

# A breath of fresh air?

## The unseen dangers of mine gas

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**M**ost coals and coal-bearing rocks contain significant amounts of methane, together with smaller quantities of other gases. The abundance of methane, commonly known to miners as 'firedamp', released during mining, has always been one of the greatest safety hazards to confront the coal miner. A long history of disastrous fatal explosions led, in the early nineteenth century, to Sir Humphry Davy's development of a practical flame safety lamp, following a particularly serious explosion in 1812 at Felling Colliery on Tyneside.

Other gases which occur, usually in comparatively small quantities, in working and abandoned coal mines, include hydrogen sulphide, which may form locally by the reaction of acidic water with pyrite, and carbon monoxide, which can be produced by incomplete combustion in underground fires and explosions. Both gases are highly toxic. Small quantities of radon may also occur in old workings. Methane continues to be released from coal-bearing rocks after mining has ended.

These gases may remain trapped underground in abandoned workings, though in certain circumstances they may locally migrate to the surface via a variety of geologically-related pathways. Surface escapes of methane, commonly accompanied by combustion, are comparatively well known in most coalfields

Of particular concern, however, is the generation in old workings, often in large volumes, of a gas known as 'blackdamp', more familiar to miners in north-east England as 'stythe'. This is effectively air from which most, or all, of the oxygen has been removed, and is thus a mixture composed mainly of nitrogen and carbon dioxide. Blackdamp is colourless, odourless and tasteless and is normally heavier than air. It is formed by the oxidation of coal, timber, ironwork, and minerals such as pyrite in badly ventilated workings, and is especially prone to accumulate in old pillar and stall workings.

Under certain circumstances blackdamp can migrate to the surface. In conditions of good ventilation, it may dissipate harmlessly by dilution into the atmosphere. However, where ventilation is restricted in some way, surface accumula-

tions of blackdamp may reach dangerous concentrations. Being heavier than air it may accumulate in cellars and trenches, and may enter buildings through foundations, pipe ducts, or in some instances directly through the ground surface.



Fergus McTaggart, BGS © NERC

*Old, and partially collapsed, pillar and stall workings in a long-abandoned coal mine at Plessey Woods, Northumberland. Large volumes of 'stythe' may form and accumulate in such workings.*

Surface emissions of blackdamp appear to be particularly common in parts of the Northumberland Coalfield, but are known from other coalfields. A man and his dog were asphyxiated by 'stythe' in a workshop at Widdrington, Northumberland in 1995. In the same incident other members of his family were overcome by the gas, but were successfully revived. In Barnsley, in 1998, a man died in a trench which filled with blackdamp from nearby abandoned coal workings. Numerous other, potentially dangerous, surface emissions of blackdamp are documented and although several people have been seriously affected, fortunately there are no other recorded fatalities.

Such is the concern amongst residents in Northumberland that one district council in the region issues guidelines to all households on how to recognise the symptoms of 'stythe', and provides a 24-hour emergency telephone helpline to report emergencies. Oxygen monitoring equipment has been installed in houses thought to be at risk and a specially convened council committee meets regularly to monitor incidents and to consider remediation measures for 'stythe' emissions.

Remediation measures include drilling boreholes to vent old workings, or areas

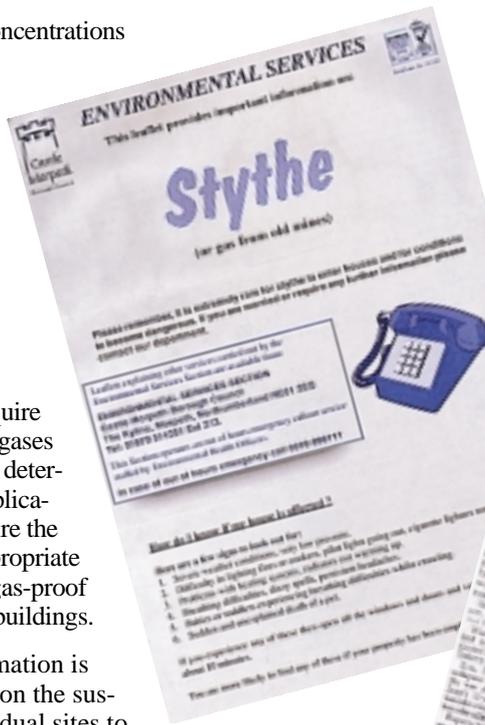


*Mine gas vent at Sunderland AFC Stadium of Light, built near the site of Wearmouth Colliery, Sunderland.*

known to contain concentrations of gas. It is normal practice today during mine abandonment to install vents in mine shafts and adits to allow gases to be safely ventilated and dissipated into the atmosphere. Several planning authorities in Northumberland require the risks from mine gases to be assessed when determining planning applications, and may require the incorporation of appropriate safeguards such as gas-proof membranes in new buildings.

However, no information is currently available on the susceptibility of individual sites to blackdamp emissions, and incidents are treated on a case-by-case basis. Clearly there is a pressing public safety and economic need to delineate those areas likely to be at greatest risk from blackdamp.

It is known that, as with most mine gases, surface emissions of blackdamp are most frequent during periods of low atmospheric pressure, and thus tend to be commonest during the winter months. However, the migration pathways and mechanisms driving surface emissions of this gas are complex and are dependent upon a great variety of conditions, both natural and man-made. Blackdamp is known to form and to accumulate within abandoned, unventilated workings. Whereas many such workings are recorded on plans, there are extensive areas of long-abandoned workings in coalfields such as Northumberland, for which no plans exist. Porous bodies of rock, such as many Coal Measures sandstones can serve as effective reservoirs for the gas. Although old mine openings, such as shafts and adits, are obvious routes for gas migration to the surface, migration pathways may be far from obvious and are not necessarily simply restricted to such openings. Sandstone bodies, together with faults and joints, as well as fissures in rocks disturbed by mining, may all provide extremely effective conduits for gas and emissions may occur at considerable distances from



Top left\*: Leaflet from Castle Morpeth Borough Council, warning about the dangers of gas from old mine workings (stythe). Above\*\*: Newspaper headline 'Death Gases'.

\* Courtesy of Environmental and Planning Services Department, Castle Morpeth Borough Council.

\*\* Courtesy of the Journal, Newcastle upon Tyne.

the original source of the gas. Impervious rocks, such as mudstones, may form effective barriers preventing or restricting the migration of gas. Similarly, superficial deposits such as till, or boulder clay, may provide efficient seals preventing gas escaping to the surface, though excavation of trenches or foundations may break these seals. The migration of groundwaters and, in particular, rising levels of mine water in abandoned workings once pumping has ended, are crucial factors in controlling the movement of gases and can drive gas to the surface. Drainage of flooded workings during excavations or opencast mining may open pathways for gas migration.

A clear understanding of the geological succession, structure, hydrogeology and geotechnical characteristics for both the

'solid' and 'drift' geology is essential in delineating areas likely to be susceptible to surface gas emissions.

Through its programme of continuous revision the BGS today has a very detailed, and constantly improving, picture of the geology of Britain's coalfields and is uniquely placed to investigate problems of mine gas. As part of the BGS Urban Geosciences Programme this information is being employed to prepare a prototype computerised system which will identify those areas in Northumberland which are most susceptible to gas emissions. This will serve as an invaluable tool in environmental and public health planning and will enable the most efficient targeting of resources to the safe long-term remediation of the most 'at risk' areas.