EGU21-4267
https://doi.org/10.5194/egusphere-egu21-4267
EGU General Assembly 2021

Multi-level fluid monitoring to understand the origin of transients

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Anomalies in timeseries are frequently reported in the context of earthquake precursor studies. The state of knowledge can be summarized as follows: (i) significant anomalies exist, (ii) seismo-tectonically induced anomalies might exist, (iii) anomalies of non-tectonic origin exist and may look very similar to tectonic ones. Thus, presumably only a fraction of all reported precursors is real in the sense that they are of seismo-tectonic origin. A key problem in earthquake prediction research is to understand the origin of an anomaly and thus the separation of internal and external drivers like e.g. rainfall.

State-of-the-art fluid monitoring techniques allow for a high temporal resolution compared to the low-resolution discrete sampling approach used in the last decades. A unique approach will allow to monitor ascending fluids along a vertical profile in a set of drillings from a depth of a few hundred metres to the surface. This setup can provide hints on the origin of temporal variations related to the opening of fault-valves, admixture of crustal fluids to a background mantle-flow or the release of hydrogen during fault rupturing. Gas migration velocities can thus be measured directly from the arrival times of anomalies at different depth levels. In addition, potential admixtures of mantle fluids with crustal or meteoric fluids during the ascent to the Earth's surface can be quantified.

A prototype of a multi-level gas monitoring system has been implemented at a mofette. Mofettes are gas emission sites where CO2 ascends through long-lived, narrow channels from the deep crust and possibly the Earth's upper mantle and thus provide natural windows to magmatic processes at depth. The primary objective of our research on mofettes is to clarify physical links between fluid properties, their pathways and the relation to swarm earthquakes. The Hartoušov mofette field with an estimated daily CO_2 flux between 23 and 97 t over an area of about 350,000 m^2 has been chosen as a key site in the frame of the ICDP project: "Drilling the Eger Rift: Magmatic fluids driving the earthquake swarms and the deep biosphere." It is located in the Cheb Basin, which terminates the Czech part of the Eger Rift to the West and is known for recurring earthquake swarms and mantle degassing. Gas and isotope compositions will be continuously analyzed in-situ at different depth levels (30 m, 70 m, 230 m) reached by three adjacent boreholes.