CHAPTER THREE: METHODS OF COAL MINING AND HISTORICAL BACKGROUND OF COAL MINING
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METHODS OF COAL MINING AND HISTORY OF MINING IN RANIGANJ COALFIELD

The coal industry of India takes the second place after China in the Asian world and ranks fourth in western world with an output of about 170 M.T. in 1986.¹

Coal is mined by two main methods - (1) Surface mining and (2) underground mining (Fig.10). The choice of methods is determined in large part by the geological parameters of the coal deposit. Only those coal that occur at relatively shallow depths are likely to be mined by surface methods in most countries,² because removal of overburden by either manual or mechanised means in such case is economical. In case of multiple occurrence of coal seams, where the overburden to coal ratio is favourable, relatively deep coal seams can also be mined by surface methods. There are, however, a number of environmental issues associated with surface mining of coal like land acquisition problems, land reclamation, disturbance of underground water and potential pollution of surface water.³ Quite different considerations of mining technology, environmental protection, health and safety, and costs apply to underground and surface mining.

3.1 SURFACE MINING

This method of mining is generally less costly and recovers higher proportion of the coal. It is characterized
by higher labour productivity than in underground mines. There is often little need for special training for the workforce.

There is, therefore, a tendency to exploit the surface mineable coal in preference to coal mineable only by underground methods. The equipments used in the surface mining are draglines, buckets, wheel excavators, large trucks, high capacity conveyors. Technology exists to handle environmental problems in most locations at moderate cost. It is felt that they do not present insurmountable barriers to the increased production of coal from surface mines. Factors on which opencast mining depends are (1) depth of coal seam; (2) thickness of the seam; (3) inclination of the seam; (4) extent on the rise and dip; (5) workable reserve; (6) geological disturbance.

Mechanised quarries which use shovel and dumpers, consider 4 to 1 as O.B. to coal ratio for economic quarrying. The ratio of depth of OB to seam thickness is important as well as the type of OB. Ratios as high as 12 to 1 and thickness of OB to 155 or 300 ft. have proved economical. The opencast method is suitable for the extraction of shallow seams at and near the outcrop since it produces less permanent surface damage and more coal than deep mining.

In developing a site, the first step is the provision of a good hard-cored access road, generally in the centre of the area, for the heavy mechanised shovels, draglines and
scrapers used in removing the overburden and coal and for the movement of heavy lorries. Cut off trenches and drainage ditches are excavated to ensure that a minimum of surface water gains access to the working area.

Surface mining can be divided into two main types: Area and Contour mining. i) Area mining is employed where the terrain is relatively flat or generally rolling in character. The coal is removed and OB deposited in long trenches. ii) In the mountaineous terrain, Contour mining is used. iii) Auger mining where machines drill horizontally into the seam, is used in conjunction with contour mining on steep slopes.

Surface mining physically disturbs only the land that is mined, but it may have harmful effects on neighbouring lands as well. Unreclaimed land is eliminated from alternative uses.

In short, opencast mining consists of the following operations.

A. Removal of overburden comprising -
   i) excavation of overburden
   ii) disposal of overburden.

B. Winning of coal comprising -
   i) breaking of coal
   ii) shovelling and transporting of coal.
A. Top loose soil may be removed by scrapers or dozers; strata immediately below will require blasting. A series of holes are drilled in a triangular pattern with the diameter of holes being 150 mm to 200 mm. Capital equipments such as power shovels (for OB and for coal), bulldozers, and draglines needed to remove the overlying rock and dirt, are usually largest of their kinds. Drills, jack hammer, drill for drilling in boulders for secondary blasting, tractors dozers, dumpers, air compressors, cranes along with pumps, pipes and flood light fittings, switches and transformers, road roller, portable welding sets etc. are the other equipments for opencast workings. Moreover, a well-equipped workshop is necessary to run a mechanised quarry. The coal is usually transported by dump trucks or lorries to screening and loading points on the railway.

When the site is exhausted, restoration of land must began and care must be taken to restore it as far as possible to the former conditions and contours. The heaps of OB from the initial cut that have not been back-filled, are levelled by bull dozers. The soil is then replaced on top and levelled as near as possible to the original contours. Generally, grass is sown for first two years and then arable crops may be planted.
References


3.2 UNDERGROUND MINING

The majority of world's coal deposits are mineable only by underground methods. Even though surface mining is likely to expand considerably over the next few decades, it is probable that by the end of the century and thereafter the greater part of the world's coal production will come from underground mines.

Underground coal mining is usually more labour-intensive than surface mining. Unit capital investment in new mines may in some cases be comparable to that for surface mines, but total costs per ton are generally higher in underground mines. The characteristic rhythm of production tends to be fairly uniform over the life of these mines because production capability is normally strained by the designed haulage or hoisting capacity. The continuity of employment that accompanies stable production rates is very important.

A skilled, specially trained workforce is required for underground mining, one that regards itself quite properly as a separate profession. Because coal mining has been carried out for decades or even centuries in some important old mining districts, coal mining inevitably has acquired many traditional aspects. It is not uncommon to have several generations of the same family all involved in coal mining.

Two underground methods are in common use in
removing coal. They are - i) bord and pillar (B & P) or pillar and stall; room and pillar and its derivatives. ii) Longwall mining.

i) In underground mining method, the bord and pillar system is historically the older and involves driving in the coal seams a series of narrow roads or heading parallel to each other and connected by a second series of parallel roads or headings generally at right angles to the first set.¹ The roads or tunnel are referred to as 'bords' or rooms. These generally range from 14 to 20 ft. in width and the roof is stabilised by 'pillars' of coal as well as artificial supports.² The coal to be worked is cut up into pillars for subsequent extraction which may be either partial or complete according to geological conditions or to the necessity of supporting the surface. These are two stages of B & P working namely - a) development and b) depillaring.

As deeper seams are worked, the B & P system is later replaced to a large extent by longwall advancing system. Longwall mining is an European technique in which the coal face of a seam is sheared off by mechanical planes or plows. In this system of mining coal is recovered in two phases - a) advancing, and b) retreating. In longwall advancing system the coal is extracted in panels by advancing the face on a broad front into the unworked coal. The roads providing access to the coal for transport and ventilation are left behind in the worked out area and are
supported by packs of stone. Only jack-supports are used for roof stabilisation and since the jacks follow the machines as the seams is penetrated.

The two preceding systems are in effect combined in the 'longwall retreating' system. Roads or headings are again driven into the solid coal but at wider intervals so that the pillars formed are much larger than in the bord and pillar system. The pillars are then extracted on a broad face in the opposite direction from that in which the headings were driven.

On the basis of geological condition, a) caving i.e. full extraction of pillars of coal, or, b) stowing i.e. underground voids are filled up with sand, water, rock debris, etc., are adopted.

a) Ideal conditions for total caving exists with a strong floor, medium hard roof and surface area free from any surface features. There are a few merits of total caving. These are: 1) low production cost; 2) the manpower required is less; 3) more rapid face advance; 4) convergence at the face is small because of relief of weight behind; 5) surface subsidence is uniform over the area being worked.

In bord and pillar workings the leaving of pillars of inadequate size, causes failures of pillars and thereby causing the great subsidence area. Subsidence is erratic and
irregular. In longwall working, with its straight line of face and regular rate of advance, the subsidence is regular and uniform.  

b) The merits of stowing are: 1) the coal being replaced completely by stowing materials and subsidence is reduced to a minimum; 2) the ventilation at the face is good; 3) percentage of extraction is high; 4) hazards of 'gob' fires due to spontaneous heating are reduced; 5) damages due to bumps and air blasts are reduced; 6) it renders possible the extraction of a thick seam with safety.

Stowing is considered essential in the following circumstances: 1) in areas underlying fire, 2) in areas underlying important surface feature, 3) in thick seams say above 5 mt, 4) in actively gassy mines, 5) under waterlogged ground, 6) seams with massive sandstone roof, 7) seams with geological disturbance, 8) where the strata conditions are very difficult.

c) An intermediate system could be adopted which is known as splitting as a final operation under following conditions: 1) where there is no arrangement for stowing, 2) availability of sand is limited and cost of sand transport is high, and 3) where there are important surface features.

The merits of splitting, the third or intermediate
methods are: 1) less surface subsidence than total caving, 2) greater control than total caving where seams are geologically disturbed, and 3) greater protection to seams in close proximity.

Underground working are joined from the surface either by shafts (pits) and inclines. Adits are another type of entry. It is a horizontal underground passage given access to the mineral deposit and open to the surface at the one end.

Shaft is a vertical underground working which has a direct exit to the surface and which is intended for servicing the underground works. According to their functions shafts may be classified as main shafts and auxiliary shafts. The main shafts mainly serves for hoisting coal to the surface. The auxiliary shaft, is used for hoisting and lowering men, material, equipment and waste for the purpose of drainage. Ventilation is ensured to remove gas and fumes and to supply fresh air upto the working point by fixing a mechanised fan. Air shafts are common in underground workings.

Headgear ('chanak' in local language of Raniganj area) is erected on which headgear pullies are mounted to divert and glide the steel rope called winding rope, on to which a cage is fastened. The winding rope is coiled on a drum, driven by electric motor, or steam engine. The whole device is called winding engine. It is the means of bringing men and mineral from the mine and to the mine.
Inclined shaft or incline has the same functions as corresponding vertical workings. Incline has gentle dip and is used where coal seams are not in great depth and shaft sinking is not possible because of the existence of any surface feature just over the underlying working zone. In steep seams where coal can be made to gravitate, special inclined workings are driven known as 'chutes' or 'winzes'.

Tubs carry coal from underground to surface. Tubs move on rails laid underground up to working as coal cutting points, and on surface, up to coal unloading points. Tubs are pushed into cage at pit bottom in case of shafts and then hoisted. These tubs are unloaded on surface either manually or by a tippler - a mechanical device to unload tub, in the depot, the unloading point.

Sometimes raw coal is passed through a screening plant called CHP (coal handling plant) to segregate steam, i.e., lumpy coal and slack, i.e., dust.

From coal face to pit bottom the means of transport may be 1) tubs, 2) by conveyors laid underground from face to pit, 3) by mine cars (2½ MT to 3½ MT capacity large tubs) drawn by diesel engines underground. Tubs are hauled to pit by rope haulages. This system essentially consists of a drum on to which the haulage rope is coiled. The drum is rotated by an electric motor through gears and the moving rope pulls up the tubs in which coal is loaded. Advantage
of gravitational pull is taken for sending the empty tubs
down the gradient of coal seam to the faces.

Transportation from pit bottom to pit top by winding
engine and cage in shafts and directly by rope haulage or by
conveyors in inclines is common. From pit top to coal depot,
coal tubs are either manually pushed to be unloaded where
distance is too near or pulled by rope haulages to depot or
may be carried by conveyor also. Unloading is done either
manually or mechanically with the help of tippler. Coal is
transported to consuming point by railway wagons or trucks
to be carried on roads.

There are a number of methods of winning or getting
coal: 1) by coal cutting machines and blasting - this is
the normally adopted method in most non-mechanised and semi-
mechanised mines; 2) pick mining which is now obsolete;
and 3) by blasting without cut (solid blasting) - this is
done in non-gassy mines with special type of explosives and
also in opencast mines.

Coal cutting machine essentially incorporates a 'jib'
tongue) round which a chain containing cutting picks rotate.
This machine is manoeuvred within coal face and a cut is
produced. The purpose of a cut is to create a free face for
promoting breaking of coal in blasting.

Coal faces are holed by drills and these holes are
charged with explosives which are fired. The shock produced,
breaks coal. Loading of coal in face is done by loader machines such as, side discharges loaders, joy loaders, front-end loaders etc.

In B & P mining, some 30% of a given area of the seam is exposed by development, whereas with longwall mining only 5% of the area is exposed. Extraction of the pillar in the longwall system with equipment as developed today under suitable conditions yields high rates of production with good roof control and extremely safe working condition.

In India with strong roof conditions and seam thickness of 2.5 mt. to as much as 6 mt., the B & P system is favoured with lesser capital investment. With few trained personnel the method proves very successful. In B & P system 25 to 30% of the total coal in situ is normally recovered in development phase while on depillaring phase pillars are cut and recovery rate without stowing is 65 to 70% of left out coal. Percentage loss of coal with stowing is 5 to 10% while without stowing it would be upto 20 to 30%.

Subsidence becomes a very important issue of today. Areas mined with B & P method frequently experience subsidence decades after the operation has ended. Longwall mining is a more favourable method in regard to subsidence. Ground movements initiated by longwall mining are completed in a relatively short period. The settling process is quite consistent even over large areas allowing surface structures
to move as a whole, limiting damage. Only the border areas might experience serious problem. The process leads to spontaneous combustion which taking place where high temperature prevail because of greater depth of mines and favourable oxygen supply conditions through surface cracks, bore holes, pit mouth, etc.

Now-a-days in India the tendency to exploit quarriable coals by opencast methods as against extraction of coal amenable to underground mining will grow on account of need to match production capacity with rapid demand growth. Opencast mines on account of their better economy and shorter gestation periods fit better into any strategy for production growth. It may be noted, however, that recent trends abroad indicate that the rate of increased productivity from larger equipment is slowing.
References


3. Ghosh B., Winning and Working (Coal), Published by Dhanbad Publishers, Post Box 45, Dhanbad, p.44.

4. Ibid., p.39.


6. Meyers R.H. (Editor), 'Coal Handbook'.
3.3 MINING TECHNOLOGY ADOPTED IN RANIGANJ COALFIELD

In spite of about one hundred fifty years of checkered history, in the early seventies the coalfields presented a vast spread of fragmented leaseholds and hundreds of owners. On 31st January, 1973, the non-coking collieries were taken over by Union Government. This laid the foundation of what is known today as Eastern Coalfields Limited. One of the foremost tasks after nationalisation was amalgamation of smaller holdings. Initially 214 working collieries and 156 closed or abandoned mines were taken over. Later on, another 52 mines (mostly closed or seasonally operating) were taken over in outlying areas. All these mines were amalgamated into 92 reconstituted collieries.

There are fifteen areas including steel plants coal mines within ECL. Three of the fifteen areas are located in the state of Bihar. They are the mines under 1) Nirsha, 2) Kapasara and 3) Mugma areas. Others within the boundary of West Bengal are - 4) Pandaveswar, 5) Bankola, 6) Kenda, 7) Kajora, 8) Kunustoria, 9) Satgram, 10) Sripur, 11) Sitarampur, 12) Sodepur, 13) Salanpur, 14) Dishergarh Area and 15) Steel Plant Mines (S.P. Mines).

At the time of nationalisation in 1973, about 90 per cent of the production came from underground mines and 10 per cent from manual quarries. Most of the mines had limited production capacity and about 81% of them were producing less
than 500 tons per day or 0.15 M.T. per annum. Bord and pillar system of mining was the prevalent method of working in underground mines except for two longwall faces which were in operation in conjunction with stowing. Predominance of thick seams and shallow cover were also the reasons for adoptions of bord and pillar system. In the past most of the underground mines were working through shafts. In view of limitation of capacity and high investment for sinking and winding equipment, the present trend is for use of cross measure drifts or inclines for coal excavation. Such inclines have been planned upto about 1.4 km length with limiting gradient of 1 in 4. Length of such inclines could be further increased with the availability of high capacity conveyors and suitable fast drivage equipment.

Modest efforts have been made to mechanise the operations in bord and pillar system. As regards longwall method, trial faces were worked with individual friction and hydraulic props. Recently powered supports with ranging drum shearer have been introduced in longwall faces at two mines for extraction of thick seams.

In the opencast mines a few projects with capacity 0.2 to 0.4 M.T. per year were started during 1974-75 with disel shovels, scrapers, small capacity dumper sets. In case of opencast mines, the size of the mines will range from 8 to 12 sq.km. Opencast mines in this coalfield are limited due to non-availability of adequate quarriable reserves.
In 1986-87, the detail study area, namely the Satgram area with twelve working mines, has fallen within capacity 'C' (production 1 to 2 million tons per year) and Kunustoria Area (only 2 mines among the 10 have taken for detail study of the thesis) has fallen to category 'B' (2 to 3 MT per year).

Inspite of experience of mining in Raniganj coalfield since 1774, methods of mining have not undergone any perceptible change. The practise of bord and pillar system of mining for development and depillaring still continues and have inherited several unsound mining practices like,

a) development of entire area of mine without forming panels,
b) selective mining, c) development of thick seams in multi-sections and d) formation of inadequate size of pillars and wide galleries. Production from development workings exceeded the production from depillaring working and this resulted in locking up of large number of coal pillars. Multi-section development in few cases was without adequate or regular parting and not maintaining coincident verticality resulted in loss of coal. Lack of investment resulted in small and manually operated underground and opencast mines which have a limitation of the economic overburden to coal ratio 1:1 only.

Underground mining has generally been confined to seams 1.2 mt. and above in thickness while opencast mining is confined to seams 3 mt. or more in thickness. Stowing
or 'sandstowing' the void spaces in underground mines is necessary to facilitate better extraction and conservation of coal by increasing the life of the mine and its reserve and to stop future subsidence of the land surface above. But at present, some deliberate subsidences have been done at some localities below which depillaring has been completed in the underground mines. Since high cost is involved in sandstowing in underground mines, this is done in only selective places only where important villages and towns stand above the concerned mines.

The normal practice of coal production by the ECL authorities in the underground mines in the Raniganj coalfield is by development: depillaring methods at a ratio of 50:50. Within the depillaring part 60% production is obtained by caving and 40% is achieved by sandstowing.
References


2. Ibid., p.317.


5. - A Survey by Mining Journal Research Services 'Mining Magazine', September 1987, p.244.

3.4 HISTORY OF COAL MINING IN RANIGANJ COALFIELD

Coal mining in India had an early origin. Remains of old slag heaps within the coal-bearing areas of eastern India and such names of villages and localities as Kalipahari (black hill), Damodar (fire in womb), Barakar (big mine) and Angarpahara (charcoal mine) indicate that in older times coal was used for fuel and reducing iron ore.¹

Archeological evidence indicates that coal was being used in our country even during the more remote periods of history. Coal was being mined and used in Bengal particularly in the Raniganj coalfield before 1600 A.D. In those early days, the people from Medinipur area used to come up the river Damodar from Tamralipta with boats laden with salt which they used to sell to the traders along the river route, and on their return journey used to load the boats with coal obtained from Raniganj and sold coal to local merchants on their way back.²

After the Battle of Plassey, the coal industry then existed in and around Kalipahari, Dishergarh and Barakar (the first and the third names are indicative of "coal hill" and "large mine"). The indigenous coal industry which existed in the eighteenth century in a miniature form was completely uprooted by East India Company's Policy.³

The first published reference to the mining of coal in India dates back to the year 1774, during the time of
Warren Hastings, when permission to work coal mines in Bengal was accorded to John Sumner and Suetonious Grant Heatley. They were both in the service of the East India Company and discovered certain coal mines of Bengal.

The Company Board consisting of Warren Hastings as president and others, gave the permission to mine the area except the cultivated lands adjacent to mines. Mr. Redfearne subsequently joined M/s. Sumner-Heatley in October, 1774. As a result, mines were reported to have been developed in the Raniganj field, at Aitura (Ethora) possibly in the Disher-garh seam, at Chinakuri near the Damodar river, doubtless in one of the middle Raniganj seams, and at Damalia, also near the Damodar, apparently in the Nega-Raniganj seam. At least several thousand 'mounds' (1 mound = 82 pounds appr.) of coal were raised, of which some 2,500 'mounds' were delivered to government in 1775. The latter reported it to be of poor quality. As a result of various vicissitudes, this original adventure apparently ended in failure.

No further attempt was made to mine coal in India for nearly forty years until 1814, when mining was commenced at Egara near Raniganj town. Although this effort was again temporarily unsuccessful. In 1814, Mr. William Jones from England discovered Heatley's workings. He sank down shafts in the vicinity of Damalia. His early prospecting efforts found a coal seam at Raniganj (near Egara village - 23°36'N and 87°86'E) which he began to work on his own
It was the discovery of the first seam of coal at Raniganj in 1815 that was destined to change the history of the large tract of land, later known as the coalfields of Bengal and Chota Nagpur. In those days, as indicated earlier, coal from the mines from the Raniganj area used to be brought down to Calcutta by country boats and barges plying along the river Damodar.

After 1820, other coal mines under European management were opened in the Raniganj coal field in quick succession.

a) 1823 : Chínakuri Colliery - By Mr. Betts on the site of Heatley's old workings.


c) 1830 : Chanch and Nuchibad Mines - By Mr. Hom-pray of M/s. Jessop & Co.

Since the introduction of steam engines the coal demand increased and William Jones was given permission by Bengal Government to search for coal. In the above mines, the working seam was 9 ft. thick, about 90 ft. from surface and galleries were driven in every direction, 2000 to 3000 people were working with wages from 3 to 4 rupees per month according to merit.
Most of the mines opened between 1820 to 1830 were situated at no great distance from the Damodar river and exploited the seams of Raniganj coal measures, particularly between Sitarampur and Chinakuri and near Raniganj. Quarrying was also carried out in the Upper Barakar seams near Chach, to the west of Barakar river.

In 1820, an agency house took Raniganj mine from Mr. Jones as he could not repay the loans taken from Government. M/s. Alexander and Company, the agency house, eventually failed in 1835 and the Raniganj mine with all the land and buildings, passed into the hands of Prince Dwaraka Nath Tagore. Thus, Carr Tagore & Co., was formed. They owned Raniganj and Chinakuri mine. In the year 1837, Chanch, Nuchibad and Narainkuri mines passed into the hands of M/s. Gilmore Hamfray & Company.

In 1843, M/s. Carr Tagore & Co. and M/s. Gilmore Hamfray & Co. were amalgamated to give birth to a new joint stock company, being christened as the Bengal Coal Company. The birth of Bengal Coal Company on the very soil of Raniganj marked the first determined and organised attempt to exploit coal in the country.

The earlier form of mining was to quarry the coal from outcrop side. All that had to be done was to dig a few feet, remove the earth and rocks and then get at the coal seam. As the work proceeded the seam went deeper and
the stage was reached when it was no longer possible to dig and remove a comparatively large mass of earth, stones and rocks to recover every ton of coal.  

The habit of exploiting the seams at their outcrops by means of inclines was the other method in general in practice during the early days of mining within Raniganj coalfield. The practice combined in the old days with a complete disregard for the importance of barriers, has doubtlessly resulted in the loss of large areas of many of the seams as a result of fires and flooding.

The earliest method of working underground was the pillar and stall (bord and pillar) system. In those days of mining pillars were small, ranging, according to Dr. Blanford, from 12 to 18 ft. square and the galleries being almost as wide as the pillars. By this system of working, allowing the most favourable circumstance, not more than two-thirds of the coal could be extracted and in the case of the thicker seams, recovery of coal was considerably less. In many instances, however, the crushing of such small-sized pillars occurred long before the mine had reached its maximum development and resulted in underground fires, influx of water from the surface and the abandonment of large areas of valuable coal both within and around the limits of the workings.

The first systematic, geological survey and mapping of this coal field was made during 1845-46 by Mr. D.H.
Williams who was appointed by the East India Company. A
detailed map was prepared on the one inch to a mile scale by
Dr. W.T. Blanford during 1858-60.

In 1854, the advent of the East Indian Railway in the
coil bearing areas marked the beginning of an era of amazing
progress both in coal mining and its transport facilities. On 3rd February, 1855, the railway was opened upto Raniganj
for serving mainly the coalfields in and around Raniganj.
The Raniganj Coalfield remained the most important producers
of coal in the country, till the westward extension of railway
lines.

The tools employed by the workmen of that time were
crowbars, hammers of large size and wedges. Picks were used
in the Chinakuri mine. The coal, instead of being 'holed
under' or cut away at the bottom, and then wedged down from
above, was cut out above and broken away from below by corw-
bars and wedges.

In all other mines they followed the method by
Mr. William Jones. This included chipping out a small hollow
near the face of the coal from above in blocks of small size,
then driving of wedges and crowbars into the joints to bring
down the coal from the side. The primitive method of dewater-
ing the workings of the 'terah' (a long horizontal pole or
bamboo, working the top of the two vertical poles and having
a bucket or an earthen pot, attached to its longer end by a
vertical bamboo, while its shorter end, bearing a stone or a
mass of mud as a counterpoise, is hauled down by ropes) had disappeared and up-to-date pumping plants were installed at the larger collieries.

Mr. Thomas Oldham, then Superintendent of the Geological Survey of India, in his report, dated 14th June, 1859, furnished to the Government, a statement of the yearly output of coal at that time from various collieries in the Raniganj Coalfield.

The Coal Companies and concerns of 1858-59 were (1) Bengal Coal Company (2) Baboo Gobind Pundit, (3) M/s. Ershine & Co., (4) East India Coal Company, (5) Baboo Kaylasnath Roy, (6) Baboo Chatternath, (7) Baboo Sugmai Nundi and ten others.

There were forty-two coal mines having the total annual production in 1858-59 about 90,79,000 'maunds' and coal mines spread over in 7 zones as divided by Oldham. The principal coal mines among the 42 were at Egara, Harishpur, Babusol, Nimcha, Banbahal, Sibpur, Banali, Mangalpur, Bansra, Raghunathchak, Jote Janaki etc. and two quarries namely Dussal Quarry and Mahmudpur Quarry. At that time, Bengal Coal Company was the largest coal company and Baboo Gobind Pundit was the closest rival.

During 1850-1860, nine seams of Raniganj Measures with an aggregate thickness of 120 ft. in the eastern part of the field along with eleven seams aggregating about hundred
feet thick in the western part, were worked. The Barakar seams having thickness of 69 feet, were being worked. Equitable Coal Company joined in the field of coal industry by 1868.

According to W.T. Oldham's Survey the deepest pits in the Raniganj Coalfield scarcely exceeded 75 yards while half of the produced coal came from open workings or quarries. In some parts of Raniganj coalfield, many such open workings were of marvellous extent and size covering hundred of acres.  

Oldham has further recorded, "No single instance of the underground workings made or kept plans. The memory of the 'old men' was the only source from which information could be obtained as to the extent of workings".

In those early days of coal mining, the ideal of mine owners and operators was "more holes, more coals". As many as 58 shafts were sunk in 1200 acres having a 18 ft. thick seam in the middle of the 19th century.

The East Indian Railway was opened from Calcutta to Raniganj in 1855 and during the next ten years it extended westward to Barakar and northward via Sitarampur to link up with the system that of the Gangetic plain.

By 1868, five principal companies were engaged in producing coal in the Raniganj field and together they produced about 88% of the total output of some 492,700 tons.
They were (1) Berbhoom Coal Company Limited, (2) Bengal Coal Company Limited, (3) East Indian Coal Company Limited, (4) Equitable Coal Company Limited and (5) Gobind Pandit of Searsol.

Government had not claimed the rights to the mineral wealth of the area but had the agreements on a royalty basis with the local land owners. During this period coal from this field was being removed by rails, carts and boats on the Damodar river. Thus, the coal industry began its uninterrupted career from 1820 when a mine was opened in Raniganj area of West Bengal. By 1854 only three more were in operation. Starting of the East Indian Railway line gave an impetus to the industry and by 1877 altogether 56 mines were at work producing ten lakh tons.

The period 1850 to 1870 witnessed the floatation of large joint stock coal companies like Apcar & Co. and the Equitable Coal Company. The Apcar & Company was among the first to put down shafts near Sitarampur to work the Dishesagarh seam. In 1873, the coal industry was joined by two more entrants, the Raniganj Coal Association with Kilburns as the Managing Agents, and the New Beerbhoom Coal Company. Two years later, the Barakar Coal Company entered the mining field. With these giant companies thus engaged in coal mining, the annual coal production in India in 1878 almost touched the one million ton mark (mostly from Raniganj coalfield).
In 1891, the Government first proposed to apply the provisions of the Factories Act to coal mines. This actually led to the formation of a sub-committee from Bengal Chamber of Commerce whose duties were to watch the course of legislation. Eventually at a meeting of the mines sub-committee, the Indian Mining Association (IMA) was formed on 6th May, 1892.

By 1881, Raniganj had alone 90 out of a total of 95 mines in India. It was since 1894 till 1900 that there had been a very considerable and rapid expansion in the Raniganj coalfield where a number of new mines were opened. The Raniganj coalfield produced nearly 3 million tons of coal in 1900 out of a total Indian production of 6.1 million tons with the Jharia field as its closest rival.

The labourers on the coal mines were chiefly semi-aboriginal or aboriginal castes, such as Bauris or Santals. But low caste Hindus and the poorer classes of Muhammadans also worked in the collieries. The owners and proprietors of each colliery possessed, either as zemindars, patnidars or as lessees for a term of few years. Santals were preferred to other workmen, but they rarely remained long in regular employment. Women and children were working, mostly above ground. About 9% of the total labour force was women who worked on the surface. The miners kept a large number of holidays in a month. The majority of labourers were recruited from the villages surrounding the coalfields and from the adjoining parts of Bankura, Manbhum, Birbhum and Santal Parganas.
The underground work was performed at a fixed price per tub of coal by families or gangs of men, women and children, who chose their own hours of labour. The men cut the coal and the women and children carried and loaded it into tubs. In a very few mines safety lamps were used. The miners employed above ground and in quarries were mostly peasants.

The coal put on the market, which was known as Bengal coal, was 'good to middling' steam coal. The greater part of it was consumed in the railways, jutemills and other manufacturing concerns, in India.\textsuperscript{11}

Between 1900 and 1919 the movement for better equipment of collieries accelerated, as the pits grew deep and gaseous and labour scarcity increased due to rapid development of all other coal fields.\textsuperscript{12}

During the period 1890 to 1913 labour problem became one of the vital problems of the industry.\textsuperscript{13} Between 1914 and 1919 there was a boom in the production of coal as there was a large demand during the first world war. A large number of new collieries were established particularly in the eastern part of the coal field. Deeper pits and numerous inclined workings commenced in seams previously regarded as too inferior to be of economic value. There was a depression in production in 1920-21 and the total output fell in one year. In the year 1921 two deeper shafts...
of about 1,480 ft. were sunk in the Dishergarh seam at Parbeliya colliery. In 1927-28, 1300 feet shaft sinking of Ningah colliery was completed.

The opening of Kasta branch of the East-Indian Railway gave additional facilities to the Trans-Ajay area. There was substantial development in coal transport, underground mine ventilation. Naked lights were totally prohibited in those collieries where the coal was liable to spontaneous combustion.

The systems of raising coal to the surface varied from primitive method of manual labour to hauling sets of five or ten tubs on inclines provided with rails set to gauges or winding out of well-fitted shafts upto 640 ft. in depth by direct acting engines. At one colliery in the first decade of twentieth century double-decked cages with four tubs were introduced.

At all the important collieries, however, modern headgears and haulage ways existed. Advances in other directions included the electrification of many of the larger collieries. Dishergarh Power Supply Company's Central Power Station at Sodepur was completed in 1922. This was the largest of its type and distributed power to a number of collieries adjoining the Damodar and Barakar rivers. In the case of certain more important collieries, coal cutting machines were in use and efficient screening plants and
mechanical ventilators were installed. Use of safety lamps was introduced where fire damp was prevalent.

From 1921 till 1931 there was a steady rise in production, but the years 1931-33 again marked a depression. In the year 1936, Government of India set up committee to enquire into the methods of extracting underground coal and secure the safety of the workers. The Coal Committee set up in 1945 had considered that the permanently settled areas of the coalfield must be acquired by state government with its mineral rights. Another committee set up in 1951 suggested the amalgamation of small collieries. The important recommendations of the next committee formed in 1951 were that any colliery which was not producing 10,000 tons per month or had an area less than 100 acres should be amalgamated. The next fifteen years, however, showed little or no advance in this direction.

The first Mines Act was formulated in 1901. New rules were added with the Act at different times and finally in 1923, Mines Act of 1901 was replaced. It provided gradual elimination of women from underground work. In 1937, an amendment shortened the hours of shift from 12 to 9 hours for underground works and from 12 to 10 for surface works. Further, the age limit for the children workers of mine was raised from twelve to fifteen.

In 1939, a Sand Stowing Bill was passed by the Indian
Legislators for making it compulsory for certain mines to pack their goaf areas with sand to avoid collapses and subsidences. There was a steady rise in production due to several steps taken by the Government. From 1890 to 1945 the growth of coal industry could be divided into seven periods:

1. 1890 to 1913 - adolescent years.
2. 1913 to 1919 - years of war impetus.
3. 1920 to 1926 - decline from wartime levels.
4. 1926 to 1930 - recovery of output.
5. 1930 to 1936 - period of slump.
6. 1937 to 1942 - recovery of growth.
7. 1942 to 1946 - controls in the Second World War.

In pre-independence period there were three main structural forms of mines. They were: a) Captive collieries owned by consumer interests e.g. railways and iron and steel industries; b) collieries controlled by managing agents who also financed and operated a number of other industries; c) private collieries operating in small units representing individual enterprises.

In January 1973, 711 non-coking coal mines in the states of West Bengal, Bihar, Maharashtra, Madhya Pradesh, Orissa, Assam were taken over and later nationalised. Coal India and its subsidiaries were formed in 1975.
Raniganj coalfield went under the management of Eastern coalfields Limited with its headquarters in Sancto-ria, Burdwan. The main object of nationalisation of the coal industry as laid down in the preambles, was to subserve the common good by ensuring rational, co-ordinated and scientific development and utilisation of coal resources consistent with the growing requirement of the colliery.

History of Environmental Hazards Associated with Coal Mining

The history of coal mining in this field was almost identical to all other coal fields of India. There were small uneconomic collieries to function and slaughter mining i.e. unscientific methods prevailed.

These small collieries were generally ill-equipped and aimed at securing the easiest coal. As a result, coal bearing areas became pock-marked with small hollow workings which led to unsound development in the neighbourhood and often became the cause of disastrous fire (Mahindra Report - Chapter III, Section II). The domination of small mines in the growth of the industry was evident from the fact that although as early as in 1873, more than half of the fortyfour mines produced on an averages above 850 tons a month, the position remained the same after seventy five years.

As regards the method of working in early days, it was characterised by Mr. Blanford as wasteful. The mining practices adopted by the then colliery owners were in total
disregard of the principle of mineral conservation and safety. To extract coal in lesser cost, pillars in deep workings were deliberately allowed to be drowned. In many collieries shafts were driven beyond safe limits. The workers were forced to work under the most adverse conditions and safety regulations were completely ignored.

Violations of mine safety laws were widespread. Extensive fires and collapses were the result of unscientific mining practised over the years and the cost to the nation was considerable in the shape of loss of coal reserves and in the controlling fires. Mine ventilation was poor, roof support inadequate, safety equipment conspicuously absent.

Working of those days was vividly described in a letter dated 2.12.1852 by the wife of a Sessions Judge of Burdwan district. She described one of her visits to the mines of Bengal Coal Company at Raniganj. She mentioned that along the road leading to mines, on the right hand side there were, "the high heaps of coal quite like lofty ramparts, and one of these was on fire, the flames burning out in many places, I supposed this waste coal had been accidentally ignited". Describing the workings she stated, "The mine, is excavated on a regular plan, which leaves 15 sq.ft. of coal and cuts away the adjoining 15 sq.ft. ... we were told the passage extend a mile each way and we were under the village of Raniganj."
The danger of fires was also mentioned in that letter. According to it, "fire is the thing most dreaded in their gloomy region, and old mine near this was destroyed by its becoming ignited".

Only a few years later many of the Raniganj mines were lost by fire and subsidence. A large area in the Raniganj field collapsed in November, 1964, and fire broke out in the subsided area in March 1865. The subsidence of Raniganj was also mentioned in a letter dated 24th December to the Directors of Bengal Coal Company.

Mr. Treharnee Rhees who made a study of the Raniganj-Jharia coalfield, felt that as a consequence of pillars near the outcrops being of dangerously small dimensions, roof had caved in and the surfaces damaged, workings had become waterlogged, encroachments had taken place and underground workings connected up.

Sandstowing was made a statutory requirement for underground coal extraction after the Coalfields' Committee in 1922. Sandstowing had been practiced at least to a limited extent, at several collieries including Raniganj Seetalpur, Parbeliya and Saltor. These collieries were all situated in the near vicinity of the Damodar or the Barakar river.

Aerial ropeway was used for transporting sand to the collieries from river bank and from there fed into the
underground workings. In 1928, a sandstowing plant was installed at Sodepur colliery.

Explosion of fire damp occurred in Mangalpur colliery and in Parasia colliery. The ventilation of the mines was entirely natural and from the shallowness of the pits, it was good and sufficient, but with a greater depth of shaft, especially if fire damp occurred, there would be a necessity for improved ventilation.

There were a large number of gassy mines and the liability of the coal of Raniganj to spontaneous combustion was a serious drawback. For many years it was the practice at all the collieries around Raniganj to leave the small coal in the mine, which was formerly quite unsalable, and several fire occurred. The Chowkidanga Colliery caught fire early in 1961 causing a great deal of damage. In 1873, a large fire occurred in one of the principal collieries and resulted in great loss of property.

Thomas Oldham of the GSI acted as a consultant and made reports and recommendations of the collapse and the fire. In his first report of December 1864, he advocated explosion-proof stoppings being built and urged on the importance of proper mine plans being kept. But the most remarkable was his recommendation that the coal be cut by machinery. In his second report he recommended that the panel system of working might be adopted. If Oldham's recommendations of 1864 and 1865 had been adopted, the coal lost
due to fires and collapses would have been checked.

The coal mines of Raniganj were usually wet and water bearance capacity of some seams were quite high. All the quarries were under the disadvantage of being idle for at least five months in the year, from June to October, as during rainy season, water accumulated in them more rapidly than it could be removed. In fact, greater number of the quarries were only worked from the end of December till April or May, that is, four to five months in a year. The labourers employed in them become unemployed, during the remainder of the year. In many instances, the quarry previously worked was not emptied of water after the rains were over, but a new quarry was opened at the side of it. So the outcrop of many seams of coal was marked by a series of large excavations filled with water.

Even a casual inspection of the field reveals the very considerable advances made in coal mining within this area during the past century. Extensive flooded quarry or incline workings, with their surrounding derelict buildings and machinery, bear witness to the injurious and wasteful methods of winning the coal in the early years of coal mining. Alongside there are up-to-date shafts, well-equipped with modern mining appliances run under capable management and supervision. The method of working which existed in the past persists even to this day, though with considerable modification.
References

1. Ghosh A.B., Coal Industry in India (An Historical and Analytical Account) Part I (Pre-independence Period) p.34.


3. Ibid., p.1.


5. Kumarmangalam S., Coal Industry of India.

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