

Characteristic length measurement of a subsurface gas anomaly - an integrating monitoring approach over heterogeneous distributed gas flow paths

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Geogenic gases such as CH₄ or CO₂ from natural sources, gases (CCS-CO₂, H₂, Natural gas, City gas ...) from a geological repository, or a leaking gas pipeline can present serious risks in industrial and urban areas where the density of infrastructural elements increases as well as above and below ground. To extend the lead time for risk treatment in such critical regions, reliable detection of gases within the shallow subsurface is required to observe critical gas accumulations before degassing into the atmosphere.

A near real-time monitoring approach is introduced to determine the volumetric expansion of such a gas escaping from a leak in the subsurface. Considering the pressure relaxation with the ambient air pressure, the approach enables the forecasting of the final size of a pressurized gas body in terms of characteristic lengths. According to theoretical basics, such a characteristic length, which allows to perform a gas (safety) measurement based on a purely geometrical measure, behaves independently of subsurface properties, i.e., it enables a reliable quantification of the escaping gas, irrespective of its heterogeneous flow path distribution. A field test for a 10 l/min pinhole leakage of CO₂ injected in an unsaturated Chernozemic soil (agricultural test field Bad Lauchstädt) that was equipped with linear gas sensors demonstrates the lateral-vertical volumetric gas expansion along the environment of these gas sensors, and confirms the applicability of the new characteristic length approach.