vents during periods or events of intense gas emanation. The model of the active mofettes has to consider its bonding to deep-seated faults, the presence of sediment deformation structures due to gas pressure, upward transport of sediment particles by gas jets and reducing conditions caused by the magmatic CO_2 flux.