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CCS-related experiences of near surface soil gas monitoring experiments

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Near surface soil gas monitoring is one important methodological and technical component in the establishment and secure management of CO_2 storage sites, e.g. their survey before, during and after CO_2 injection. In order to test, evaluate and contribute to the development of adequate tools, the BGR department of gas and isotope geochemistry and the department of utilization of the deeper underground – CO_2 storage, carry out studies in the monitoring of gas flows from the near surface underground to the atmosphere. The overall aim of these activities is to gather reliable knowledge on the design of significant baseline data before CO_2 injection to the underground, the safe long-term survey of CO_2 within storage sites, and the detection of possible leakages and diffuse discharges from reservoirs.

The studies are often integrated in European projects, like NASCENT, CASTOR, CO_2GeoNet, CO_2Remove and others, and therefore jointly executed with several other European partner institutions involved in the field of CCS. Study sites comprise both onshore and offshore natural analogues with known gas exhalations as well as areas possibly suitable to future CO_2 storage. They are mainly located in Germany, Austria and Italy.

The applied monitoring methods include: Soil gas sampling for concentration measurements and isotope analysis, registration of gas fluxes by accumulation chambers, and the continuous recording of soil gas parameters by permanent monitoring stations.

As an overall result it became obvious that soil gas sampling for further analysis is a

time-efficient monitoring method in the CCS context. It may cover large areas in short time and delivers information to the origin of escaping gases. Gas flux experiments by accumulation chambers are ideal for fast interventions or the verification of observed anomalies. If combined with stable carbon isotope analysis, they offer a powerful tool for CO_2 source evaluation. The operation of permanent soil gas monitoring systems yields data on high temporal resolution. They are therefore most suitable as standard technique for soil gas baseline surveys and, moreover, they offer an integrative monitoring approach close to wells, boreholes and further leakage-sensitive pathways. Consequently, even small leakages of nearby sources could be detected from a comparison with obtained long-term records.

The data and data series of the conducted soil gas studies underline that soil gas monitoring in the context of a secure management of CO_2 storage sites is a site-specific task! Soil gas monitoring data have always to be interpreted in terms of the individual local conditions depending on a very complex set of influencing factors. If meteorological or geohydrological factors are determinant for one site, soil-related or even geophysical influences like seismic impact can be decisive for another. Thus, only long-term studies allow a reliable interpretation of soil gas data by detecting systemic relations between variations of the data and their numerous influencing factors. Baseline surveys for the surface near monitoring of CO_2 storage sites should always start well before the initial utilization of the site.