

Recent developments in coal mining

Lloyd Boardman¹

BOARDMAN, L. (1994). Recent developments in coal mining. *Proceedings of the Shropshire Geological Society*, **10**, 7–9. An overview of the kinds of exploration techniques which have developed during the 1980s and 1990s for coal mining, notably drilling, coring and seismic geophysics.

¹affiliation: Senior Geologist with British Coal

INTRODUCTION

Modern coalmining exploration has been becoming very sophisticated, in recent years much of it based on geophysical methods. This article provides a snapshot of the kinds of techniques which have developed during the 1980s and 1990s.

There are two main reasons for doing exploration. The first is to discover as much as possible of the hazards which may be encountered in the mining operation and thus achieve maximum safety. Typical hazards and obstacles are aquifers, pre-existing shafts, old borings and also ingress of oil and gas. The second reason is to find new areas of coal and discover if such new coal can be mined economically.

Thus exploration becomes a method of risk reduction, physical and financial.

MINING TECHNIQUES

Modern mining by machines limits the minimum thickness of seams which can be operated economically. There are two systems usually adopted. The first is where two parallel roadways are constructed and the working face advances between them. The second is where roadways are run round three sides of a block and the working face retreats back to the starting position of the roadways.

There are advantages and disadvantages in using both systems. In both systems the roof is supported using power supports: hydraulic jacks with large pads, installed at metre intervals along the length of the working face. At the end of a cut the machine and the supports are moved forward together and the roof allowed to collapse progressively to the floor behind. If a seam is faulted the cutting machine comes up against a

rock face instead of coal. If it is economically feasible the whole operation is raised or lowered to a new level; all very expensive, depending on the throw of the fault.

Various other obstacles may be encountered such as deltaic planes, distributor channels, peat swamps and lagoons, all of which disrupt the working of the seam. Seams also split up, merge, and have lumps and bumps. The worst of these sedimentary structures is a sand body with compaction faults which results in unstable roof conditions, not at all welcome.

GEOLOGICAL CHARACTER

The sedimentary history of most large coal seams is often very diverse. In a seam several metres thick there might be a mixture of sediments laid down at differing times so the coal may have mixed characteristics of ash, sulphur and chlorine, usually with dirt bands between the subsections.

The cutting machines are non-selective and have to take the coal as it comes, so it is important to know how the bands move through the seams from one end of the mine to the other. The value of the coal produced varies with the ash content and the amount of dirt mixed in with the coal. Thus an attempt has to be made to blend the output to a specified quality, which means varying the output from different working faces to get the right mix. The alternative is to treat the output by "washing" to improve its quality, but this is very expensive and messy.

These are the kinds of problems that exploration attempts to answer in order to reduce the safety and financial risks.

EXPLORATION

Where do we look for new coal? There is a very large amount under the British Isles and the object

is to home in on the best bits. A lot of it is too deep to mine by current methods and in present conditions. The depth cut-off is 1200 metres where the geothermal gradient makes it too hot for safe working; added to this is the heat from machinery which can only be marginally offset by ventilation.

Exploration since nationalisation in 1947 reached two peaks of activity, one in the mid 1950s and another and larger around the end of the 1970s. The first peak was an overall survey. The second peak was a reaction to the world fuel crisis, a massive investment programme looking for a projected output of 175 million tons in the mid-1990s, a figure which has been eroded by circumstances to 40 million tons.

The 1970s exploration policy included significant amounts of seismic surveying; none was carried out during the earlier period. The Coal Board did not experiment with seismic methods until about 1971. Oil and gas exploration had used the technique for a long time but the requirements for coal were altogether different. Oil and gas occur in large thick sediments at great depth. Coal for mining purposes is in relatively thin bands and no deeper than 1200-1500 metres, and presents much smaller targets.

The surface seismic reflection technique needed a lot of experimentation and research which was very successful and resulted in a sustained period of exploration. A number of new, highly productive mines were established, for example, in Selby and northeast Leicestershire. Also new areas of coal deposits were found in a number of widely dispersed places so that known reserves are calculated to be quite considerable.

Seismic surveys are carried out by drilling holes varying between 5 and 20 metres deep, putting into the holes 1 kg of dynamite and laying out a line of geophones on the surface. The geophones and an exploder are connected up to a recording truck housing a very fast camera, recorders and computer. When the shot is fired the energy causes reverberations and reflections from the various underground structures; these are recorded within a period of about two seconds. The data are analysed and a picture is developed of the structures underground. The whole operation is mobile, the drill for the shot holes being tractor mounted so that, within reason, it can go anywhere. In sensitive areas where explosions would be impractical a vibrator vehicle is used to generate the energy. A truck with underslung hydraulic vibrator pads

generates a range of frequencies. In places where even this cannot be used individual "thumpers", like those used for small repairs to tarmac, are set up in groups with the geophones and recorder truck as before.

The seismic technique, as used for coal exploration, requires a much greater attention to detail than the methods used for oil exploration. On-site testing of shot size and depth of shot hole is carried out and the method fine-tuned in order to optimise the results necessary for interpretation of the reflection. Where very detailed surveys are required the area to be studied is gridded on, say, a 2 km x 2 km square. The results obtained can then be modelled by computer to give a three dimensional picture 1 km deep. If the survey shows favourable conditions the next step is to drill bore holes to obtain cores down to the necessary depths and get accurate information for development costing and strategy planning.

The boring is carried out with a normal drill rig, although nowadays these are made up of prefabricated unitised pods for rapid turnaround. The cores are examined by geologists and the holes further investigated using wireline logging. Wireline logging provides a great deal more information and detail and is a vast improvement on what went before. Wireline logs are round stainless steel tubes packed with electronic instruments, measuring background radiation, resistivity and so on, enabling rock types, thickness and position of bedding planes, dip, jointing and fractures to be checked and accurately positioned.

Seismic techniques can be used underground as well as on the surface where coal seams themselves are used as a guideway for the energy. A series of holes are drilled, across the length of the working coal face, using a hand held screw drill. The holes are about two metres deep and spaced at about two metre intervals. Dynamite charges and geophones are alternately inserted into the holes and all are wired up to recording and computer equipment. The charges are then set off one at a time. If no reflected energy is recorded this is great news, as it means there are no obstacles in the way. Any reflections show up faults or variations in the seam for distances up to several hundred metres ahead.

Further variations in the use of this technique have been devised and a very useful one is a survey to show possible continuity in seams. A borehole is sunk to the level of the seam of interest

and a geophone cemented in at that level. Another borehole is drilled down to the same seam but several hundred metres away and a dynamite charge set off. Recording the energy characteristics of the geophone output, frequency amplitude and type of energy in the guided wave produced by the charge allows a geologist to interpret the results and be certain of conditions within the seam. He can then tell the mining engineer exactly what to expect.

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