

MINING AND THE ENVIRONMENT

Fred G. Bell

British Geological Survey, Blyth, Nottinghamshire, United Kingdom

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Summary

Mining has played a fundamental role in the development of civilization. It is a robber economy, disturbs land, may alter topography and change hydrogeological conditions, and gives rise to land spoilation. The environmental degradation it causes should be kept to a minimum. Land restoration can proceed concurrently with mining and be completed once mining has ended.

Subsidence occurs when a mineral deposit, water, oil, brine, or gas is taken from the ground, unless precautions are taken or the mining takes place at great depth. The type of subsidence depends upon the method of mining. Subsidence can be slow or rapid, and can affect large areas and have serious effects on surface structures. The collapse of old shafts has led to the loss of life. Various measures can reduce the effects of subsidence.

Mining produces waste, especially metalliferous mining where less than 1% of the material mined may be ore. Coarse discard waste is disposed of in spoil heaps, and tailings in tailings lagoons. Acid mine drainage is often associated with metalliferous deposits and coal mining. It can seriously pollute streams and decimate vegetation. There are various methods of dealing with it. Heap leaching, used to extract metal from ore, uses a solvent, commonly cyanide, and may lead to ground contamination.

Coal mining problems include spontaneous combustion and hydrocarbon gases. Spontaneous combustion may affect underground mines, opencast mines, spoil heaps, and stock piles. Various methods, not always successful, have been used to control underground fires. Other methods are used for burning spoil heaps. If methane escapes to the surface it may accumulate in buildings and lead to explosions. Mineral dusts, especially fine quartz and asbestos, can give rise to serious health problems and ultimately death if inhaled.

1. Introduction

Mining, alongside agriculture, represents one of humankind's earliest activities, the two being fundamental to the development and continuation of civilization. However, unlike agriculture where there is some choice in where and what to grow, mining can only take place where minerals are present in economically viable deposits. Another important aspect of mining is that it is a robber economy, in that a mineral deposit is a finite resource and so mining comes to an end when the deposit is exhausted or uneconomic. Deposits that are abandoned when they become uneconomic to work may be reworked at some time in the future, when mining technology or demand makes their exploitation once again worthwhile.

Mining and the associated mineral processing and beneficiation do have an impact on the environment. Unfortunately, this frequently has led to serious consequences. The impact of mining depends on many factors, especially the type of mining and the size of the operation. It can mean that land is disturbed, that the topography is changed, and that the hydrogeological conditions are affected adversely. Mining also has social impacts on the environment. Communities grow up around mines. When the mines close, the communities can suffer and may die.

In the past the mining industry frequently showed a lack of concern for the environment. In particular, the disposal of waste has led to unsightly spoils being left to disfigure the landscape, and to pollution of surface streams and groundwater. Urban areas have suffered serious subsidence damage by undermining. Today, however, the greater awareness of the importance of the environment has led to tighter regulations being imposed by many countries to lessen the impact of mining. The concept of rehabilitation of a site after mining operations have ceased has become entrenched in law in many countries. An environmental impact assessment is necessary prior to the development of any new mine, and an environmental management program has to be produced to show how the mine will operate.

Although the adverse impacts on the environment must be minimized, some environmental degradation because of mining is inescapable. Mines, however, are local phenomena, although they may impact beyond mine boundaries. They also account for only a small part of the land area of a country (for example, the mining industry accounts for less than 1% of the total area of South Africa). Land that has become derelict by past mining activity can be restored, at a cost. Rehabilitated spoil heaps frequently become centers of social amenity such as parklands, golf courses, and even artificial ski slopes. Open pits, when they fill with water, can be used as marinas, for fishing, or as wildlife reserves. Even some underground mines can be used, such as

those in limestone at Kansas City, Missouri, which are used as warehouses, cold storage facilities, and offices. Mining therefore can be regarded as one of the stages in the sequential use of land.

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Biographical Sketch

Fred Bell graduated with a B.Sc and M.Sc. from the University of Durham and received his Ph.D. from the University of Sheffield, UK in 1974. More recently, he received a D.Sc. from the University of Natal. He is a fellow of the Royal Society of South Africa, a fellow of the Institution of Civil Engineers and the Institution of Mining and Metallurgy, and a fellow of the Geological Society, being both a chartered engineer and a chartered geologist. He is the recipient of several awards.

Professor Bell now is a Visiting Research Associate at the British Geological Survey. Previously, he was Professor and Head of the Department of Geology and Applied Geology, University of Natal, Durban, South Africa, during which time he also was a Distinguished Visiting Professor, Department of Geological Engineering, University of Missouri-Rolla, USA.

Professor Bell's research subjects have included ground stability, subsidence, ground treatment, engineering behavior of soils (clays, expansive clays, saprolites, tills, laminated clays, dispersive and collapsible soils, sands), engineering behavior of rocks (sandstones, carbonates, evaporites, shales, basalts, dolerites, granites), cement, lime and PFA stabilization of clay soils, acid mine drainage, mining impacts, landfills, derelict and contaminated ground, rock durability in relation to tunneling, slope stability, aggregates, building stone, and geohazards.

In his professional activity Professor Bell has been involved in a variety of work in the UK, southern Africa, and Malaysia concerning site investigations; foundations; settlement problems on clays, fills and sands; old mine workings and subsidence; longwall mining and subsidence; ground treatment; groundwater resource assessment; slope stability; use of mudrocks for brickmaking; assessment of various rock types for aggregates; contaminated ground; acid mine drainage; landfills; dam sites.

Professor Bell is author/editor of 17 books, several reprinted, one in its fourth edition, one translated into French, two into Italian and yet another into Malay, and an Indian edition (in English). He is also author of over 200 papers on geotechnical subjects. He has served on the editorial boards of five international journals and has been a series editor for three publishers.