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The Impact of Mine Closures on Ground Water and the Environment: A UK Lesson for all Countries

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ABSTRACT

There has been an active coal mining industry in the United Kingdom for over 600 years and many of the coalfields have been almost completely exhausted. In the metalliferous mining areas of Cornwall there has been an even longer history of mining which stretches back for over 2000 years. During recent years there has been a considerable and rapid reduction in mining activity. For example, the closure of over 100 mines and the loss of 0.5 million jobs in the last 15 years during the run up to privatisation of the coal industry. The resultant impact of the cessation of underground pumping and the rise in ground water, in some areas to its natural level for the first time in hundreds of years, has been the cause of considerable concern. There are lessons of an economic, political, social and environmental nature to be learned from this situation for other countries contemplating similar action. Practical examples from the authors experience in the UK and Eastern Europe will be described to illustrate the least-cost remediation methods employed to alleviate the problem. The need for environmental management systems is also stressed.

Key Words: ground water, mine closure, environmental management systems.

INTRODUCTION

When the UK coal industry was nationalised in 1947 there were about 0.75 Million men producing about 200 Million tonnes of saleable coal per annum. On privatisation some 47 years later the industry has been reduced to only 10,000 staff and a total production of about 40 Million tonnes. Many of the coalfields are now abandoned and there is no significant deep mining taking place. Such large coalfields as the Great Northern Coalfield of Northumberland and Durham which saw active deep mining for over 600 years are now completely exhausted and only a few small mines and opencast sites remain (see Figure 1).

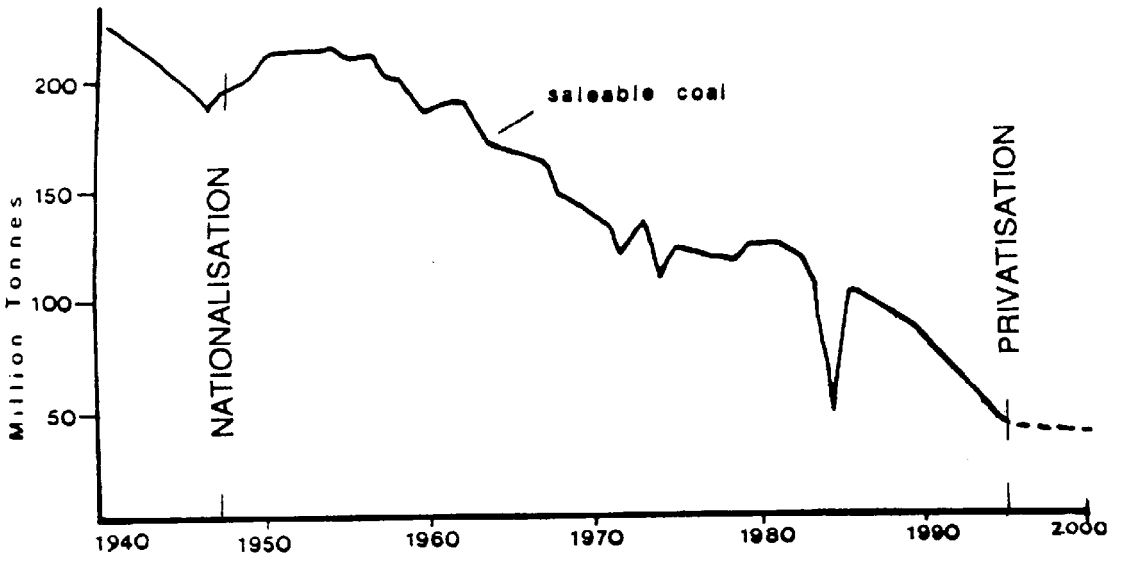

Figure 1 *The decline of the British Coal Mining Industry 1940-2000*

The legacy of vast areas of abandoned underground mine workings, many of them located under areas of extensive urbanisation and the problems that they may cause is now the responsibility of those organisations entrusted with the remains of the industry. One of the major problems that needs to be addressed is that which arises from the cessation of deep mine pumping and the subsequent rise in ground water.

Many of the coalfields have been artificially dewatered for hundreds of years and in many cases the ground water is expected to re-issue at the surface for the first time in hundreds of years. Due to the pressures caused by urban expansion during the 20th Century many low lying areas of land have been developed for housing and industrial use and it is these areas which may be affected by the rising ground water table and give cause for concern.

Also giving cause for concern is the resultant quality of the ground water after it has passed through the abandoned mine voids. In the worst case it may result in acid mine drainage (AMD) and cause pollution of downstreanm watercourses and domestic and industrial water abstraction facilities below the point of surface issue. There is also the problem of the effects of coalbed methane migration being increased due to the rising ground water.

The liability and remediation costs of these aspects of ground water rebound on cessation of mine pumping are considerable and it would be unfair to place the responsibility on the present mining industry for the consequence of several centuries of mining. As is shown by the example below of the situation in the areas of abandoned metalliferous mining in Cornwall there is an need for government funding where the declining mining industry cannot afford such expense.

The situation is by no means unique to the United Kingdom and many of the old mining areas of Europe which have also been abandoned in recent years are suffering from the same problem, especially from underfunding for remediation measures. Many of the former communist countries cannot support the uneconomic mining methods used in the past and due to the lack of capital

investment many of their minefields are being abandoned. This is particularly noticable in Poland, former Czechoslovakia and Jugoslavia, Hungary and Eastern Germany, for example.

The situation in these areas should be used as a warning for other countries where large scale abandonent of uneconomic mining areas is contemplated. For example, such areas as the older coal mining regions of Appalachia in the USA and the Ukraine.

Both industry and government should be aware of the need to prevent environmental problems on large scale mine closure and the use of integrated environmental management procedures that must be implemented in future mine planning. At present there is a great need in the less enlightened parts of the world to solve the environmental problems of historical mining activities where these procedures have, in some instances, never been heard of yet alone been utilised.

THE UK SITUATION

The major coalfields of Scotland, Wales, and NE England are now almost completely abandoned and there is only one colliery working in each of them. In each case the underground pumps have been switched off in most of the surrounding coalfield and the groundwater is starting to rise. The rise is now complete in parts of Scotland, Lancashire and is being controlled with a sequential withdrawal of pumps in Yorkshire and in the Durham part of the North East Coalfield.

Only the southern parts of the Yorkshire and Nottinghamshire Coalfield have survived the privatisation process and here a large number of underground pumps located throughout the whole of the coalfield are being maintained in order to dewater the few remaining operating collieries.

In the Nottinghamshire area of the coalfield a total of about 14.0 Million cubic metres per annum of water are pumped from several outlying pumping stations in order to keep just one colliery dry. There is a vast underground system of abandoned mine voids, shafts and adits which are all interconnected for distances up to a hundred miles.

It is considered that the responsibility for continuing pumping on such a large regional scale should be with government as the environmental libilities result from centuries of mining and are not due to present operations. The environmental liabilities resulting from the inevitable complete closure of the mines will eventually fall to government in any case.

The environmental lobbying by interested parties such as river authorities, water supply utilities and other pressure groups has certainly increased the public awareness of water pollution resulting from mining activities. This awareness usually increases the government spending on the issue, mainly because the mining industries involved are in a parlous financial state during the closure process.

The UK situation is best described by two examples from different ends of the spectrum; the Durham Coalfield situation to represent the typical nationalised coal mining industry, large ground water volumes and low pollution; and the Wheal Jane tin and copper mining in Cornwall to represent a metalliferous mining, low groundwater volume and high pollution incident.

THE DURHAM COALFIELD

There is evidence of coal working in Durham by the Romans and the first recorded commercial mining was in 1239 in Newcastle. However, the bulk of the mining took place from the mid 16th

Century upto the mid 20th Century and it is estimated that a total of about 4800 Million tonnes were mined in the county in that period.

Using accepted methods of void estimation which take account of the density of the coal, subsidence, void migration and mining method then the water bearing capacity of the coal bearing strata in the Durham Coalfield is about 1000 Million cubic metres. A maximum of 66 Million cubic metres per annum of ground water was pumped until about 1990 from 25 pumping stations located at depths varying from 51m to 600m throughout the coalfield in order to keep the last 9 deep coastal mines dry.

In the last five years the mining has been rapidly reduced and many of the pumping stations abandoned as each of the mines closed. It soon became evident that if this process continued unchecked then the ground water would eventually appear at surface in about 16 years. Most of the water is expected to issue on low lying land in the major, inhabited river valleys and from coastal mine drainage adits which discharge into the North Sea.

The quality of the mine water in the Durham Coalfield is not expected to be poor. Iron contents of below 10 ppm and pH of between 6.0 nd 7.5 are typical from isolated areas in Durham where the main water table has already rebounded to surface. Durham coals were renowned for their low sulphur content and the strata in general in Durham has a low, if not a negative Nett Acid Producing Potential (NAPP). There are no other significant contaminants in the mine water discharges expected.

However, the environmental lobby and the local government officials now demand that the water is is not contaminated with iron and therefore not visibly orange in colour. An iron content as low as 1.0ppm can produce ferruginous discharge and be visibly unpleasant to the riparian observer.

Much of the county is of outstanding natural beauty and the major river in the area passed the "World Heritage" site of Durham Cathedral, a monumental pile built in the year 800. The idea of such a historically significant structure being surrounded by a ring of orange water was just too much for the environmentalists to bear and immediate action was demanded.

At the time of writing (January 1995) it has been announced that as part of the Environment Bill passing through Parliament that the responsibility for dealing with "historical mine waters" will pass from British Coal to the newly formed Coal Authority which is funded by government. The overall bill for such remediation and control in all the British Coalfields has been independently estimated to be in the region of £0.5 Billion.

WHEAL JANE (METALLIFEROUS MINING)

The closure of Wheal Jane Mine in 1991 brought to an end almost continuous copper and tin mining for over 2000 years in a significant part of the Cornish minefield. All the mine workings are connected by drainage levels over an area of about 40 square kilometres. On closure and subsequent ground water rebound the mine discharge of about 5.o Million cubic metre per annum and pH 2.6 contained a whole gamut of toxic metals such as Cadmium, Arsenic, Copper, Zinc, Lead, Iron etc. in very high concentrations that far exceeded current pollution limits.

It was not possible for the mining company involved that was in dire financial straits to pay for the remediation and nor was it possible for the regulators, the National Rivers Authority (NRA) to bring a prosecution for pollution against them. In the first instance this was because the company was being run down and it was argued that they only mined a very small proportion of the whole

ground water regime affected and in the second instance, the legislation at the time [Water Act 1989: Section 108(4)] stated that there was no responsibility for remediation of pollution on mine abandonment.

There was therefore no point in proceeding with prosecution against the mining company and it was considered, that in the light of the massive public outcry against such gross pollution of the downstream watercourses, that funding must come from government to remedy the situation.

To this end the Department of the Environment granted £8.0 Million over three years for a pilot scheme for an engineered wetland and chemical treatment facility as an interim measure to remedy the pollution. However, this money will run out in 1995 and there is a great need for an inexpensive, passive treatment method to solve the problem in the long term. Research is continuing worldwide into this aspect.

OVERALL UK SITUATION

The main problem in dealing with such major pollution incidents resulting from mine closure is that the usual poor financial state of an industry in decline means that if they are forced into paying for these liabilities then they are likely to go bankrupt. Employment and potential for future business development is therefore lost. The responsibility for such liabilities therefore will inevitably end up in the public or government sector. It is therefore argued that it is for government on either a national or interntional scale to accept responsibility for such massive historical liabilitites.

However, having made this statement it must still be accepted that the responsibilities for current and future mining operations should be borne by the privatised industry that takes over from the nationalised one. In the UK the newly privatised coal industry is implementing environmental managent systems in order to protect the large investment in the industry by the financial institutions. The UK banks have invested over £1.0 Billion in the privatisation of the coal industry and environmental liabilities play a large part in their assessment of any project.

THE SITUATION ELSEWHERE

In some parts of the world, especially the former communist states, there has been little experience of environmental management and as many of the large, uneconomic mines are being privatised there is a concurrent large closure programme as the non-profit making parts of the industry are discarded.

In other parts of the world, notably South Africa, where there is a long history of mining and the country is very dependent on the industry for its prosperity, there has been a more pragmatic approach to the problem. Here, all mines are now expected to have in place an environmental management programme and on closure the Government will issue a closure certificate if all the aspects in the programme have been achieved. If this is so then the government will assume all responsibilities after mine closure for environmental protection, especially those concerning hydrological matters.

In North America the Comprehensive Environmental Response Compensation and Liability Act or "Superfund" has been the cause of much debate. For example, the requirement for coal mining in Pennsylvania during the 1980's to adhere to rapidly enforced and very stringent legislation

regarding mine drainage, in particular the limitation on Manganese, led to many operators filing for bankruptcy.

The end result of this was that even worse enviromental problems ensued and needed to be solved through public funding. The lesson learned here was that it is not possible for the modern mining industry to be held responsible for a legacy of historical mines even if it was only 150 years old.

In Poland the author was a member of a team investigating the environmental, economic and social aspects of the first coal mine closure in the Silesian Coalfield. Apart from being very unpopular with the workforce and the local media, the team found it very difficult to assess the true economic and physical state of the mine that dated from 1738. Virtually no environmental management system was in place and the situation regarding groundwater control and the effect of cessation of pumping on the surrounding mines had not been fully considered in an economic or environmental sense.

There is a considerable problem throughout the Eastern European countries where there are huge environmental issues to be considered of rapid closure of large mining areas brought about by the sudden realisation that they cannot compete economically on a global front. Whether it is with Uranium mining in Eastern Germany, metal mining in Slovenia or coal miningin Hungary, Poland or Czech Republic the problems with ground water rebound are considerable and cannot be left unchecked.

There is a great need for international funding and the design of large and effective environmental management systems that also embrace the financial and social aspects in these emergent countries. There is also a need within these systems for sensible, cheap but cost-effective water control and pollution remedial methods.

REMEDIATION METHODS

Remediation methods for such large scale problems must be low cost. preferably passive, environmentally acceptable, relatively labour free and unobtruive. In the case of deep mines the best available technology has yet to provide a method where the polluted groundwater can be treated underground before it issues at surface.

To summarise, the best environmental options available for control measures after mine closure would appear to be:

- Set up environmental management systems well in advance of closure to deal with the main ground water issues.
- To continue pumping at a reduced volume at higher levels in the strata in order to minimise water issuing at surface.
- To use cheap and effective passive water treatment methods such as engineered wetlands to treat surface issues,
- Protection of surface structures from the effects of acidic waters on concrete foundations, toxic landfill sites etc.

- The control or prevention of increased methane migration due to ground water re-bound in abandoned coalfields.
- As a last resort, the use of expensive chemicals or preferably biochemical methods to treat water both underground and at surface.

CONCLUSIONS

The experience gained in mine closure in established major mining areas of the UK and Europe should stand as a lesson to those contemplating such action in the new world and the developing countries. The environmental issues at stake are often irreversible and can be prevented by judicious forward planning. It is difficult to solve the problem in the long established, historical mining areas of the world where much of the environmental damage was created several centuries previously.

However, for the modern and future mining areas the enforcement through government legislation and employment of well-designed environmental management systems can prevent the wasteful expenditure of extremely large sums of money in ground water control and pollution treatment. The experiences in the old and declining mining industry in the old world is there for all to benefit from. The present mining industry cannot afford to pay for the huge legacies of past mining activity and the answer must lie in government support. For liabilities associated with current and future mining projects then it is up to the industry itself to adopt the maxim that "prevention is better than cure" and take advantage of well designed environment management systems.