Continuous Ground Gas Monitoring

By Dr. Steven Goodman, and adapted from GasClam: Continuous Ground-Gas Monitoring Becomes a Reality, from Dr. Peter Morris

It is almost inevitable in the initial phases of a construction sites development, that a Ground Gas risk assessment process is required by the local planning authority, and subsequently undertaken by a developer or their contractor. This normally encompasses spot monitoring visits that can last up to 12 months or more, if methane is found at over 5% by volume.

However, it is important to realise that the true objectives of a ground gas monitoring survey period is to determine the true ground gas regime and how that will likely change in the future, it is not just a screening exercise. Currently, this is most commonly achieved by discrete periodic static measurements of ground gas concentrations, from which a ground gas regime is inferred. Nevertheless, this approach is inherently flawed, with the inability to accurately measure ground-gas concentration and ground-gas fluxes. Neither are measured directly and both are likely to be temporally variable.

Measurement is indirect because ground-gas concentration is inferred from periodic sampling of gas accumulated within a borehole and flux is then inferred from these borehole gas concentrations. The unit of flux is volume/time, therefore it cannot be measured directly without time series data. With the ability to collect time series data, an improved measurement of flux can be made and temporal variability can be quantified and accounted for. This will improve understanding of processes, thereby reducing the uncertainty which is inherent in the inferences required in using measurements that are indirect and lacking in temporall resolution. Contaminated land and landfill industry regulators recognise the need for more representative data but cost has prevented the collection of continuous records of ground-gas measurements. However, technology such as the Gasclam in-borehole continuous ground gas monitor allow for such data to be collected.

The current approach relies on discrete measurements of concentration from which representative ground gas concentrations and gas migration potential are inferred. However, as system data is poorly resolved temporally uncertainties in these inferences remain large. For example, the frequency of variation in gas concentration may be higher than the sampling frequency, in which case measurement will not be representative. The benefit of continuous monitoring in overcoming the mismatch in sampling frequency and variability in the gas concentration. Importantly, time series data also reveals that the frequency of variation in gas concentration is highly variable.

Higher temporal resolution of not only gas concentration but also other environmental variables allows their inter-relationships to be more clearly defined. This in turn allows dominant controls on gas concentration to be recognised and for better prediction of gas concentration as other parameters change. Atmospheric pressure is considered to be a strong driving force for gas migration (Wilson et al, 2008). In general it is assumed that concentrations are higher when pressure is low and vice versa and because of this current guidance (e.g. CIRIA Report 665) recommends collecting at least one spot sample below 1000mbar in falling pressure. However, continuous ground gas measurements show the arbitrary nature of the 1000mbar limit and that concentration changes continuously with variances in atmospheric pressure, rather than displaying a clear dependency on the absolute atmospheric pressure. Furthermore, the widely reported relationship between pressure and concentration does not always exist; with the inverse relationship having been observed.

So, we can see that the ability to monitor environmental parameters and concentration simultaneously will provide an understanding of the processes contributing to ground-gas production and migration. Initial results suggest that the relationship between environmental parameters and concentration are complex and currently poorly understood. The potential for further understanding of processes will allow for a more representative conceptual model. This has a further impact on risk assessment, which is currently based on inferences of worst-case conditions determined by limited periodic measurements of gas concentration.

It is also common that we have to consider the risk of organics contamination in ground gas in the form of volatile organic compounds (VOCs). These can easily be ignored or misidentified due to ground gas monitors mistakenly identifying them as methane (CH4). This is as a result of the monitor infrared absorbance over methyl groups on methane (R-CH3) which are almost ubiquitously found on most other organic compounds.

As such, Photo Ionisation Detectors (PIDs) are often used to identify the presence of such compounds by spot sampling the ground gas. These are very useful as an initial screening exercise if methane levels are genuinely not present in volumes beyond approximately 4% by volume. Any concentration close to this renders a PID impotent due to methane absorbing the UV output of the PID lamp. Hence, VOC analysis requires to be undertaken, either through grab sampling and laboratory analysis. However, onsite VOC analysis can now be achieved through the use of Micro GC systems, such as the Frog 4000 from Defiant Technologies. This unit allows for full field VOC analysis equivalent to laboratory standards for both qualification and quantification of organic vapours present with target analysts being able to be separated and detected in less than five minutes.

Continuous gas-monitoring data has revealed several potential flaws in the existing monitoring methodologies. The identification of ground-gas regimes that vary on a site-specific basis indicates the potential for a mismatch between the frequency of sampling and the variability of gas concentration, demonstrating the importance of selecting an appropriate sampling frequency to avoid missing valuable information. This can be clearly seen when comparing the concentration duration curves from the high frequency data and spot sample measurements.

When combining this tool with onsite field analysis of VOCs in boreholes we have a significantly increased potential to get a fuller understanding of the true nature of ground gas regimes and the potential contamination of soils and ground waters with organics.