

A potential danger in the subsurface

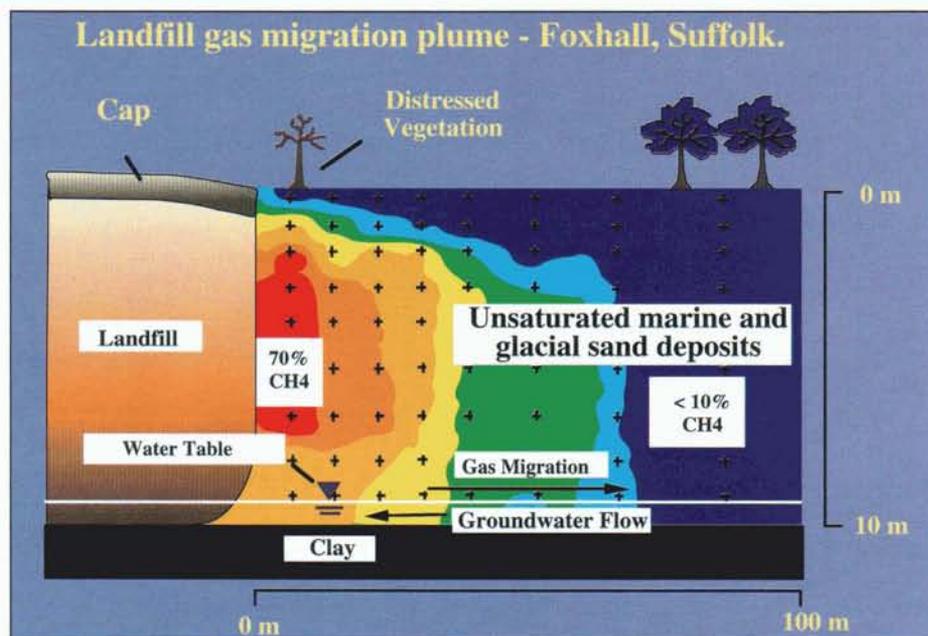
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Keyword

The death, injury and complete destruction of buildings by the explosions at Loscoe and Abbeystead in the 1980's highlight the danger posed by methane in the subsurface. The Loscoe explosion involved the migration of methane from a landfill through fractured sandstone. At Abbeystead, methane dissolved in groundwater in Carboniferous strata entered an aqueduct tunnel and was subsequently pushed into an underground pump-house when water was discharged down the tunnel.

Methane is formed in two major ways: by the biodegradation of organic material by micro-organisms in the absence of oxygen (biogenic methane); or abiologically over geologically long periods of time following the burial, compression and heating of organic material (thermogenic methane). Sources of biogenic methane include rotting vegetation, landfills, sewers, peat bogs or organic chemicals discharged in groundwater. Thermogenic methane includes natural gas from oil and gas reservoirs, or associated with coal or organic rich geological formations.

Methane



Cross-section showing methane concentration (% volume for volume) along the axis of gas plume at the Foxhall Landfill.

With the ever increasing need to build on or near landfills or contaminated land particularly in industrialised areas where coal mining has taken place, developers will continue to encounter methane in the subsurface and will need to understand its origin to be able to protect their development effectively.

The following factors need to be considered in order to identify a source of methane:

- Comparison of the composition of the gas with the composition of known sources.
- Determination of a migration pathway between the source and the detection point.
- Identification of a potential for migration along that pathway.

Composition is often used as the first indicator of provenance. It is therefore important to have a well defined database on the characteristics of various sources. These include the major and trace gas components and isotopic content, particularly of carbon compounds. However, changes in chemical characteristics of the source gas may occur during migration. Thus to increase confidence in assigning a source, geological knowledge is required

to show that there is a potential pathway by which gas could migrate from the supposed source, and that there is a mechanism operating that will allow the gas to migrate along that pathway.

The BGS has been involved in characterising sources of methane using stable isotope ratios of carbon and hydrogen in methane, and carbon in associated carbon dioxide. The BGS, with Department of the Environment funding, has also investigated geochemical changes that occur to landfill gas as it migrates from a source. This work has been undertaken at a landfill site at Foxhall in Suffolk, where a gas plume has been mapped in three dimensions beyond the perimeter of the site. This involved drilling and sampling for methane, carbon dioxide, oxygen, nitrogen and associated volatile organic compounds. One important finding is that as methane migrates it is microbially oxidised to carbon dioxide, so that ratios of these components, often distinctive in unaltered source gas, cannot be used to distinguish between sources. However, volatile organics particularly halogenated compounds extend furthest from the landfill. Thus when all the methane is oxidised and only carbon dioxide remains, the presence of these volatiles can be used to infer a landfill source.