British Geological Survey

Mitigation of minewater pollution

The need for research, monitoring and prevention

Steve Dumpleton

Keyworth

Ochrous discharge into the River Loxley at Loxley Bottom, Malin Bridge, Sheffield. The discharge comes from an obscured water adit from Woodend Colliery, Stannington, and has a significant impact on the water quality and aquatic life. Some 21 000 m^2 of river bed is affected, over a distance of 3 km downstream from the discharge. The discharge is acidic (pH 4.9–6.3). As well as causing an ochrous precipitate of ferric hydroxide on the river bed, the minewater also has significantly elevated concentrations of zinc and manganese.

In April 1993, with no warning, highly ferruginous and acidic minewater began to emerge from old coal mine workings at Lower Ynysarwed near Neath, in the South Wales Coalfield. Although mining had ceased here as long ago as 1938, the water had been controlled by pumps at the adjacent Blaenant colliery until they were switched off in 1991. By the end of 1993, the discharge had more than doubled in volume, and a 12 km section of the Neath Canal had become grossly polluted, coating the canal bed with an orange precipitate of ferric hydroxide and killing most of the aquatic life.

This incident illustrates the environmental effects of polluted water discharge from abandoned collieries. It is not a new problem. Coal mining is the most extensive activity in the long history of British mineral exploitation. Local ochrous discharges into rivers and streams from long abandoned, generally small-scale mine workings, are known from the older parts of many coalfields. However, with the recent closure of many coal mines, and sometimes the abandonment of entire coalfields, minewater has now become a significant cause of freshwater pollution in these areas.

Mining has always had to contend with underground water. Historically, the development of the steam engine enabled large volumes of water to be pumped from the mines, making possible the rapid growth of the industry in the nineteenth century. On abandonment, the workings are liable to flooding unless pumping is continued. Because coal workings are often complexly interlinked underground, often from one colliery to another, it is necessary to maintain a network of pumping stations to de-water abandoned mines, in order to prevent the flooding of currently operating collieries.

"... coal mining is the most extensive activity in the long history of British mineral exploitation. Local ochrous discharges into rivers and streams from long abandoned, generally small-scale mine workings, are known from the older parts of many coalfields ..."

Coal and coal-bearing rocks commonly contain the mineral pyrite (ferrous sulphide FeS_2). During mining operations, air comes into contact with pyrite in damp conditions. Bacterial action assists oxidation to soluble ferrous sulphate, and this is accompanied by the release of sulphuric acid. The speed of this process is enhanced by the increased surface area caused by mining-induced fractures. When the last mine has closed and pumping has stopped, water levels recover, dissolving the pyrite oxidation products, resulting in contaminated minewater rising towards ground level. If this reaches a surface water course, further oxidation and hydrolysis occurs, leading to yet more acidity and the precipitation of ochre on the stream bed.

Mining permanently alters the state of the ground. In many coalfields, several coal seams have been extracted in extensive, overlapping 'stacks' of workings. Subsidence fractures extend upwards, not only causing damage to property on the surface, but also creating pathways for minewater movement. Although disused mine shafts may be filled and sealed, underground workings, especially access roadways, may remain open long after abandonment, providing many miles of interlinked conduits through which large volumes of minewater may flow.

"... due to exhaustion, or to economic or political factors, the mines will eventually close ..."

Barriers of unworked coal are sometimes left as a protection against flooding from adjacent waterlogged old workings. However, cessation of pumping may cause such a build up of water that these barriers fail, resulting in sudden surges in minewater flow. This is thought to be the cause of the incident at Ynysarwed.

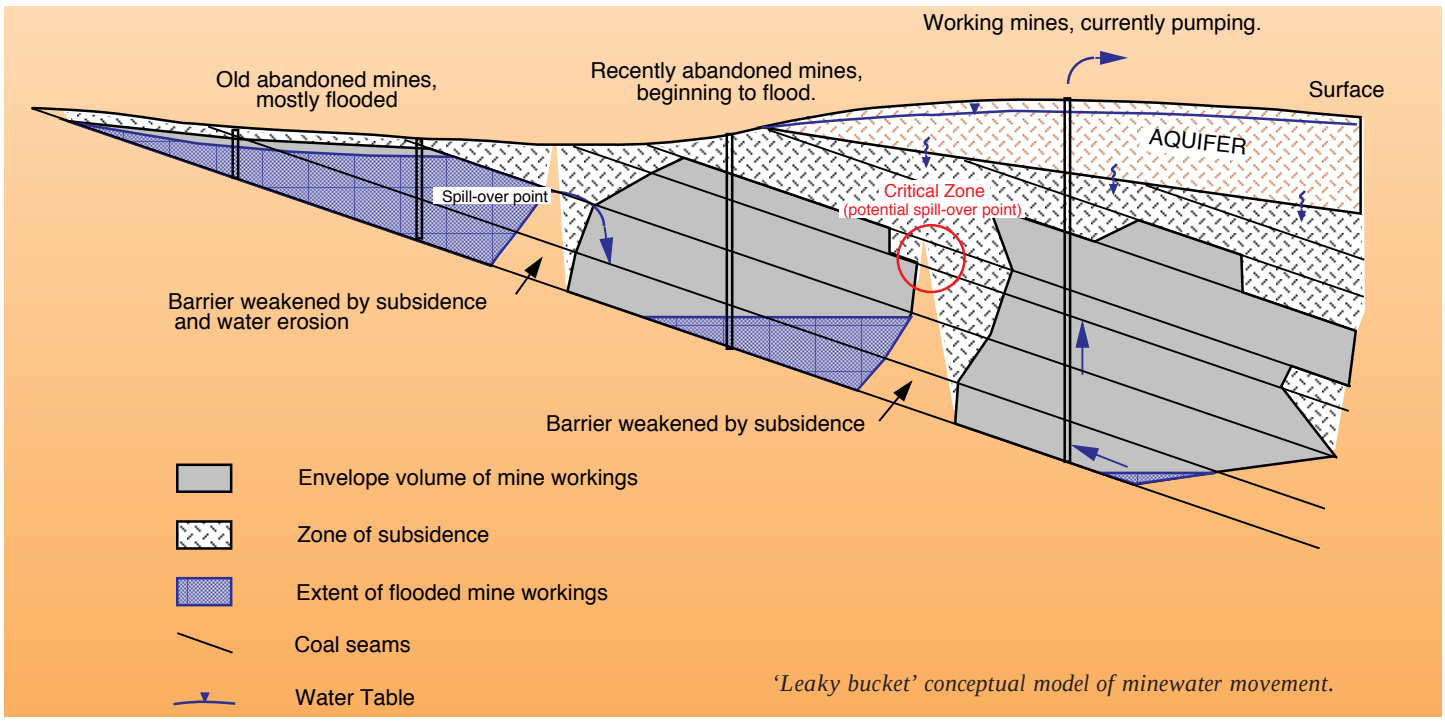
In the recently abandoned Durham coalfield, pumping stations still control water levels in the east of the exposed coalfield. To the west of the pumping stations, however, several uncontrolled ferruginous minewater discharges occur as a result of rising water levels. Research carried out at Newcastle University indicates that if pumping ceases, serious pollution is likely, especially in the River Wear, building up over a period of 40 years or so.

The Yorkshire–Nottinghamshire coalfield is Britain's largest, now with only a very few working collieries remaining. The present-day mine workings lie at the deep, eastern extremities of a network of interconnected old workings which extend westwards, rising up to the surface. These form several 'ponds' in which a group of pumping stations control underground water at carefully maintained levels, thus protecting the working mines.

Due to exhaustion, or to economic or political factors, the mines will eventually close. The situation closely resembles that at the Durham coalfield, and decisions will have to be made about whether or not to continue pumping. Recent work carried out at the BGS suggests that minewater pollution would be inevitable if pumping were to cease, not only affecting surface water courses but also posing a possible risk to the Permo-Triassic water-supply aquifers which overlie the concealed coalfield.

"... more research is needed to assess the rates at which minewater will rise, where the worst impacts will be, and what remediation or prevention measures can be taken ..."

More research is needed to assess the rates at which minewater will rise, where the worst impacts will be, and what remediation or prevention measures can be taken. Co-operation between the Environment Agency, the Coal Authority, the mining companies and the considerable hydrogeological, environmental and mining expertise of universities and the BGS is essential in order to understand and minimise the risks from this potential environmental problem.



'Leaky bucket' conceptual model of minewater movement.