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ASSESSMENT OF THE ACCURACY OF THE SOIL GAS RADON DEFICIT TECHNIQUE FOR MONITORING AND QUANTIFYING RESIDUAL LNAPL CONTAMINATION

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Hydrocarbon spills into the subsurface can lead to the formation of light non-aqueous phase liquids (LNAPL), i.e., a separate phase, immiscible with water, representing a long-term environmental threat. Traditionally, the presence of mobile LNAPL is evaluated by installing monitoring wells in the area of potential concern [1]. This approach, however, provides only qualitative evidence of the thickness of LNAPL observed in the wells, thus not providing information on the distribution of residual LNAPL in the subsurface [2].
As an alternative, in the last decades, radon (Rn) has been widely proposed as a naturally occurring tracer for light non-aqueous phase liquids in the soil (e.g., [3], [4]) since it has been shown to tend to partition into LNAPL. Rn concentration in soil gas is expected to decrease in the impacted area compared to the value observed at background locations (not impacted by LNAPL), creating a measurable Rn deficit. This work examines the feasibility of using soil gas data collected in unsaturated soil at some distance from the source zone to apply the Rn deficit technique to identify and quantify LNAPL contamination. To this end, we developed a steady-state 1-D analytical solution based on a 3-layer model that simulates the transport and distribution of Rn in the source zone, capillary fringe, and overlying unsaturated soil [5]. The analytical solution was first validated against a more detailed numerical model available in the literature [6]. Then, a series of simulations were carried out to evaluate the vertical concentration profiles of Rn in soil gas above the source zone and in a background location not impacted by LNAPL. Simulation results showed that the parameters that most influence the migration and distribution of Rn in the subsurface are the distance of the soil gas probe from the source zone and, to a lower extent, the type of contamination (e.g., diesel or gasoline) and soil type. Based on these results, to aid the determination of LNAPL saturation, some nomograms have been developed that can be used to apply the Rn-deficit technique from Rn concentration data in soil gas collected at a certain distance from the LNAPL source zone. The developed nomograms show that the Rn deficit is more evident as the measurement point approaches the source area. According to the obtained results, the Rn deficit technique is a feasible method for qualitatively identifying residual LNAPL when Rn in soil gas is measured at distances lower than 2m from the contaminated zone. However, for an accurate quantitative estimation of the LNAPL phase content, soil gas probes should preferably be located at distances lower than 1m from the source zone. The nomographs provided in this work, which allow the estimation of LNAPL saturation as a function of the distance of soil gas probes from the LNAPL source zone and of the type of soil and contamination, are generally applicable to all sites involving relatively homogenous soils. Conversely, more sophisticated numerical models should be preferred (e.g., [6]) in the case of heterogeneous soils involving geological barriers or stratified contaminations.

Participation

In-Person

References

[1] Newell, C., Acree, S. And Ross, R., Huling, S. (1995). Light Nonaqueous Phase Liquids, Ground Water Issue, US EPA/540/S-95-500. United States Environmental Protection Agency, Washington, DC.
[2] CL:AIRE (2014). An illustrated handbook of LNAPL transport and fate in the subsurface. London: CL:AIRE. http://www.claire.co.uk/LNAPL.
[3] Schubert, M., Freyer, K., Treutler, H. C. and Weiß, H. (2001). Using the soil gas radon as an indicator for ground contamination by non-aqueous phase-liquids. J. Soils Sediments, 1(4), 217-222
[4] Höhener, P. and Surbeck, H. (2004). Radon-222 as a tracer for nonaqueous phase liquid in the vadose zone: experiments and analytical model. Vadose Zone J. 3 (4), 1276–1285.
[5] Cecconi, A., Verginelli, I., and Baciocchi, R. (2022). Modeling of soil gas radon as an in situ partitioning tracer for quantifying LNAPL contamination. Sci. Total Environ. 806, 150593.
[6] Cohen, G.J., Bernachot, I., Su, D., Höhener, P.,Mayer, K.U. and Atteia, O. (2019). Laboratory-scale experimental and modelling investigations of 222Rn profiles in chemically heterogeneous LNAPL contaminated vadose zones. Sci. Total Environ. 681, 456–466.

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