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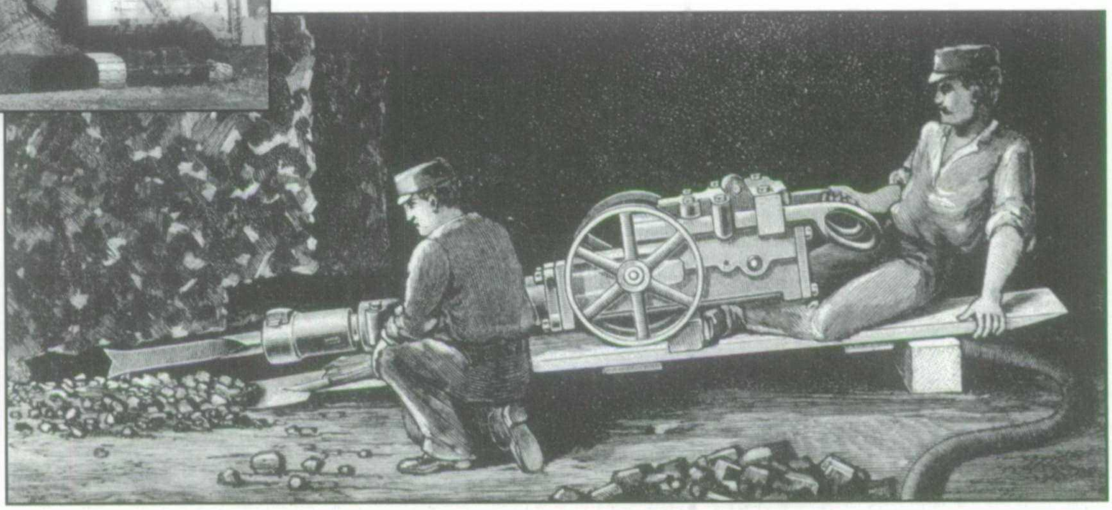
Coal Mining in Canada: A Historical and Comparative Overview



Delphin A. Muise
Robert G. McIntosh

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5

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Delphin A. Muise
Carleton University

Robert G. McIntosh
National Archives of Canada
Archives nationales du Canada

National Museum of Science and Technology
Musée national des sciences et de la technologie
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Top, left:/En haut, à gauche :

A power shovel loads a waiting 170-tonne hauler. In open-pit mining, loading can also be done using front-end loaders. (Reprinted from Coal Mining 4, *Coal Association of Canada).*

Une pelle mécanique remplit un camion diesel de 170 tonnes. Dans les mines à ciel ouvert, le chargement peut aussi se faire en utilisant des camions à chargement à l'avant. (Reproduit de Coal Mining 4, *Coal Association of Canada)*

Bottom right:/En bas, à droite :

The coal cutter, operated by electrically driven compressed air pumps, was used to undercut the coal while miners blasted and loaded coal and made 24-hour operation of the mines possible. This coal cutter, the Ingersoll-Sergeant distributed by the James Cooper Company of Montreal, is typical of the type used in Nova Scotia's coal fields. This advertisement first appeared in The Canadian Mining, Iron and Steel Manual *in 1897. (Courtesy of the Library, Canadian Centre for Mineral and Energy Technology).*

La haveuse de charbon, qui fonctionnait grâce à des pompes à air comprimé actionnées à l'électricité, servait à faire une saignée à la base du charbon, tandis que les mineurs travaillaient à le faire sauter et à le charger, et rendait possible l'exploitation des mines 24 heures sur 24. Cette haveuse – l'Ingersoll-Sergeant vendue par la James Cooper Company de Montréal – est typique de celles employées dans les mines de la Nouvelle-Écosse. L'annonce que voici est parue pour la première fois en 1897, dans The Canadian Mining, Iron and Steel Manual. *(Source : la bibliothèque du Centre canadien de la technologie des minéraux et de l'énergie)*

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Abstract

This historical assessment reflects the technological, material cultural, social and political history of Canada's coal industry. The availability of technologies for actually mining coal and the need to transport it to locations where it was to be consumed led to many innovations in Canadian society. The historical experience can be divided into five distinct phases.

The *Early Colonial* phase (up to the 1820s) was characterized by casual exploitation of surface outcroppings, primarily in Cape Breton, with very little technological sophistication. During the *Resource Enclaves* phase (from the 1820s to the 1880s) British technology was used to extract easily accessible coal from the earliest coal mines on the east and west coasts of the continent, and transport it to nearby coastal regions. During the *National Expansion* phase (from the 1880s to the 1920s) coal was integrated with the aspirations of the National Policy era. There were influxes of Canadian capital and domestic coal was used for manufacturing and transportation purposes throughout Canada. During the *Competition and Decline* phase (from 1925 to 1965) the industry was restructured to meet the competition from foreign coal producers and from alternative sources of energy. Capital was withdrawn and the industry was downsized, while mechanization increased to counteract the low productivity of older mines. During the *Fully Mechanized Mine* phase (from 1965 to the present) there has been a renewed market demand for coal, but also fierce competition requiring elaborate new technologies. The balance has shifted in favour of large, remote open-pit mines in Alberta and British Columbia, which use massive new technologies to access, process and transport coal to markets abroad. Coal is increasingly used to generate electricity in Canada or for metallurgic purposes abroad; the demand for coal for industrial uses has declined.

While the national experience is the focus of this study, it draws heavily on the body of literature dealing with Nova Scotia, until recently the dominant coal mining zone in Canada, and deals most extensively with the first four phases.

Résumé

Cette évaluation historique reflète l'histoire de la technologie, de la culture matérielle, des aspects sociaux et de la politique de l'industrie canadienne des charbonnages. L'accès à des techniques d'extraction de la houille et la nécessité de transporter le minerai vers les régions consommatrices ont entraîné de nombreuses innovations au sein de la société canadienne. Sur le plan historique, on distingue cinq étapes dans cette évolution. La *Période coloniale initiale* (jusqu'en 1820) s'est caractérisée par une exploitation occasionnelle des affleurements, surtout au Cap-Breton, au moyen de techniques peu évoluées. Au cours de l'étape des *Ressources-enclaves* (de 1820 à 1880 environ), l'emploi de la technologie britannique a permis d'extraire les gisements facilement accessibles dans les premières mines de charbon, sur les côtes est et ouest du continent, et d'acheminer le charbon vers les régions côtières avoisinantes. À l'étape de l'*Expansion nationale* (des années 1880 à 1920), le charbon a été intégré aux aspirations de l'époque de la Politique nationale. Des capitaux canadiens ont été investis dans ce secteur et les gisements de charbon intérieurs utilisés à des fins de fabrication et de transport dans l'ensemble du Canada. Au cours de l'étape de *Compétition et déclin* (de 1925 à 1965), l'industrie a dû être restructurée en raison de la concurrence des producteurs de charbon étrangers et de la présence d'autres sources d'énergie. Les capitaux se sont retirés et les activités de l'industrie ont été réduites, la mécanisation plus poussée permettant de compenser la faible productivité des mines les plus anciennes. À l'étape de la *Mine entièrement mécanisée* (de 1965 jusqu'à présent), il y a eu un regain de la demande commerciale de charbon, accompagné toutefois d'une concurrence féroce exigeant de nouvelles techniques complexes. De grandes mines isolées à ciel ouvert en Alberta et en Colombie-Britannique se sont imposées, qui utilisent de nouvelles techniques massives d'accès, de transformation et de transport du charbon vers les marchés étrangers. Si le charbon est de plus en plus utilisé dans la production d'électricité au Canada et dans des procédés métallurgiques à l'étranger, la demande de cette ressource à des fins industrielles a diminué.

Cette étude est axée sur l'expérience nationale dans son ensemble, mais elle s'appuie fortement sur la documentation se rapportant à la Nouvelle-Écosse – jusqu'à récemment la principale région de charbonnages au Canada – et traite en détail des quatre premières étapes de l'évolution de cette industrie au pays.

Foreword

This monograph contributes to the historical assessment of the National Museum of Science and Technology's collection that deals with fossil fuels. Based on the concepts and issues associated with the Transformation of Canada theme, it is aimed at helping the Museum in the strategic development of its collection, particularly artifact acquisition, conservation, disposition and documentation. This assessment provides support for the scientific content of the exhibits and educational activities.

Two recognized experts on the history of Canadian mining, historians Delphin Muise and Robert McIntosh, used a multidisciplinary approach to meet the challenge of preparing this document, in terms of resources and deadlines as well as the subject matter itself. The authors tapped a wealth of documents in the physical sciences (including geology, geophysics and mineralogy) as well as in engineering, ecology, museology and in the history of material culture, as can be gathered from the number and variety of bibliographic sources, the glossary and especially the originality of the information presented.

While looking at the resource extraction, processing and distribution operations that shaped the coal mining industry in Canada, Muise and McIntosh identify the constraints that had an effect on the development of the industry: first, the complexity of Canada's geophysical landscape; and second, the type, location and accessibility of deposits, which eventually led to the establishment of regional markets. The authors also discuss the innovations and technical processes that contributed to the expansion of the industry, and the impact these had on the human and natural environment, on labour organization and on skilled manpower requirements.

By examining the historical context within which the technical, socioeconomic and industrial aspects of coal mining have evolved in Canada, the authors have paved the way for other, more specific studies. A number are already underway: comparisons between underground and open-pit mining operations; the transportation of mineral fuels to potential markets; the mechanization of today's mines and the resulting impact on traditional skills and on specialization in the workplace; the development of mining communities; and the disposal or recycling of toxic emissions from industrial zones.

Avant-propos

Cette monographie s'inscrit dans le contexte de l'évaluation historique de la partie de la collection du Musée national des sciences et de la technologie se rapportant aux combustibles fossiles. Fondée sur les concepts et problèmes associés au thème de « La transformation du Canada », elle a comme objectif d'assister le Musée dans le développement stratégique de sa collection, en ce qui concerne particulièrement les fonctions d'acquisition, de conservation ou d'aliénation des objets, ainsi que leur documentation. En même temps, cette évaluation sert de support au contenu scientifique des expositions et des activités éducatives.

Spécialistes reconnus dans le domaine de l'histoire minière canadienne, les historiens Delphin Muise et Robert McIntosh ont su répondre fort pertinemment aux défis qu'exigeait la préparation de ce document, tant sur le plan des ressources et des échéanciers que dans le traitement du sujet lui-même, devant s'appuyer nécessairement sur une démarche multidisciplinaire. Comme en témoignent effectivement la quantité et la diversité du contenu bibliographique, la préparation du glossaire, mais surtout l'originalité des données fournies aux lecteurs, les auteurs ont eu recours à des documents relevant des sciences physiques – telles la géologie, la géophysique et la minéralogie – ainsi que de l'ingénierie, l'écologie, la muséologie et l'histoire de la culture matérielle.

Dans l'étude des opérations associées à l'extraction, la transformation et la distribution des ressources qui allaient donner son élan à l'industrie canadienne des charbonnages, Muise et McIntosh ont défini les contraintes qui ont eu un effet sur le développement de cette industrie : d'abord la complexité du paysage géophysique canadien, puis la nature des gisements, leur emplacement et leur accessibilité, qui ont mené, en fin de compte, à la concentration régionale des marchés. Une discussion des procédés techniques et des innovations qui ont participé à l'expansion de l'industrie ainsi que des répercussions de celle-ci sur le milieu humain et naturel, sur l'organisation du travail et sur la spécialisation de la main-d'oeuvre complète cette analyse.

En examinant le contexte historique de l'évolution technique, socio-économique et industrielle de l'exploitation des ressources carbonifères au Canada, les auteurs auront pavé la voie à des recherches qui traiteront de sujets plus spécifiques. Certains thèmes

This contribution by Delphin Muise and Robert McIntosh has opened up exciting areas of research for those interested in Canada s mining history.

Louise Trottier
Curator, Energy and Mining
January 1996

retiennent déjà l'attention : la comparaison entre les procédés d'exploitation des mines souterraines et des mines de surface, le transport du combustible minéral sur les gisements et vers les marchés, la mécanisation des mines contemporaines et ses influences sur le savoir-faire traditionnel et la spécialisation du travail, la formation et l'aménagement des communautés minières, la disposition ou le recyclage des substances toxiques émanant des zones industrielles.

En définitive, on peut estimer que la contribution de Delphin Muise et de Robert McIntosh possède le mérite d'offrir un champ d'investigation privilégiée aux chercheurs qui s'intéressent au développement de l'histoire minière au Canada.

La conservatrice, Énergie et ressources minières,
Louise Trottier
Janvier 1996

Preface

While coal mining has been a largely international industry from a technological perspective, various innovative technologies have been developed in Canada. In a vast country such as this, coal reserves are widely dispersed and their exploitation has been subject to different physical, social and political conditions.

This study will concentrate on the first four phases of coal mining in Canada: the *Early Colonial* phase (up to the 1820s); the *Resource Enclaves* phase (from the 1820s to the 1880s); the *National Expansion* phase (from the 1880s to the 1920s); and the *Competition and Decline* phase (from 1925 to 1965). A brief epilogue outlines the *Fully Mechanized Mine* phase (from 1965 to the present). While the national experience is its focus, it draws heavily on the existence of a stronger body of literature dealing with Nova Scotia, the dominant area of the industry until the most recent era.

Chapter One introduces the coal industry and briefly summarizes some of its salient features. Chapter Two surveys mining during the pre-Confederation era, focusing on the General Mining Association's operations in Nova Scotia, and early mining in British Columbia. Chapter Three examines the maturing coal industry from the 1880s to 1920, a period when coal became the predominant fuel for industrial energy and heating in Canada. The implementation of state policies within the industry and increasing market demand is looked at, along with the impact changing technologies had on work practices. A final section examines the education of miners, mine accidents and early labour-management conflicts.

The first half of the 20th century is studied in Chapter Four, beginning with a brief overview of the declining demand for coal, after five decades of continuous expansion. The political economy of coal mining is described — the creation of fewer, more capital-intensive mining firms, and the increased role of the state in regulating operations and taxing coal mining. As early as the beginning of this century, aging Canadian coal mines and changing market pressures led to improvements in productivity that enabled them to compete with the cheaper American supplies of coal. The increasingly coal-dependent central Canadian manufacturing economy was quite sensitive to the price of coal. Attempts to introduce longwall methods and mechanization saw technology transfers and adaptation in the Canadian *coal fields*. A consequence of change was industrial conflict throughout the first half of the 20th century, much of it conducted against the backdrop of an industry in decline, the consequences of which are examined in the closing section of this chapter.

Chapter Five offers an overview of the major themes covered in this study and some tentative conclusions regarding coal's place in Canada's technological transformation. The Epilogue examines the fully mechanized mines of today. Particular attention is paid to materials-handling, coal preparation and transportation. The newer preoccupation with directing science and technology toward sustainable development without environmental degradation is challenged by clear evidence that past mining practices have inflicted severe damage on the environment.

Chapter 1

Introduction

The chemical composition and abundance of coal is largely the result of geological events several hundred thousand years ago, when decomposing vegetable matter was compressed to form carbon-based [fossil] fuels. Aside from carbon, the various elements of coal, particularly sulphur, have a direct impact on its use. Scientists classify coal into three basic categories, mostly a function of age and hardness: *anthracite*, *bituminous* and *lignite*. By the late 19th century, bituminous coal, the most common type found in Canada, was generally divided into two types: *gas coal* and *steam coal*. Gas coal contains higher levels of sulphur and other volatile gases and was preferred for making coal gas (used at the time for street lights) and for producing the metallurgical *coke* that was commonly used in steel making in the latter half of the century. Steam coal generally has a higher carbon content, produces fewer sulphur *by-products* and has a lighter and cleaner ash. It was preferred for heating purposes and for powering most steam engines, especially those aboard vessels or trains where coal was the primary fuel used to propel the engines. If coal is to be used in the production of coke and gaseous by-products, higher levels of sulphur are preferred. If the basic objective is to supply energy at maximum efficiency, lower sulphur steam coals are preferred.[1]

Aside from their burning qualities, which are a function of purity and hardness, a number of other aspects must be considered in any discussion of the emergence of Canada's coal industry, such as geographic location relative to the point of consumption, and accessibility to subterranean seams. In different coal fields, and even at different depths within a given seam, the chemical properties of the coal can vary considerably. The manufacture of coke, purified bituminous coal that results when various gaseous components are baked off, was an important development. When the baking is completed, the result is almost pure carbon, which was substituted for charcoal in most metallurgical applications by the late 19th century. Over time, with the technological advances that took place, mostly outside Canada, the chemical industry developed the capacity to capture the separated gases.

Coal has been central to Canada's transformation from its rural-based, regionally centred, resource-dependent colonial phase to its integrated urban/industrial national experience of the 20th century. Unlike earlier economic staples (cod, fur and timber), coal had a low value relative to its bulk. It was commonly found in Western European nations interested in North American colonies, where it was associated with the industrial revolution occurring in the 18th and 19th centuries. Given the mercantilist ideology of the colonial era, it was seen as an inappropriate staple product to be developed within a colony. Beyond serving strictly local markets for heating fuel, development of a complex coal industry depended on the expansion of North American markets, which emerged only in the middle third of the 19th century. As a result, coal mining became a significant part of the external economies of colonies comparatively late. Coal is not found in either Ontario or Quebec, the areas destined to become Canada's industrial heartland, a fact that, more than any other, caused major disjunctures in development of the resource over the years. In fact, the heartland depended on American suppliers throughout much of our history (and still does).

Our earliest coal mines, at the closing decades of the 18th century, were on the east coast — on Cape Breton Island and at Pictou in Nova Scotia. On Vancouver Island, coal was systematically mined from the mid-19th century onward. Coal mining in the interior of British Columbia, Alberta and Saskatchewan occurred after the arrival of the railroad, toward the end of the 19th century. About the same time, the development of the railway helped open up smaller coal fields in central New Brunswick, as well as in Nova Scotia's Cumberland County, at Springhill and Joggins, and, on a smaller scale, at a number of locations in Inverness County on Cape Breton.

From the 1850s onward, the use of coal-fired steam engines for manufacturing, as well as the use of coal in railway, steamboat and stationary steam engines, placed coal at the centre of North America's urban/industrial transformation. Emergence of a massive new basic steel-making industry, as well as dramatic expansion of the railways serving Canada, drove the demand for coal to new heights as the 20th century

1. If various types of coal were to be burned in enclosed metal containers to provide motive power, it was essential that its burning properties be known with some precision. Research on bituminous coal's properties began in earnest in the 19th century as a way of determining the most efficient coals for steam propulsion. The amount of energy available was of obvious importance when calculating the distance a given amount of coal would propel a vessel — assuming one did not want to be left stranded in mid-ocean. Efficient standards for coal used for industry were also determined. One also had to ensure that burning more volatile coals would not harm machinery.

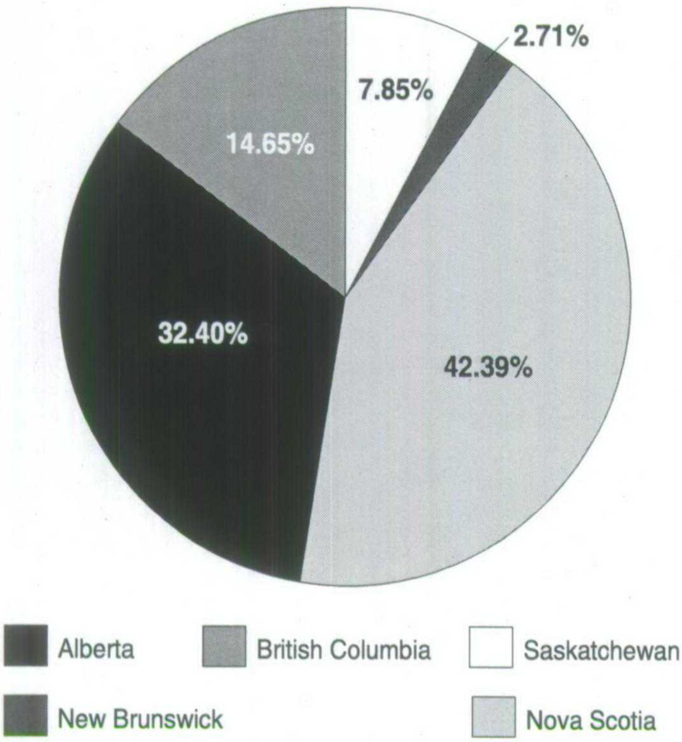
began.[2] Overall consumption of coal in Canada increased from about 750 000 tons per annum at Confederation, to 3.5 million tons in 1886. By 1902 it had risen to over 10 million tons and reached a pre-World War I peak of 31.5 million in 1913.[3]

As national markets expanded, so did capacity. Annual output increased from less than 10 000 tons per annum — from a single pit on Cape Breton — in the early 1800s, to nearly six million tons by 1900. Over 17 million tons per annum were being produced by the 1920s. Output remained around that level through World War II, though there were significant changes in sources. Both output and consumption began to decline in the 1940s, from which there was no real recovery until the recent development of massive new export markets in Asia and other parts of the developing world.[4]

Workforces in mines grew along with output. Early technological innovations focused on moving coal from the deeper mines. Increasing a coal mine's capacity was mostly a function of putting more miners at the *coal face* in increasingly complex underground mines. Early in the 19th century a few dozen men laboured in shallow Cape Breton coal pits, usually for just a few months each year. By 1900, nearly 10 000 men and boys were employed; only a decade later 30 000 were employed in the five provinces where coal was being mined. The numbers employed peaked in the 1920s, after which mechanization broke down the correlation between output and the number of workers employed at mining the coal. Today, with over 80%

Coal Output (by province), 1784–1973

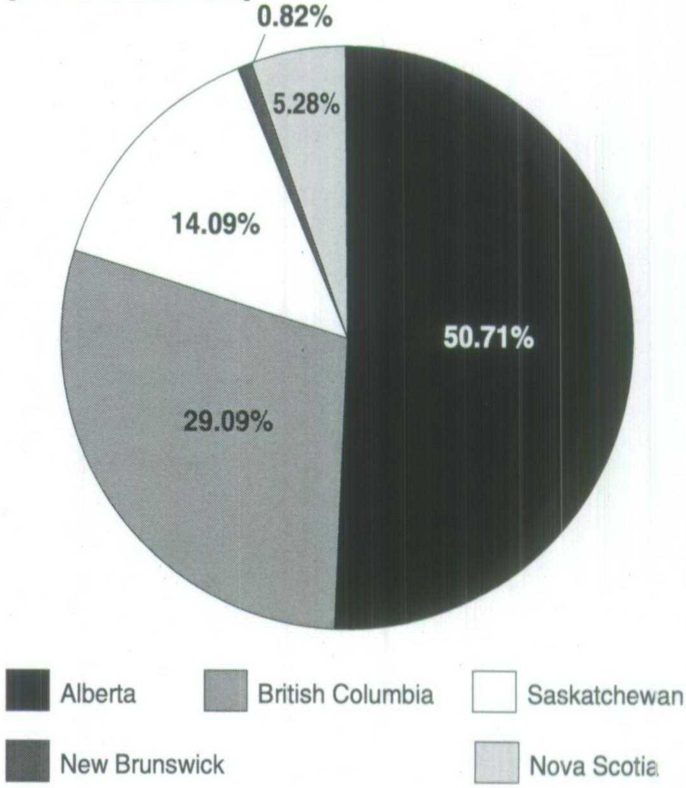
[Total = 1.2 billion tons]



The first billion tons. *Throughout our history, Canada has produced just over 2.3 billion tons of coal. The first billion took us almost two centuries to produce and was mostly the product of underground mines in Nova Scotia, Alberta and British Columbia. Much of this coal was consumed within Canada and was integral to the industrial and communications transformations that contributed so much to the making of the nation.*

Coal Output (by province), 1973–1994

[Total = 1.2 billion tons]



The second billion tons. *Predictions in the 1960s about coal's demise as an important source of fuel for Canada proved premature. Our second billion tons of coal took just two decades to be achieved, primarily as a result of the adoption of highly technical open-pit mining in Alberta and British Columbia. Together those two provinces account for just about 80% of output. Most of that coal is destined for foreign markets.*

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2. D.A. Muise, Rosemarie Langhout and Ron Walden, "Fuelling Canada in the 19th Century: From Wood to Coal," *Historical Atlas of Canada Vol II: Addressing the 20th Century* (Toronto, 1993).
3. Edwin Gilpin, "Coal Mining in Nova Scotia," *Transactions of the Canadian Society of Civil Engineers*, II (1888), 383, Dominion Bureau of Statistics, *Coal Statistics for Canada, 1927* (Ottawa, 1928), 27. The Dominion Bureau of Statistics maintained detailed statistics regarding coal consumption/production for all of Canada from the close of World War I. Responsibility for maintaining coal statistics now rests with Natural Resources Canada.
4. *Royal Commission on Coal*, (Carroll) 1946 (Ottawa, 1947).

of all Canada's coal coming from open pit or surface mines, fewer than 10 000 people are employed in what has become one of the most highly mechanized sectors of the Canadian mining industry.

Adapting to these changes has not been without its conflicts. Every new way of taking coal affected the relationships between workers and managers. Much of the historical literature on developments in the industry concentrates on the impact these tensions had on the affairs of the communities involved. In fact, in Canada as elsewhere, the experience of coal miners prompted some of our earliest labour organizations, and directly involved the state in regulating relations between capital and labour. It was attempts to regulate relations between coal miners and their bosses that drove some of the innovations in labour legislation passed in this country, both at the federal and provincial levels.

From time to time, national energy policies have sought to mediate divergent interests within the Canadian economy, with mixed success. A number of arguments have been presented for the failure to use Canadian coal in central Canada, but it is mostly a factor of costs. Though there were periods when markets for Nova Scotia coal in central Canada have been significant, this matter has been a long-standing grievance for coal-producing provinces. As a consequence, Canadian coal producers have relied heavily on export markets to sell coal not consumed within the region where it is produced. In the 19th century, coal from Nova Scotia and British Columbia was exported to the adjacent areas of the United States; more recently, British Columbia and Alberta coal is being sent to Japan and Korea in large quantities, while Cape Breton's coal is sent to various European nations. In contrast to the experience of the 19th and the first half of the 20th centuries, over the past 50 years coal's place as Canada's prime source of energy has been steadily challenged by oil, natural gas, hydroelectricity and nuclear power. Most of the coal burned in the country today is used to generate electricity.[5]

Finding New Ways

Searching for new ways of mining coal has been a long and eventful process. Technological constraints arise from the basic fact that coal exists in seams that can extend from one metre to dozens of metres in thickness and that are either close to the surface or at depths of thousands of metres. To compound the problem, coal deposits or fields usually have a number of overlying seams that reflect different periods of formation and might have varying conditions and qualities, both among the seams and at different depths within a seam. At a given mine, coal might be extracted from more than one overlain seam simultaneously, creating problems with different grades, etc., as well as complicating the entire mining process. In most fully developed deep mines, coal is normally mined simultaneously at several different depths or levels. All these considerations create potential problems in successfully extracting coal in a condition suitable for markets and under circumstances of safety acceptable for the men involved.

The challenge of mining coal can be compounded by geological quirks. Seams can be uneven, irregular and/or faulted. They can also dwindle down to nothing, forcing premature closure of a mine at considerable loss of capital. In some circumstances, coal is found close enough to the surface that the earth's surface can be stripped away and the coal mined directly from the surface in *open-pit* or *strip* mines. For the most part, however, at least until the 1960s when larger earth-moving vehicles became available and more remote but extremely rich deposits began to be exploited, mining has been conducted underground, following seams for up to several kilometres.

Many Canadian initiatives in mining technology have addressed the wide variety of our coal formations. Canadian mine managers and mining engineers have participated actively in an internationally based professionalization of the industry directed toward improving and adapting different technologies to different circumstances. Between the deep underground *slope* mines exploiting comparatively thin coal seams of the sort found in Nova Scotia and on Vancouver Island and the huge open-pit strip mines found in parts of northern British Columbia and Alberta today, a wide range of approaches to mining coal have been taken. The grade and quantity of coal found in any given basin defines the development of mines there and can have an impact on its final use as well. The pace of mining development, including technologies employed for both exploration and exploitation, have traditionally been the initiative of mining companies, though workers influence rates of technological adaptation. In recent years, governments have assisted development of new technologies for improving overall productivity and developing infrastructure necessary for delivering coal to distant markets.[6]

5. John MacDougall, *Fuels and the National Policy* (Toronto, 1982); and Frank R. Anton, *The Canadian Coal Industry: Challenge in the Years Ahead* (Calgary, 1981).

6. Elwood Moore, *American Influence in Canadian Mining* (Toronto, 1941) represents an earlier school of writing on the history of technology stressing Canadian borrowing of foreign inventions. Dianne Newell, *Technology on the Frontier: Mining in Old Ontario* (Vancouver, 1986) and Donald E. MacLeod, "Miners, Mining Men and Mining Reform: Changing the Technology of Nova Scotian Gold Mines and Collieries, 1858–1910" (Ph.D. dissertation, University of Toronto, 1981) place more emphasis on Canadian initiatives in developing technology and training for innovation.

Each phase of development has made particular demands on workers. The earliest mines operated with little technology and depended primarily on the labour of unskilled young males. The simple tools used to pry coal from outcrops meant mines seldom went far below the surface. Introduction of steam-engines — in the 1830s in Nova Scotia and the 1850s on Vancouver Island — made mines larger and mining more complex, creating more extensive divisions of labour and different types of mine work. Since some of the jobs could be handled by a child, there were dramatic implications for the structure of workforces. Generally, a distinction was made between workers who had access to the coal face and actually mined the coal, and those whose primary responsibility was to develop the infrastructures to transport the coal in the mines and on the surface. Over the past century, the successive reorganizations of mine operations above and below ground have resulted in a workforce dominated by machine-operators and electrical technicians. Most contemporary mines are powered by automatic machines that are able to produce many more tons per day than mere humans ever could. In large open-pit mines today, heavy machine operators are on the front line of mining; in highly mechanized deep mines, it is the operators of the automatic miners.

Mining coal underground traditionally consists of a number of steps. Below ground, the coal is removed from the seam and is transported out of the mine. A wide variety of technologies are required to deliver essential elements to the mine and miners, such as air and water, both of which became more vital as mines expanded in size. The challenge of technical innovations, particularly underground, are to integrate production so that improvements at one stage of the process are not nullified by creating bottlenecks at others. Above ground, the impurities in the coal are removed and the coal is sorted and sized for different markets.

For many years, coal mining was one of our most labour-intensive resource industries. The mine workers all deserve a prominent place in any account of coal mining because of the tasks they performed, the nature of their training, the threats they faced in the workplace, and their struggles with mine owners to control the workplace. But it is the mining engineer whose place became central to coal mining with the heavy demand for mechanization following World War I.

Chapter 2

Pre-Industrial Coal Mining in Nova Scotia and British Columbia

In New France, where considerable effort was made between the 1660s and 1750s to become self-sufficient in various necessary commodities, smelting of metals was important but little attention was paid to coal deposits. The forges developed at Trois-Rivières were intended to make the colony independent of foreign supplies of iron, but the absence of coal in the St Lawrence-Great Lakes lowlands meant they depended upon readily available charcoal as a source of heat energy for smelting. While technologically primitive, large quantities of iron ore were smelted at Trois-Rivières to supply the colony with a range of iron products. But there was little attempt to integrate developments there with resources from other parts of the French empire in America where coal was readily available, most obviously in parts of Acadia and the Ohio Valley areas.[7]

The construction and occupation of a massive fortress at Louisbourg early in the 18th century meant there was a large French presence in close proximity to well known coal reserves for the first time. Prior to Louisbourg's founding, there had been only casual exploitation of "sea coal" from the cliffs lining the bays and harbours just to the north of Louisbourg. New England fishermen and traders had probably shipped small amounts that they had pried from the seams along the coasts. The French brought out a number of specialist miners for construction of the massive fortress. Their blacksmiths and foundries needed fuel, so they turned to the coal deposits only a few kilometres away to operate their forges and heat the damp quarters of the fortress. Though there is little information on how much coal was cut for these purposes, it appears to have been undertaken on a regular basis. This earliest coal mining in the province would probably have been pried loose with steel bars and picks and shovelled into tubs or directly aboard small boats for shipment.[8]

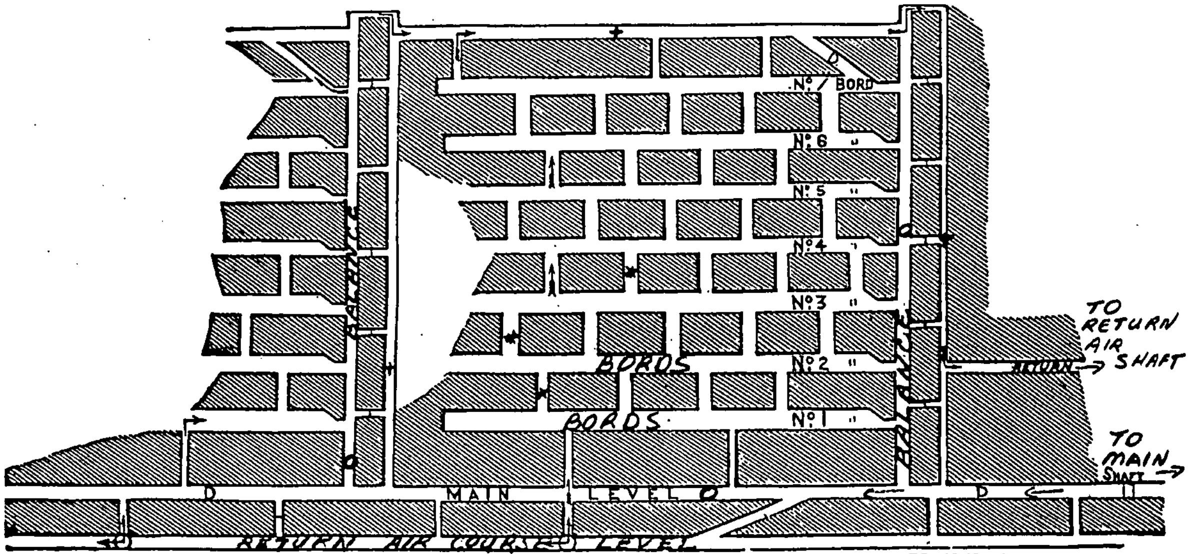
The success of the British military during the wars of the 1750s concluded with the transfer of all of Acadia to British control in 1763. This resulted in the destruction of the fortress at Louisbourg and effectively put a halt to the development of coal resources on Cape Breton. Though several British notables petitioned the Crown for privileged access to these coal reserves, the response from British authorities, on the advice of the powerful Board of Trade, was the that development of coal resources in colonies should be discouraged. The reasoning was quite simply that coal was abundant in the mother country and that any developments in the colonies would lead inevitably to some form of competition. As a result there was official proscription of any sort of development on Cape Breton or at any of the other coal resources that were becoming known in the province.

Though there is evidence of continued casual use being made of the sea coal that was so easily cut and shipped from along the coasts, such activity was illicit. Occasionally though, soldiers, dispatched to the area to protect the island from intruders, were sanctioned to cut enough coal to heat their own barracks and to sell a modest amount in the growing sea-port capital of the colony at Halifax. Following two decades of relative inaction, during which time the American Revolution convulsed the older colonies, British authorities gradually changed their position on Cape Breton's coal. In 1784, Cape Breton was separated from Nova Scotia and the newly established government there was authorized to allow limited development of coal mines. During the ensuing 40 years, a succession of lessees cut coal in varying amounts to sell in Halifax and other developing urban communities around the region, such as Saint John and St John's. The lessees, who for a brief time included the government of the island, were discouraged from any intensive development by leases limited to terms of seven years. There was little prospect that any entrepreneur would be prepared to invest heavily in the coal mines without being guaranteed long term access to the resources.[9]

A few experienced coal miners arrived from Britain to oversee shallow workings, but there were few technological advances during these years. *Adits* were driven into surface outcrops of coal seams and coal was extracted to the shallowest level possible in the absence of mechanized haulage, pumping of water or ventilation. Crowbars, picks and shovels were used to mine the coal from the seam. "Horse whims" or wheelbarrows were used to transport coal from shallow pits, not more than a few metres underground. When mines reached their operating capacity, they were

7. Louise Trottier, *Les Forges du St Maurice: Their Historiography* (Ottawa, 1980).
8. Coal mining during the Louisbourg occupation by the French is treated in Dilys Francis, *The Mines and Quarries of Cape Breton Island During the French Period, 1713–1760* (Research Report, Fortress Louisbourg, Nov. 1965).
9. J.S. Martell, "Early Coal Mining in Nova Scotia," in Donald Macgillivray and Brian Tennyson (eds.), *Essays in Cape Breton History* (Sydney, 1980).

METHOD OF WORKING PITCHING SEAMS.—NOVA SCOTIA.



SCALE 30 Yds.= ⅜ of an Inch. PLAN No. 2.

* CONNECTING HEADS
\+ RETURN AIRWAYS
O INTAKE AIRWAYS

Working area of a mine by the bord and pillar system. *The bord and pillar system was in a constant state of evolution, as mines became deeper and more complex. Effective planning of a mine of this type could accommodate operations at different levels along a slope, allowing for effective ventilation by way of cross-headings and more efficient movement of coal using the hoisting system to deal with increased output. (Reprinted from E. Gilpin,* Coal Mining in Nova Scotia*).*

abandoned in favour of another adit at some other spot along the outcrop. Coal was carried by wagon to the nearby shore, where small skiffs transported it to waiting vessels that shipped it to the consumers in the region's towns, and even to the United States.

As mines extended farther underground, *pillars* of coal had to be left to support the superincumbent strata; mining was conducted in adjacent rooms called *bords*. This system of *bord and pillar* mining gave mines their characteristic checker-board appearance that would prevail into the 20th century. Hand-picks and shovels, along with crowbars, hammers and wedges were used to remove coal from seams at greater and greater depths, especially after the arrival of experienced British miners. Sleds with runners called *skips*, which were pulled along a road-bed of round poles by young labourers, were used to bring coal to the base of mine shafts where they were raised from the pit by rope and pulley-type *gin*-wheels, powered by horses. As underground haulage roads became too long, a shaft would be abandoned in favour of a new one sunk wherever coal outcrops were available. Problems associated with hoisting, ventilating and pumping water from the working areas limited mine depth to perhaps 50 metres.

While officials of the local government were charged with supervising the mines, little control was exercised over the workings, which remained quite primitive. In the final analysis, the period produced little more than several abandoned shallow mines, with little or no development of surface workings beyond the rough barracks, occupied by the workers, and a wharf. Local governments used virtually all the royalties earned from the coal mines to keep the wharf in some sort of acceptable condition and pay the salaries of their officials. The shallow pits left behind were a problem for later operators, who had to deal with the subsidence that occurred because of the failure to leave sufficient overburden to allow for development of the deeper parts of a seam.[10]

Throughout this period, Cape Breton's mines had a capacity of something under 10 000 tons per annum and were operated on a short seasonal basis during the summer months. The shipping season from Sydney harbour was limited by the arrival of pack ice in December and there was little movement of coal during the winter and spring months. Altogether, developments during this period contributed little to the advancement of the industry. The vagaries of the local government, whose only apparent source of taxation was revenue from coal leases, made the lives

10. R. Brown, *The Coal Fields and Coal Trade of the Island of Cape Breton* (London, 1871); Stephen J. Hornsby, *Nineteenth Century Cape Breton: A Historical Geography* (Montreal and Kingston, 1992).

of the mine operators difficult. There was constant interference with the freedom to mine coal and little incentive to expand the capacity of the rather primitive workings.[11]

Shortly after 1800, an awakening interest in the coal fields surrounding Pictou harbour occurred. Pictou's deposits had been known to native people long before arrival of white settlers. Shortly after 1775, when the the highland Scots immigrated to mainland Nova Scotia, interest in the coal reserves developed despite continuing prohibitions against mining coal, because of its value for household uses and black-smithing. Persistent campaigning by both Pictou entrepreneurs and Halifax-based merchants and officials finally convinced officials in the British Colonial Office to allow mines to be opened there. On much the same terms as in Cape Breton, mines were soon sunk close to the East River and coal was lightered aboard shallow draft skiffs to waiting vessels. Output was less than in Cape Breton during this period, with never more than a couple of thousand tons per annum being lifted. The technologies used there were much the same as those in Cape Breton, and there were a succession of small-time mines operated by expatriate British colliers.[12]

This pre-industrial experience in Nova Scotia and Cape Breton *collieries* had only a limited impact on surrounding communities and, as with the prior Louisbourg experience, virtually no technological or scientific implications. It is, nonetheless, instructive regarding relations between the politics of empire and restricted economic development in colonies. Coal was becoming a commodity much in demand in the growing towns and cities, where firewood was not so readily available to heat the ever larger stone and wood houses during cold, damp winter nights. If demand brought economic opportunity, it also brought with it possibilities for political interference, since privileged access to colonial resources was the basis for early mercantilist exploitation of staples in the colonies.

In 1820 Cape Breton was re-annexed to Nova Scotia, bringing its coal deposits under the gaze of Halifax, where a number of merchants were anxious to bring coal under more systematic exploitation. The basic objective was to gain a preferred market with a monopoly position in terms of the right to mine coal. In both Cape Breton and Pictou County, a number of Halifax-based entrepreneurs attempted to take advantage of opportunities for profit. The need for steady supplies of winter heating fuel in the region's growing towns was a fact that all governments had to address one way or another. But New England was always seen as the key to expanding the market, where the pace of urbanization was quickening and coal was in short supply. The only substantial competition at that time was from British coal that was taken across the Atlantic as ballast aboard returning timber ships, a competition that would prove worrisome for Nova Scotia's coal producers for much of the rest of the 19th century.

The potential for royalties from coal had become apparent in the early phase of development, even if the amounts that were realized in Cape Breton and Pictou had done little more than cover the expenses of administering the mines. The Imperial government's protectionist attitude was based on a fear that the extensive development of colonial coal mines would interfere with home manufacturers by encouraging colonial competitors. But in the years following the long and expensive Napoleonic wars there was an inclination to maximize economic rent from the colonies. As well, there was pressure from their officials on the spot on successive Imperial governments to consider changes. While London considered minimum development to help defray the costs of local government acceptable, officials there remained disinclined to encourage any intensification of activity in the coal fields. Of course, all this disinclination could have been overthrown if influential parties in Britain could persuade officials that some larger purpose would be served by allowing further development of coal resources.

In a back-handed way, that is precisely what happened when Crown officials were convinced to transfer a long-dormant mineral lease in the name of the Duke of York, the profligate younger brother of King George IV, to a London jewellery firm in exchange for forgiving his debts. The Duke had been convinced by a confidence man back in the 1780s that there were recoverable precious metals to be found in Nova Scotia and had the mineral rights of the entire province transferred to his name. An investigation failed to turn up any such reserves so the lease was never taken up. But it had never been cancelled either. So, what had been impossible for local entrepreneurs interested in the coal mines all of a sudden became Imperial policy, this time carried forth in the person of a British firm with monopoly privileges granted directly from the Crown.[13]

11. Hornsby, *Nineteenth Century Cape Breton...*; see as well Robert J. Morgan, "Orphan Outpost: Cape Breton Colony, 1784–1820" (Ph.D. thesis, University of Ottawa), 1972.
12. James M. Cameron, *The Pictonian Colliers* (Halifax, 1974), Chapter 3.
13. Martell, "Early Coal Mining..."; D.A. Muise, "The General Mining Association and Nova Scotia's Coal," *Bulletin of Canadian Studies*, VI, No. 2/VII, No. 1 (1983), 70–87; Marilyn Gerriets, "The Impact of the General Mining Association on the Nova Scotia Coal Industry, 1826–1850," *Acadiensis*, XXI, 1 (Autumn, 1991), 54–84.

The arrival of the General Mining Association (GMA) in the closing years of the 1820s marked a decisive departure for local coal mining.[14] Most important was the appointment of experienced British mining engineers — Richard Smith in Pictou and Richard Brown at Cape Breton. Their first obligation was to ensure that mines earned a profit for their corporate masters in London, but they were also charged with seeing that the most up-to-date practices and technologies available from British coal fields were systematically adopted. They and the corporation's directors were convinced that the only way to achieve a proper cash flow from their operations was to invest in a mining organization capable of expanding to meet the needs of the developing markets along the American seaboard. They saw profitability as a function of the capacity and regularity of production to take full advantage of their improved technology. It was a lesson that would be applied to the development of the industry by successive generations of mining engineers and entrepreneurs.

Increasingly over the 1840s and 1850s, the GMA's British-granted privileges were challenged by colonial politicians wanting to extend local autonomy promised by the winning of responsible government in 1848. Among the leaders of that campaign was Joseph Howe, who, as leader of the province's Reform party, was anxious to extend the political grasp of the colonial legislature. The coal question was one of Nova Scotia's central political issues until 1857–58, when, after extended negotiations with London, the GMA's monopoly was finally removed. Pressure to break the monopoly had been all the more intense because of prospects of increasing exports to the U.S. during the years of Reciprocity (1854–66). A group of new companies were incorporated; many on Cape Breton, where 14 remained in operation in 1866. In 1865, the last full year of operation for the Reciprocity Treaty, over two-thirds of Cape Breton's coal went to the U.S. On the abrogation of the treaty, Maritime exporters not only faced escalating tariffs but Pennsylvania and Ohio coal producers that benefited from subsidized freight rates were competing for their traditional New England markets. In spite of that, output continued to increase for a few years as the expanding colonial markets compensated for lost American markets.[15]

The British Columbia Experience

Demand for coal in North America emerged more slowly on the Pacific coast than on the eastern seaboard. Long known to the aboriginal people of Vancouver Island, who brought them to the attention of Hudson's Bay Company (HBC) officials as early as 1836, coal deposits there were slow to be exploited. In an effort to discourage trade in coal between Vancouver Island and the U.S., the Royal Navy opposed the development of mines at that time.[16] The Hudson's Bay Company had a trading monopoly in most of what would become British Columbia, and in the vast northwestern interior. The HBC showed little interest in mining coal until 1849, when declining profits from fur trading activities prompted them to look for new sources of income. Strong markets for coal developed in California after the gold rush of 1849, which had prompted the rapid development of San Francisco. By 1860, that city alone was consuming 168 000 tons of coal annually. Since there were no available deposits along the American west coast, much of it came from Vancouver Island, where coal was conveniently located close to tide-water along the eastern coast of the Island. After mid-century, when the arrival of the railroad opened up the northwest coast of the U.S., regional coal markets expanded. As well, the increasing number of steamships plying Pacific waters boded well for the future of a coal industry.

Active HBC coal production at Beaver Harbour (Fort Rupert) started after an inquiry from an American shipping firm, the Pacific Mail Steamship Company in 1849. Native labourers were employed at first, but the HBC was encouraged enough by potential markets to bring Scottish miners out to Vancouver Island in September of 1849. Beaver Harbour coal, which was a rather poor quality of bituminous grade for steam purposes, failed to win the Pacific Mail Steamship

14. The firm of Bridge, Rundell and Bridge, transformed into the General Mining Association, petitioned the government in London for a long-term lease over Nova Scotia's coal reserves and set out to acquire the existing limited local leases that might have impeded their monopoly over the resources. Within a short time, they had negotiated a 55-year monopoly lease for themselves over the entire coal fields of the province. All this was accomplished with little or no direct negotiation with the Halifax government, which had been pressuring for change to the lease structure for some time. Within months they were operating mines and expanding markets for coal.

15. Muise, "The General Mining Association..."; Brian D. Tennyson, "Economic Nationalism and Confederation: A Case Study in Cape Breton," *Acadiensis* II, 1 (Autumn, 1972); D.A. Muise, "The Making of an Industrial Community: Cape Breton Coal Towns 1867–1900," in Don Macgillivray and Brian Tennyson (eds.), *Cape Breton Historical Essays* (Sydney, 1980), 78. See also Hornsby, *Nineteenth Century Cape Breton....*

16. Henry Youle Hind (ed.), *Eighty Years of Progress in British North America* (Toronto, 1863), 369; Hartwell Bowsfield (ed.), *Fort Victoria Letters, 1846–1851* (Winnipeg, 1979), xvii; Daniel Gallacher, "Men Money and Machines: Studies Concerning Colliery Operations and Factors of Production in British Columbia's Coal Industry to 1891," (Ph.D. dissertation, University of British Columbia, 1979) 24–25.

contract. Still, by 1851 the HBC had committed itself to continued commercial mining; that year 12 822 tons of coal were exported from Fort Rupert.[17]

Exploratory work at Nanaimo, once again prompted by reports of coal by natives, revealed promising seams of coal located close to tide water and of better quality for the steam coal markets then emerging in American coastal cities. In 1851 the HBC shifted its mining activity to Nanaimo as more miners were brought from Britain. A pit of 50 feet (15 metres) was sunk, where a six foot (1.8 metre) seam, which was subsequently worked in several parallel galleries, was struck. Mining continued on a limited scale during the following decade, although steam engines were used for hoisting coal from the mine. On the surface a more primitive, horse-drawn, wooden-railed surface railway took the coal to a nearby shipping pier. Company directors were reluctant to invest any more money after the mid-1850s because of the softening coal markets in the U.S. As the affairs of the Company were somewhat uncertain, so development work at the Nanaimo mine was restricted by the costs of investments. The company could report exports of only 6 000 tons over its first decade.[18] The vast distances from the mother country and the expense of bringing out technology and miners restricted the possibilities for profitable investments without an assured market.

After the Board of Trade removed the HBC's trading monopoly on Vancouver Island in 1859, a number of smaller companies began operating at Nanaimo. Shortly after, the HBC sold its operations there to the London-based Vancouver Island Coal Mining and Land Company. As many as 40 mining ventures were promoted on Vancouver Island over the ensuing three decades, though only a few produced any coal. One, the Harewood Coal Mining Company, was financed in 1864 by naval officer H.D. Lascelles and managed by Robert Dunsmuir, a miner who had been first brought to Nanaimo to work for the HBC in 1850. A few years later, in 1871, Dunsmuir discovered a coal field at Wellington farther north on the Island. He enlisted Royal Navy officers stationed at Esquimalt to invest in his endeavour, and organized Dunsmuir, Diggle and Company, a mining corporation that was the dominant player in Vancouver Island coal mining throughout the latter third of the 19th century. According to one source, Dunsmuir had put up no capital of his own but was given half interest and absolute control of operation, which he ran with an iron hand.[19]

Benefiting from strong export markets in the U.S. through the 1870s, when production on Vancouver Island increased more than tenfold, Dunsmuir bought out a number of his smaller rivals, including the Baynes Sound Coal Mining Company in 1875, the South Wellington colliery in 1879 and the East Wellington colliery in the mid-1890s. In 1883, Dunsmuir bought out his sole remaining partner, Diggle, and assumed exclusive control of all the northern Vancouver Island mines, the output of which soon exceeded that of Nanaimo's mines. By the time the original Wellington site was abandoned in 1900, Dunsmuir had opened a new mine nearby at Extension. At the end of the century, control of Vancouver Island mines was shared between Dunsmuir's corporation and the Nanaimo-based New Vancouver Coal Mining and Land Company, as it was known after reorganization in 1889.[20]

Technologies Associated with Early Steam-Powered Coal Mining

The adoption of steam engines removed the physical constraints that had kept early mines so limited in scope and capacity. Coal pits began extending deeper underground. In Nova Scotia, a new shaft was sunk in 1830 to 200 feet (61 metres), a second in 1834 to 320 feet (98 metres), and a third, the Foord Pit in Pictou, where the *cornish pump* was installed, to 840 feet (256 metres) in 1868. The No. 1 shaft of the Esplanade colliery at Nanaimo, started in 1881, extended 628 feet (191 metres) underground before striking the coal seam.[21] As these more sophisticated coal mines became more mechanized they were called *collieries*, following British fashion. These far larger mines could contain many more working places, points at which coal was mined. Steam-powered pumps freed working places and travelling roads of water. Later steam engines would be used to drive fans that

17. Gallacher, "Men, Money, Machines...," 44, 58–59, 74; and Bowsfield, *Fort Victoria Letters...*, 84.
18. Hubert Hugh Bancroft, *History of British Columbia 1792–1887* (San Francisco, 1890), 186, 192–93; J.H. Kemble, "Coal from the Northwest Coast, 1848–1850," *British Columbia Historical Quarterly*, II, No. 2 (1938), 123–30; Gallacher, "Men, Money, Machines...," 46–56, 90; Charles Robb, *Mineral Resources of British North America* (Montreal, 1863), 370–71.
19. Barry M. Gough, "Fort Rupert, Its Coal and Its Spar Trade," in E.B. Norcross (ed.), *The Company on the Coast* (Nanaimo, 1983), 29–30; Gallacher, "Men, Money, Machines...," xiii; Margaret Ormsby, *British Columbia: A History* (Vancouver, 1958), 215; E.O.S. Scholfield, *British Columbia: Sixty Years of Progress* (1913), 117.
20. Gallacher, 4, 146–60; Charles Graham, "The Problems of the Vancouver Island Coal Industry," *Transactions of the Canadian Institute of Mining and Metallurgy* (1924), 456; Norman Gidney, "From Coal to Forest Products: The Changing Resource Base of Nanaimo, B.C.," *Urban History Review*, 1 (June 1978), 38.
21. Hugh Millward, "A Model of Coalfield Development," *The Canadian Geographer*, 29, No. 3 (1985), 239; Brown, *Coal Fields and Coal Trade...*, 63–64; New Glasgow *Eastern Chronicle*, 25 January 1868; British Columbia, *Mines Report*, 1883, 416; Edwin Gilpin, "Coal Mining in Pictou County," *Transactions of the Royal Society of Canada*, IV (1896), 172–73.

would move fresh air to the coal face and all the travelling roads in the mine to dissipate the dangerous gases sometimes given off by the coal.[22]

The adoption of the steam-engine was closely linked to corporate investment. Relatively large sums of capital were necessary, not simply for the engines, but also for the elaborate work associated with them; sinking deeper shafts required much work before coal could be produced efficiently. In addition, surface buildings, rail lines, and recruiting and housing workers all required large capital outlays before much financial return could be realized. It was estimated by some that the GMA spent more than $500 000 on their operations in Nova Scotia over the first 30 years of their operation before paying out any dividends.[23]

Sinking shafts and constructing surface buildings and workers' dwellings could entail commitments of hundreds of thousands of dollars at typical mines in the mid-19th. Cape Breton's International colliery had to raise $450 000 in New York over its first 15 years of operation after 1858. And Boston-based financiers needed $165 000 to develop the Caledonia Mines after 1865. Regional capital entered Cape Breton's coal fields as well. The Block House and the Victoria Mines were capitalized at $130 000 and $150 000 respectively. No surface railway was necessary at either of these last two mines, and little was spent on machinery apart from steam engines. Mining represented the largest capital investment in the colonial economy during that period.[24]

In light of the levels of capital at stake, development work at a new mine became more painstaking. It usually began with an assessment of a coal seam, conducted by examining surface outcroppings and drilling as deeply as possible for core samples to test the extent and location of the deposits. Deep drilling was not commonly available until the late 19th century, when the diamond tipped drill was introduced. This expensive innovation was subsidized by the Nova Scotia government in the interest of developing accurate information about the extent of the coal deposits. Local conditions, particularly the thickness and pitch of a coal seam, determined whether a vertical *shaft*, an oblique *slope*, or a horizontal *drift* would form the principal point of entry underground. Colliery managers were responsible for deciding how much coal would be left to support shafts and buildings on the surface in the immediate areas, since subsidence could prove a major problem in areas where coal was extracted close to the surface. Before any active mining could proceed, drill-core surveys enabled managers to determine, as much in advance as possible, how to actually *win* the coal, and the number and direction of underground roads driven into the seam; adjustments were made as the main shaft was sunk into the coal.[25]

When development work began, two shafts were sunk to the seam to be worked. One was a main haulage shaft used to remove coal from the deeps, the other was a service shaft to move men and materials into the mine and to provide ventilation. These shafts were usually connected by underground passages. The grade of the main roads had to be such that water flowed toward the bottom of the pit so that pumps could drain the mines of any water encountered along the way. This also ensured that fully loaded *tubs* travelled downhill as they came to the level before they were to be hoisted to the surface. Roads also had to overcome any *faults* or breaks in the seam, though it was often difficult to predict the course of coal seams deep underground.[26]

Within this expanded workplace, four principal tasks were performed: first, the actual mining of the coal in the bords; second, transporting the coal out of the mine; third, maintaining the mine; and fourth, surface work — either preparing coal for shipment to market or preparing materials for dispatch into the mine. The capacity of a mine depended on how many miners could be delivered to appropriate coal faces at any given time and how efficiently their coal could be raised to the surface and shipped to market. As mines grew larger, these tasks became more difficult.

The actual mining of the coal was perhaps the least mechanized aspect of this endeavour. While the means of removing coal from the depths changed over the last half of the 19th century, dispersion of the actual mining in dozens of distinct bords continued. The mines were organized around a well established bord

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22. An outstanding example of that sort of technology transfer was the so-called "cornish pump" located at Albion Mines in Pictou County, the housing of which survives and has been partially restored as a focal point of the new Museum of Industry in Stellarton, the modern name for Albion Mines. A similar pump was installed at the Prince mine in Cape Breton, though it has not survived.

23. See Brown, *Coal Mining on Cape Breton*; and Marilyn Gerriets, "The Rise and Fall of a Free-Standing Company in Nova Scotia: The General Mining Association," *Business History*, Volume 34, 3 (July, 1992) 16–48.

24. Marilyn Gerriets, "The Impact of the General Mining Association on the Nova Scotia Coal Industry, 1826–1850" *Acadiensis* XXI, 1 (Autumn, 1991). Immediate pre-Confederation investments are summarized in Nova Scotia, *Mines Report*, 1866 et seq.; and in Geological Survey of Canada, *Report of Progress, 1872–73*, 290. In addition, Henry Y. Hind's various reports on collieries are amazingly thorough, viz. *Report on the Victoria Coal Mines at Low Point, Sydney, Cape Breton* (Halifax, 1867); *Report on the Point Aconi Coal Property, Sydney Coal Field, Cape Breton* (Halifax, 1870); *Report on Sydney Colliery* (Halifax, 1871); see as well *A Sketch of the Mineral Resources of Cumberland Co., Nova Scotia* (Halifax, 1872).

25. "Mr Buddle's Account...." offers a detailed description of the mines including intricate drawings of the underground workings as a way of indicating the necessity for extensive planning to gain the bulk of the coal from the seam being mined.

26. H.F. Bulman and R.A.S. Redmayne, *Colliery Working and Management* (London, 1925), 158.

and pillar system, which was designed to extend workings far underground without endangering either the lives of the miners or the precious roads and airways that served the system. The characteristic checkerboard pattern evident in most mining plans of the early period were marked by considerable irregularities; the tendencies of the seam determined the most efficient procedures in given places.[27] At the coal face, a single miner with a *buddy*, or small groups of miners working in adjacent spaces, tore coal from seams using their own muscle power and basic hand-held machinery. Gunpowder was introduced shortly after the arrival of steam engines, and its use became common over the years. It was used to loosen coal at the face and to assist in the driving of tunnels throughout the mine, and considerably increased the amount of coal an individual miner could produce. Gunpowder was inserted into holes drilled by hand-held augers; there was no mechanical undercutting of the coal, which was loosened with iron picks and steel wedges.

Underground, transportation systems had to keep pace with increased output from the more numerous and productive bords. In mines accessed by slopes, hoisting coal to the surface was a single operation — the coal was removed from levels to the main slope for haulage to the surface. In mines with vertical shafts, removing coal often required two steps. First it had to be *hauled* to the base of the shaft, and then it had to be *hoisted* up to the surface, often in different containers. This distinction between hauling coal along horizontal planes underground and hoisting coal to the surface along vertical or sloped planes was essential to the subsequent mechanization of mining underground. Generally, hoisting was the first activity in the mines to be mechanized. Powerful coal-burning steam engines were installed on the surface for raising coal within months of the GMA establishing their mine sites.

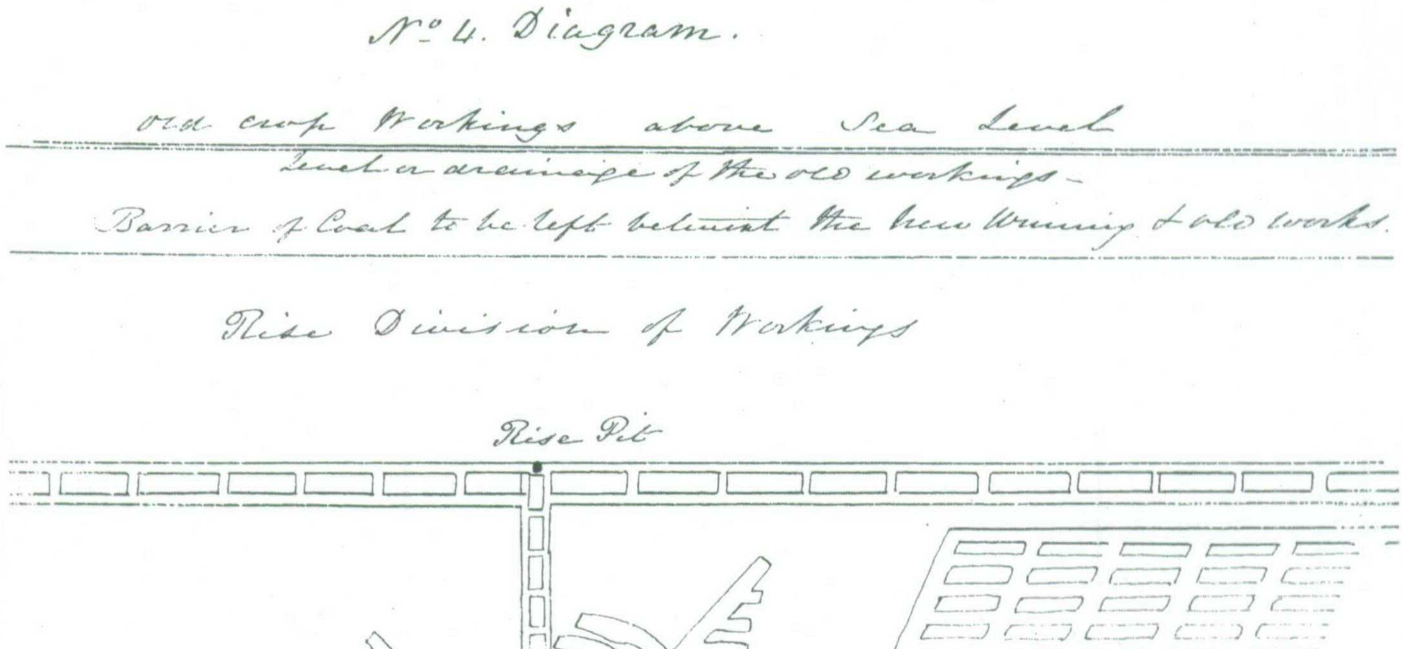
All movement of coal prior to its being lifted out of the mines was referred to as *haulage*. Along the length of a main slope or shaft, major underground passageways — *levels* or *balances* — extended at right angles at regular intervals. They usually stretched to the extremity of the *workings* within a given section of the mine, sometimes for as far as several kilometres. The larger a mine, the greater the number of levels, intersecting the course of the seam at different depths underground. Off of each level, a variety of auxiliary roads, sometimes called *lifts*, led at right angles back up along the seam to the working places or bords, each of which was separated from the next by a solid pillar of coal. Horses were introduced to haul coal from workplaces to pit-bottoms in wheeled wagons or tubs that held up to two tons of coal, or to special landings at various levels within the mines, where it could be held before being brought to the surface. Flexible and relatively inexpensive horse haulage remained in use throughout the 19th century.

Among the various activities associated with maintenance of a mine, two were most significant. *Ventilation* systems brought fresh air to mine workers and helped dissipate noxious and/or explosive gases. In the earliest deep mines, air was circulated by burning coal in large furnaces at pit-bottoms, forcing hotter air to the surface and drawing fresh air to the coal face. As mines got more complex, propulsion of air to the various working places scattered over several square kilometres became very important. Powerful fans located on the surface pushed huge quantities of fresh air into every working place in the mine; the air was directed by a complex system of *doors* and funnels that ensured that gas did not get a chance to accumulate near the working places. Where mining extended under a water table, or even where underground springs were a problem, pumps removed pit-water, keeping working places and haulage-ways free of water.

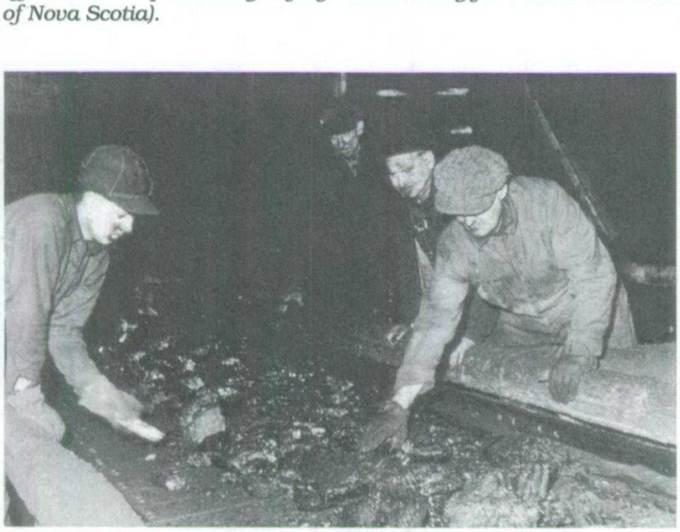
Surface work focused on the transfer of coal from the tubs or coal cars, in which it was transported out of the mine, to the ships, railway cars or carts that brought it to the consumer. Steam-powered railways to move coal short distances were introduced in Nova Scotia shortly after the arrival of the GMA. Rails were laid between mine sites and nearby waterside loading docks in both Pictou and Sydney Mines. These short rail lines were the first in British North America and represented a considerable technological achievement. The maintenance and repair of these new technologies depended on a large number of skilled foundry-men, blacksmiths, machinists and engine drivers, all of whom contributed immeasurably to a progressive technological environment within mining communities.[28]

27. See Donald E. MacLeod, "Miners, Mining Men and Mining Reform: Changing the Technology of Nova Scotian Gold Mines and Collieries, 1858–1910" (Ph.D. dissertation, University of Toronto, 1981). In all jurisdictions mine operators were obliged to submit detailed working plans of their collieries to the scrutiny of departmental officials. Literally hundreds of these plans exist for most collieries, in Nova Scotia and British Columbia especially. An early commentary on the necessity for accurate record keeping and careful filing of such mine plans is found in John Rutherford, "The Importance of Mine Records," (A Letter to P.S. Hamilton, Chief Commissioner of Mines, Halifax, 1967) PANS, RG 41 "Series A."

28. A vivid description of the vitality of the GMA's operations following the beginning of its operations at Pictou was left by Joseph Howe, a most active promoter of the province's economic vitality. While somewhat flamboyant, it gives a vibrant account of surface and underground workings. See Joseph Howe, *The Nova Scotian*, 21 July, 1830, in M.G. Parks (ed.), *Travel Sketches of Nova Scotia: Eastern and Western Rambles of Joseph Howe* (Toronto, 1973).



Buddle's report on coal mining in Cape Breton, 1834. *John Buddle was a well-known mining engineer and consultant in England during the 1830s. He was an advocate of efficiency as a means of maximizing profit from investment. This diagram, one of several in his report to the General Mining Association, indicated the rather uncoordinated nature of earlier attempts at deep mining. The report outlined the necessity for more systematic planning for exploitation of the seam of coal through a bord and pillar system (making coal mining more efficient while preserving safety and allowing for a more extensive working of the entire seam of coal). (Courtesy of the Public Archives of Nova Scotia).*



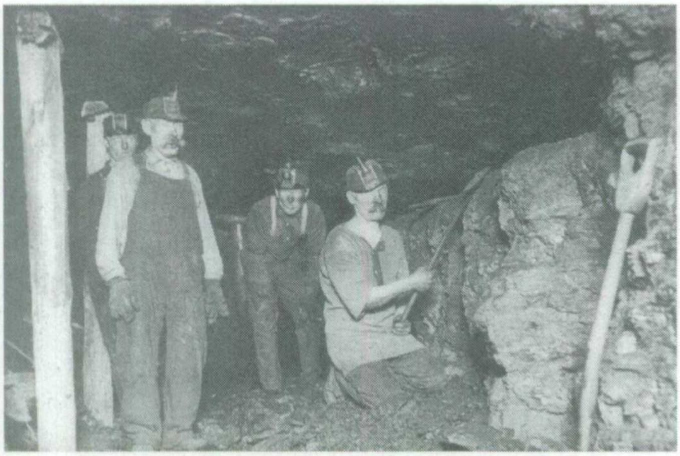
Picking tables. *In spite of attempts to monitor quality underground, coal inevitably arrived at the surface with impurities mixed in. The amount was a matter of great consequence to the miners; too much impurity could result in decreased earnings. Picking tables were moving belt-lines over which, until very recently, coal was passed after it had been dumped from the coal cars that the miners had filled at the coal face. Young boys and retired miners picked out any slate or stone that had gotten into the coal. Only after that was accomplished could the coal be further processed by sizing it into various grades. All these stages were important since there could be a considerable loss, especially in the era when lump coal was considered to have the highest value for steam production. Later, as coal came to be used for power generation, it had to be carefully washed to ensure no impurities found their way into thermal generating plants. (Courtesy of the Beaton Institute, University College of Cape Breton).*

As time went on, surface work came to include the grading of coal for the purpose of marketing. The increase in the consumption of coal was accompanied by an ever more specialized demand for particular grades of coal. *Screens* were used to size the coal and picking tables were the key element in efforts to remove impurities.

The Colliery Workforce

The increase on the sizes of mines encouraged subdivisions of labour and specialization of workers, both above and below ground, a process which produced an increasingly hierarchical workforce. At the working apex, a group of specialists emerged who were expert in the efficient production of coal in the bords. These were actual *miners*, sometimes referred to as *cutters* or *colliers*. Within the workforce there were clear distinctions between those labelled "wise-men" — the skilled coal cutters and tradesmen such as the carpenters, machinists and blacksmiths employed at each colliery — and unskilled workers, those who transported coal to the surface or were concerned with mine maintenance and preparing coal for shipment to market. Approximately two-thirds of all underground workers and one-third of surface workers were skilled, a large percentage compared with other industries operating during that period.

The collier exercised great freedom within the workplace, usually supervising his own labour and that of others. The miner often hired one or more helpers at his discretion — often a son or the son of another miner. He set his own pace and controlled the nature of his work relations. Working places were sometimes even named for the miners working them. Should the collier fall ill or be injured, his job was sometimes held for him until he returned. Miners were paid piece-rates, contracting with management to furnish a given quantity of coal at a specified price over a certain period. The wetness of an area, the thickness of the seam, the nature of the coal, and the strength of the roof were all taken into account in negotiating the price of coal with management. These local contracts were what made collective bargaining quite complex, wreaking havoc with any attempt to set rates across the industry. Miners at Sydney Mines, for instance, participated directly in the distribution of different workplaces, preventing managerial discrimination by means of periodic lotteries. In many respects, colliers practised a craft that combined elements of technical skill and the exercise of independent judgement.[29]



Miners at the face. *The intensity of hand labour at the coal face is reflected in this photo. With little more than picks and shovels, teams of miners had to undercut, drill and then blast down their sections of the coal face for hand loading into coal cars, that then had to be man-handled to the nearest travelling road for haulage. In spite of very high levels of mechanization in 20th-century mines, this form of hand operation continued to be practised in smaller or more remote sites up until the mid-century.*

In mining coal, the miner, who often shared his room with another miner, called his *butty*, would first make vertical incisions, called a *shearing*, at either end of the approximately two metre-wide work-face, simply called the *face*. Within the area delimited by these incisions he would make an *undercut*, called bottoming, extending roughly one metre into the face, in the lower half of the area marked in shearing. This work was usually done manually with a *hand-pick* and could take anywhere from two and one half to six hours depending on conditions in which he worked. Great strength and physical dexterity was required to swing the hand-pick in even, forceful horizontal arcs, usually while the miner lay on his side. This was easily the most physically demanding aspect of mining.[30]

In the earliest mines wedges were hammered into the upward limits of the seam to dislodge overhanging coal created by the bottoming. By mid-century, when gunpowder was introduced into Nova Scotia's mines by the GMA, explosive charges were used; gunpowder came into general use on Vancouver Island by the 1860s.[31] Its use called for new skills. After completion of an undercut, the miner drilled a hole in the middle of the working face obliquely upwards from a point near the roof to a depth corresponding with

29. Donald E. MacLeod, "Miners, Mining Men and Mining Reform: Changing the Technology of Nova Scotia Gold Mines and Collieries," (Ph.D. dissertation, University of Toronto, 1981); Ian McKay, "Industry Work and Community in the Cumberland Coal Fields, 1848–1927," (Ph.D. dissertation, Dalhousie University, 1983); John D. Belshaw, "British Coal Miners on Vancouver Island, 1848–1900," (Ph.D. dissertation, University of London, 1987) and Robert McIntosh, "'Grotesque Faces and figures': Boy Labour in Canadian Coalfields, 1820–1930," (Ph.D. dissertation, Carleton University, 1990) all include detailed discussions of work practices in coal mines.

30. Keith Dix, *Work Relations in the Coal Industry: The Hand-Loading Era, 1880–1930* (Morgantown, 1977), 16.

31. MacLeod, "Miners and Mining Men...," 314; Gallacher, "Men, Money and Machines...," 238.

the undercutting. An explosive charge was placed in this hole. When it was ignited, the coal fell from the roof onto the floor of the room. Experienced miners could gauge with precision the quantity of powder needed. Too much damaged the roof and the result was a fine dust rather than the preferred *lump coal*. Too little, and the overhanging coal might not be dislodged. The hand drills used in the early period were replaced by pneumatically driven machine drills toward the end of the century.

Miners were also responsible for a number of ancillary tasks. They made all decisions regarding *propping*, the erection of wooden supports to prevent the collapse of the roof at the face. They also had to lay track on which their coal tubs travelled into and out of the working face. They decided when to *brush* the roof, when to clear debris from the rock face and when to lower the floor. They were responsible for ensuring that there was a clear area for transporting the coal and deciding which method of moving the coal tubs in and out best suited the workplace.[32] One particularly onerous part of a miner's work was loading and pushing coal tubs to the point where they could be collected by a horse and driver for delivery to the hoisting stages. This task, above all others, prompted him to hire a *loader*, who took on the responsibility for pushing.[33]

The second phase of bord and pillar mining involved *robbing* the pillars. This was a particularly treacherous task, generally performed by only the most skilled miners. After a series of bords were mined out in a given area of a mine, pillars of coal left as roof supports between the bords were mined or drawn. The challenge of robbing pillars was to take out as much coal as possible before the roof collapsed. To do this successfully, a miner depended on his ability to anticipate, often by sound, when a situation was becoming threatening — i.e. to cut coal until just before the roof collapsed on top of him.

The superior position occupied by colliers was evident in privileges they enjoyed. The emblem of the miner's freedom was absenteeism, a traditional prerogative that he exercised for reasons as varied as tending his garden or enjoying a sporting event on a fine summer day. The miner also enjoyed some control over the length of his working day — he customarily went down the pit at 6 a.m., but came up when he felt he had accomplished enough for that day. Cape Breton's Caledonia Mine was typical: "the men are their own masters, and they come up when they like." At the same time, mines everywhere in Canada were affected by the seasons, which could cut down the number of days a miner could work to fewer than 100 a year. This provided incentives to maximize output during the short producing season.[34]

Workers performing tasks associated with other mine functions — ventilation, underground haulage and hoisting or surface work — enjoyed fewer rights. Called datal workers because they were paid a daily wage, they were restricted to the hours of work established by mine officials. They also did specified tasks that often resembled labouring jobs. Unlike the miners, they were subject to the direct supervision of others. Hierarchical wage levels testify to the superior status of colliers. Boys at Springhill, for instance, started at $0.45 per day in the 1880s; drivers' pay ran from $0.55 to $1.25; and loaders averaged $1.30. Contract miners could boast an average daily income of $1.60 to $2.00. Datal workers, particularly in Nova Scotia, were often boys or young men, or, curiously enough, older men on the verge of retirement who were no longer able to survive the rigours of work at the coal face. In certain circumstances, datal work was seen as a learning experience where boys were introduced to the rhythms of an operating coal mine and were expected to gain enough experience and strength to eventually take up the picks on their own.[35]

Summary

While during the earlier period, business was conducted on a learn-as-you-go basis, the General Mining Association, and to a much lesser extent the Hudson's Bay Company, strictly applied established rules to developing their deep pits. The most important innovation in this respect was probably not so much physical changes to mine organization and new technologies, as the wealth of experience brought out with mining engineers and the hundreds of experienced British colliers recruited to work in the British North American coal fields. British miners brought with them a deeply ingrained history of mining practices and applied a host of appropriate technologies to every aspect of

32. Nova Scotia, *Mines Report*, 1881 discusses roof propping; for a concise discussion of the Victorian miner at work, see Ian McKay, "The Realm of Uncertainty: The Experience of Work in the Cumberland Coal Mines, 1873–1927," *Acadiensis*, XVI, No. 1 (Autumn 1986), 37. Contemporary accounts include Gilpin, "Coal Mining in Nova Scotia," 376–77 and John Rutherford, *The Coal-Fields of Nova Scotia* (Newcastle, 1871).
33. Pictou miner Dan Livingstone complained in 1919: "Pushing is a bad thing anyway. It is one of the worst features of mining as we have to contend with it. It draws abnormally on the miner's strength and vitality." See NAC, RG 27, Vol. 141, file 611.04:6, *Board of Investigation Proceedings*, 1919.
34. Raphael Samuel, *Miners, Quarrymen and Saltworkers* (London, 1977), Canada, *Royal Commission on Relations Between Capital and Labour* [hereafter *Labour Commission*], *Nova Scotia Evidence*, 452.
35. *Labour Commission, Nova Scotia Evidence, 302–7*. See also McKay "The Realm of Uncertainty..." and Robert McIntosh, "The Boys in the Nova Scotia Coal Mines, 1873 to 1923," *Acadiensis* XVI, 2 (Spring, 1987); D.A. Muise, "Iron Men? Yarmouth's Seamen in Transition, 1871–1921" in Colin Howell and Jack Toumey (eds.) *Jack Tar at Work: Proceedings of the Jack Tar Conference* (Fredericton: Acadiensis Press, 1991).

the industry. This meant the transfer of British technologies to the Canadian scene without much adaptation. Miners and mine engineers crossed the Atlantic with long-standing traditions of mining and working relations well established and intact. They remained utterly dependent on Britain for the tools and technologies they applied to mining coal in North America. What they introduced were the techniques necessary for deep-pit mining, based on the notion that coal seams had to be exploited over the long term in order to become profitable. This meant applying steam power to hoisting, draining and ventilating deeper mines. By 1867, the use of steam power for these purposes was widespread in coal mines throughout Nova Scotia and British Columbia, as was the characteristic bord and pillar method of extracting coal from deep mines.[36] The large infusions of capital set in motion a series of inter-dependent relationships that constituted the most significant set of labour relations Canada would have over the ensuing century.

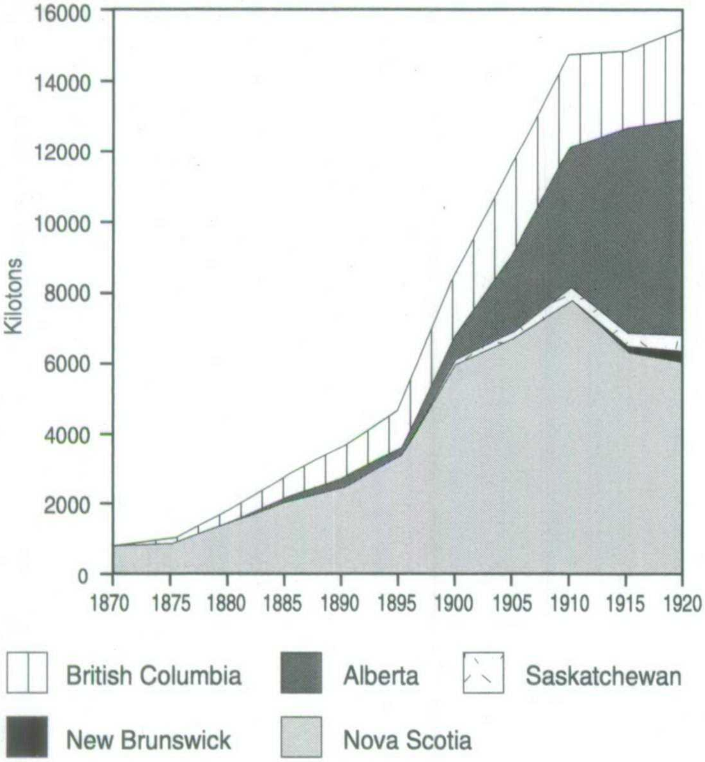
36. Muise, "The GMA and the Nova Scotia..."; Abraham Gesner, *The Industrial Resources of Nova Scotia* (Halifax, 1849), 286; J. Despard Pemberton, *Facts and Figures Relating to Vancouver Island and British Columbia* (London, 1860), 46.

Chapter 3

The Political Economy of Coal Mining in the National Era

The importance of coal to 19th century industrial society can not be over-estimated; it is comparable to the role of petroleum today. As central Canada and the Maritime provinces became more industrialized, coal became ever more crucial to national transformation. Much of the current research on Canada's transition to an urban/industrial nation obscures the extent to which the urban-based economies continued to rest on extraction and export (or use within the country) of raw or semi-finished natural resources. If coal was not foremost among the nation's staple products from a national perspective, it nonetheless provided the foundation for regional and sub-regional economies. In Nova Scotia, the coal mining and steel industries employed more than 20% of the workforce and generated a far greater percentage of the province's income. Across Canada, coal was used to fuel mills and factories, propel ocean-going ships and trains, and heat homes and other buildings.

Canadian Coal Output (by province), 1870–1920



Source: Carroll Royal Commission on Coal Mining.

***Canadian coal output (by province) 1870–1920.** Coal output responded to the development of Canadian markets during the National Policy era. The steady climb from 1880 to the eve of World War I was a function of the heavy demand during industrial development and railway expansion in the west. Virtually all of the coal produced during this period was used within Canada.*

Those two great monopolies of the British colonial era, the Hudson's Bay Company and the General Mining Association, had proved incapable of reaping the fullest benefits of their monopolies. Their profitability had been restricted by an uneven supply of qualified labour, too-small local markets for coal and a dependence on access to export markets in U.S. cities. While this situation was made more equitable under the Reciprocity Treaty with the U.S. between 1854 and 1866, markets continued to limit the development of the industry. After the monopolies were dissolved in the 1850s, dozens of companies emerged to exploit the extensive reserves of coal in Nova Scotia and on Vancouver Island. Growing markets for coal could not offset the financial weakness of many of these companies, who had to bear the burden of heavy carrying charges for the fixed assets needed to make coal mines operational. Up to the 1890s, in spite of significant expenditures for steam-based technologies, most mines remained severely undercapitalized. With expanded and less seasonally defined coal markets, consolidated ownership re-emerged. An industrial structure that was able to fully integrate the most modern mining techniques available developed, though coal mining would always be characterized by high levels of technology operating side by side with more traditional methods of mining.

Over the latter third of the 19th century, the increasing importance of coal mining garnered more attention from the state. The provinces expanded their interest from providing an environment designed to attract more capital to regulating the industry in the interests of expanded output. Along the way, royalties from coal contributed disproportionately to provincial revenue where coal was mined, but particularly Nova Scotia, where it was the largest single local source of revenue. Immigration policies were reworked to ensure a steady supply of skilled workers, while repressive labour legislation guaranteed discipline by providing military intervention when there was a dispute between coal operators and miners. In Nova Scotia militia and regular troops were called out whenever miners went on strike to improve wages or working conditions. On Vancouver Island, conflict over the use of less expensive Asian and native labourers was a chief cause of labour struggles throughout the formative years of the British Columbia industry.[37]

Despite increased activity on the Pacific Coast during the final third of the 19th century, the heart of Canada's coal industry remained in Nova Scotia. At Confederation, British Columbia's annual output amounted to just 30 000 tons; while Nova Scotia produced 532 000 tons, well over half coming from several new collieries in Cape Breton. Fifteen years later, the gap had narrowed somewhat; British Columbia produced 282 000 tons of coal, and Nova Scotia, 1 365 811 tons. Confederation had brought promises to open central Canadians markets to Nova Scotia's coal industry. In Ontario after 1850, coal consumption grew rapidly, but the nearby Ohio Valley remained the dominant supplier of coal there. British coal, brought out as *ballast* in returning timber ships, dominated Montreal and Quebec City markets during the Confederation era.[38]

In October 1867, a Nova Scotia Coal Owners' Association began to lobby for protective tariffs to improve the competitive position of their product in central Canadian markets. One problem facing Nova Scotia coal exporters was finding freight for return ships. During the pre-Confederation period, it was cheaper to ship coal to Quebec from Cardiff, Wales than it was to ship it from Pictou. The federal government, anxious to quiet anti-Confederation sentiment in Nova Scotia, responded to political pressure in 1870 by placing a duty of 50 cents per ton on imported coal. Though it was dropped the next year because of protests from Ontario and Quebec consumers anxious to preserve their access to cheaper American coal, it marked the beginning of a struggle over energy that continued between the producers on the periphery of the country and its most important consumers in central Canada.[39]

The strong conviction in central Canada that cheaper coal was necessary for industrial development ensured that Nova Scotian coal operators continued to be denied a major portion of their own national markets. A select committee of the House of Commons examined the coal trade of the Dominion during its 1875 sitting, and concluded that there was no need to re-impose tariffs on foreign coal. Coal operators testifying before that committee demanded protection and initiated a long debate about the problems associated with the location and quality of Nova Scotia's coal in relation to the large demands for industrial coal in Ontario and Quebec.[40]

Nova Scotia's coal industry entered a crisis in the mid-1870s when the American markets dwindled and a world-wide trade depression slowed economic growth throughout the North Atlantic. The crisis did not pass until the mid-1880s, after a new Conservative national government introduced protective tariffs with its National Policy of 1879. Coal was included in the new schedule of tariff protection, though the 50 cent per ton duty, raised to 60 cents the next year, was limited to bituminous coal, and various drawback provisions for the use of coal in steel-making and the foundry industries made the tariff less effective than Nova Scotia producers wanted. Despite its subsequent downward revisions, this tariff made coal from Nova Scotia competitive, at least in the Montreal market, the largest in Canada at the time. Symbolically, at the insistence of Charles Tupper, the most prominent Nova Scotian representative in the federal cabinet, coal was used to heat Ottawa's parliament buildings for a time. West of Montreal though, American coal continued to supply the emerging industrial markets. However, lucrative St Lawrence markets were developed extensively by Nova Scotian producers and output doubled between 1881 and 1891, then redoubled between 1891 and 1901, much of this as a result of burgeoning demand in Quebec City and Montreal.[41]

37. In Nova Scotia, a "Combination of Workmen Act" was passed in a single morning sitting to enable the colony to send troops to Sydney Mines to evict striking miners from company houses in 1864. See C.B. Fergusson, *The Labour Movement in Nova Scotia before Confederation* (Halifax, 1964); K.G. Pryke, "Labour and Politics: Nova Scotia at Confederation," *Histoire Sociale/Social History* 6 (1970); Kirby Abbott, "The Coal Miners and the Law in Nova Scotia: From the 1864 Combination of Workmen Act to the 1947 Trade Union Act," in Michael Earle (ed.), *Workers and the State in Twentieth Century Nova Scotia* (Fredericton, 1989), 26–7; Desmond Morton, "Aid to the Civil Power: The Canadian Militia in Support of Social Order, 1867–1914," *Canadian Historical Review*, LI, No. 4 (December 1970), 407–25; Peter Silverman, "Military Aid to the Civil Power in British Columbia: The Labour Strikes in Wellington and Steveston, 1890 and 1900," *Pacific Northwest Quarterly*, 61, No. 3 (1970), 156–64; P.G. Silverman, "Aid of the Civil Power: The Nanaimo Coal Miners' Strike, 1912–1914," *Canadian Defence Quarterly*, IV, No. 1 (Summer 1974); Don Macgillivray, "Military Aid to the Civil Power: The Cape Breton Experience in the 1920's," *Acadiensis*, III, No. 2 (Spring 1974).

38. James Herbert Bartlett, *The Manufacture, Consumption and Production of Iron, Steel and Coal in Canada* (Montreal, 1885), 101; Canada, *Royal Commission on Coal, 1946...* pp. 61–73 for output by province from Confederation onward. On the politics of coal at Confederation see D.A. Muise, "The 1860s: Forging the Bonds of Union," in E.R. Forbes and D.A. Muise (eds.), *The Atlantic Provinces in Confederation* (Toronto, 1993).

39. C.O. Macdonald, *The Coal and Iron Industries of Nova Scotia* (Halifax, 1909), 43; Hornsby, *Nineteenth Century Cape Breton...*; Gilpin, *Coal Mining in Nova Scotia...*; on the political pressures see D.A. Muise, "Politics and Constituencies: Federal Politics in Nova Scotia, 1867–1878" (Ph.D. Thesis, University of Western Ontario, 1971), Chapter 3.

40. *House of Commons Journals* (Ottawa, 1876); Ontario's search for cheap coal is treated in David F. Walker, "Transportation of Coal into Southern Ontario, 1871–1921," *Ontario History*, LXIII, No. 1 (March 1971).

41. A summary of federal tariff and freight rate supports for moving Nova Scotia coal to St Lawrence markets is provided in Canada, *Royal Commission on Coal* (Carroll) (Ottawa, 1946). See as well the summaries of consumption patterns prepared for W.J. Dick, *Conservation of Coal in Canada* (Ottawa, 1914).

As long as wooden ships that couldn't sail in ice-clogged waters were the principal means of transporting coal to markets, winter remained a time of little work. Seasonality continued to limit both output and investment over the last half of the 19th century. Operations virtually ceased at Cape Breton mines with the freeze-up of harbours in January, and resumed in March only if prospects for exports were good. The Northumberland Strait was closed down for four months during the winter, seriously limiting opportunities for Pictou's collieries. Ice-free ports were some distance from the best coal seams and access to the new markets in the St Lawrence were closed for at least three or four months each year. Seasonal slowdowns were especially significant for larger more mechanized mines, where the expense of installing expensive technology had to be recovered in shorter periods of time to allow for acceptable profit margins. Miners in Nova Scotia, for instance, averaged only 188 days of work in 1880, although mines underground had to be maintained year-round. The costs associated with seasonally idle mines were reflected in the final price of the coal.[42]

New markets allowed more regular production at mainland mines, particularly following development of the Intercolonial (ICR) and other railroads in the 1870s. Cumberland County's Springhill mine, developed in the 1870s after leases to coal lands owned by the GMA were sold to local entrepreneurs, grew to become the largest mine in the Dominion by the 1880s, partly as a consequence of their year-round railway markets. The Springhill mine not only supplied the ICR's locomotives, but also fuelled local industrial markets, opened up as towns grew rapidly through the ensuing years.[43]

By the mid-19th century in Great Britain, small or *slack* coal was no longer being discarded; slack coal was valued as never before because of coke markets opening up for ironworks. In the past the market for this crushed by-product of the mining process had been non-existent. Development of steel works in Pictou County during the 1880s, and a decade later at Sydney and Sydney Mines, contributed immensely to increasing and stabilizing markets for coal. The steel industry's huge demands for coking coal expanded the market for colliery output by creating a demand for coke. By 1910 over half the total coal output of the largest Cape Breton mines went to the local steel industry. Its requirement for small coal meant that new mining technologies that crushed more of the output were employed more extensively.[44]

Between the end of the GMA's monopoly in 1858 and the arrival of the Dominion Coal Company in 1893, control of Nova Scotia's coal mines was dispersed; no fewer than 30 mines, large and small, opened on Cape Breton. It was a period when competition for both regional and St Lawrence markets was fierce: "The coal operators in this district [Cape Breton]," wrote the editor of the *Canadian Mining Review* in 1893, "have for thirty years pursued an undeviating policy of cutting one another's throat, until one wonders there is anything left of them."[45] To enable "modern appliances" to be introduced, in 1888 Nova Scotia's Mines Inspector argued that provincial mines should be brought under "one management." It was a compelling argument that would dominate public discourse for much of the 1890s.[46]

In hindsight, a clear movement toward concentration was evident even before the arrival of H.M. Whitney and American capital. The lure of profit had drawn promoters and mine owners into a series of corporate mergers during the 1880s, all prompted by increased central Canadian participation in the ownership and management of the industry. Demands for greater capital concentrations that permitted increased mechanization and integration of all aspects of mining were paralleled by a desire to consolidate markets and reduce competition. Taken together, these tendencies re-oriented the coal mining industry in Nova Scotia to a more American rather than British-centred work culture.

A number of the large collieries in Pictou County amalgamated in 1886.[47] But much more important was Whitney's formation of the Dominion Coal

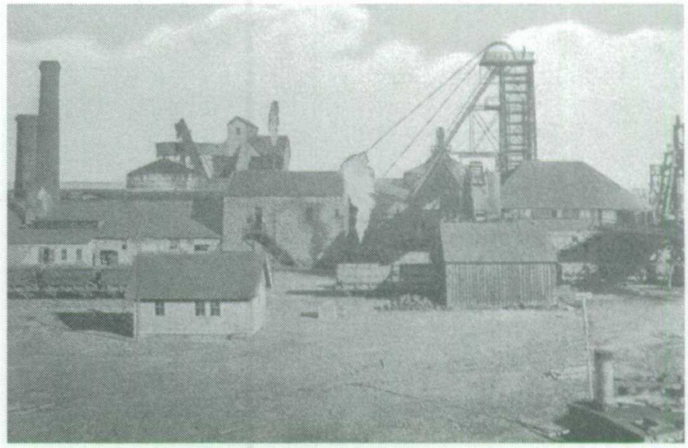
42. Nova Scotia, *Mines Reports*, 1880–1890. These reports provide detailed summaries of operations of all mines, including summaries of technologies employed and numbers of men and boys working in various divisions of each mine's operations.
43. Ian McKay, "The Realm of Uncertainty: The Experience of Work in the Cumberland Coal Mines, 1873–1927," *Acadiensis* XVI, 1 (Autumn, 1986); T.W. Acheson, "The National Policy and the Industrialization of the Maritimes, 1880–1910," *Acadiensis* I, 2 (Spring, 1972); D.A. Muise, "The *Great Transformation:* Changing the Urban Face of Nova Scotia, 1871–1921," *Nova Scotia Historical Review* (December, 1991); Carleton University History Collaborative, *Urbanization and Community Development in Atlantic Canada, 1867–1991* (Hull, 1993).
44. Robert Galloway, *Annals of Coal Mining*, Vol. I (Newton Abbot, 1971), 362. J.S. McLennan, "The Screening of Soft Coal," *Transactions of the Canadian Society of Civil Engineers*, IV (1890), 88; Robert Drummond, *Minerals and Mining in Nova Scotia* (Stellarton, 1918), 226–27; *Canadian Mining Journal*, 1911, 710.
45. Quoted in Don Macgillivray, "Henry Melville Whitney Comes to Cape Breton: The Saga of a Gilded Age Entrepreneur," *Acadiensis*, III, No. 1 (Autumn 1979), 52. Robert Drummond, *Minerals and Mining*, summarizes these operations.
46. Edwin Gilpin, "Coal Mining in Nova Scotia," *Transactions of the Canadian Society of Civil Engineers*, II (1888), 388.
47. The companies concerned were the Acadia Coal Company, the Halifax Company, and the Vale Coal, Iron and Manufacturing Company, which together controlled over two thirds of Pictou county's output. *Canadian Mining Review*, 1885, No. 8, 10. Macdonald, *Coal and Iron* 142; Cameron, *Pictonian Colliers...*; and L.D. McCann, "The Mercantile-Industrial Transition in the Metal Towns of Pictou County, 1857–1931," *Acadiensis* XIII, 1 (Autumn, 1925).

Company in 1893, an initiative that resulted in re-monopolization of the south Cape Breton coal fields and led, through a series of subsequent consolidations, to virtually the entire industry in the province coming under the control of a single corporate body. The process took 25 years to complete, but the final result was the largest free-standing corporation in Canada at the time. Transfer of control over such vast resources was made in return for promises to expand the capacity of the industry, with, of course, proportional increases in royalty revenue for the provincial government.

Dominion Coal was granted a 99-year lease, renewable for a further 20 years, on all unimproved coal fields on Cape Breton.[48] By adroitly exercising the various options he had acquired, Whitney purchased all existing Cape Breton coal leases and mines, with the exception of those the GMA operated at Sydney Mines, on the north side of Sydney harbour. The GMA's mines had been acquired in 1900 by the rival conglomerate, Nova Scotia Steel and Coal Corporation, based in New Glasgow.[49]

During the Golden Age of coal mining in Nova Scotia, between 1893 and 1920, annual output quadrupled, from under two million tons to over seven million in 1913, the peak year of output. It was a period of intense technological experimentation, as Nova Scotia producers applied the American-based machinery to the workings of their mines and reached unheard of depths. It was also a period when the industry underwent significant changes in relations with both the federal and provincial states. The trade union movement that became so important in negotiating the terms of innovation (discussed in the next chapter), was established during that same period, giving miners some say in the pace of change.

In British Columbia the closing decades of the 19th century were equally dynamic in terms of the coal industry, though the scale of operation did not match that of Nova Scotia. Railways, settlers, towns and cities all arrived in numbers unheard of in previous years. The opening and settlement of the west made available the resources along routes previously unavailable and introduced markets that had not existed earlier. On Vancouver Island the two major coal fields, Nanaimo in the south and the Cumberland area in the north, continued to expand and modernize. The monopoly of the two major conglomerates, the Dunsmuir group and the Vancouver Coal Company, continued unchallenged. The introduction of labour saving machinery that was common in Nova Scotia was somewhat uneven on the Island, where some mines still depended on large amounts of cheap Chinese labour.[50]



Surface workings, Sydney Mines, ca 1905. *The pride communities took in their mines is reflected in hundreds of post-cards depicting all aspects of their operations. This one shows the surface works of the No. 1 mine of the Nova Scotia Steel and Coal Company, which had taken over the General Mining Association's holdings in 1900. In the background are the coke ovens of the company, which provided a vast new market for the output of local mines; up to that time there was little outlet for the small or slack coal that had been produced, and no steady local market for any of their coal. The coke ovens at Sydney Mines and Sydney consumed up to half of Cape Breton's output for a short time prior to World War I. (Courtesy of the Beaton Institute, University College of Cape Breton).*

Coal mining in Canada's western interior pre-dated wide-scale European settlement in much the same manner as it had elsewhere. With long winters and the short supply of readily available wood, coal seams were worked wherever they were easily accessible — but only on a small scale using the most basic tools for local consumption. At Fort Edmonton, for instance, four men were employed digging coal in November 1863 — all of it destined for heating purposes in the immediate vicinity. The first commercial coal mine in Alberta was opened during the 1870s at Coalbanks (near present-day Lethbridge) by Nicholas Sheran. The coal from his tiny mine was transported short distances by horse and wagon and used to heat dwellings and North West Mounted Police posts in the immediate area. By the 1880s, the HBC, as it had on Vancouver Island, contracted Indians to dig coal for local use at a number of places. On 7 March 1881, the *Edmonton Bulletin* announced that 700 tons of coal had been mined from adits sunk directly into the

48. As an indication of Dominion Coal's subsequent dominance of Nova Scotia's industry we might note that at the peak of output in 1913 — by which time it had also acquired the major Cumberland County fields at Springhill as well as the major portion of Cape Breton's fields — it accounted for 70% of Nova Scotia's output and 38% of Canada's.

49. Macgillivray, "H.M. Whitney..."; *Canadian Mining Journal*, 1914, 579. Kris Inwood, "Local Control, Resources and the Nova Scotia Steel and Coal Company," *Communications historiques/Historical Papers* (1986), 254–82.

50. John Douglas Belshaw, "The British Collier in British Columbia: Another Archetype Reconsidered," *Labour/Le Travail* 34 (Fall, 1994), 11–36, offers the most recent analysis of these phenomena.

river bank of the North Saskatchewan over the previous winter. After the arrival of the Canadian Pacific Railway branch line from Calgary in 1891, mining in the Edmonton coal fields boomed, supplying the railway market and local consumers. By 1903, more than 30 small mines were operating in the Edmonton area, most rather simple adits into the coal that cropped out along the river. These small mines continued to serve the local market for some time without much capital investment and at much lower levels of productivity than elsewhere, even by the eve of World War I.[51] Railways were a major precondition of developing a coal industry in the western interior; they were a major consumer of coal and provided a relatively inexpensive carrier to the emerging urban markets of the prairie.

The Galt colliery, that operated at Lethbridge from 1882 onward, was developed on the site of Nicholas Sheran's earlier mines. When the Great Falls Railway to Montana was completed in 1890, major markets for the Galt mines emerged at the smelters there. For the balance of the century, approximately half of Lethbridge's output was exported to the U.S. By 1898 a number of mines opened along the Canadian Pacific main line in the area that would become southern Alberta. Lethbridge, with an output of 160 000 tons per annum, was the largest, but Canmore produced 85 000 tons, Anthracite 23 000 tons and Souris 15 000 tons.[52]

Subsequently, the most significant development in the western interior occurred when a CPR branch line was constructed from MacLeod, Alberta through to the Kootenay Lake area of British Columbia. Started in 1897 and completed the following year, it opened up the Crowsnest Pass area coal fields as it advanced, creating small coal communities at Blairmore, Bellevue and Hillcrest, to name only a few on the Alberta side of the border. In 1902 the Great Northern Railway was extended from Gateway, Montana into the Crowsnest Pass district as well. Commercial mining was underway in the inland coal fields of Nicola by 1907 and Similkameen by 1910. Output was destined for the CPR Crowsnest Pass Branch line and Great Northern Railways, but also helped to develop the vast markets emerging in the western U.S. The smelting of ores taken from the western cordillera on both sides of the international border required large quantities of coke.[53]

As with 19th-century Nova Scotian mines, output in the coal industry of British Columbia and the western interior was marked by strong seasonal rhythms, though interestingly enough the seasons of activity were reversed. Mines depending on domestic coal markets were most active from November to April, when people burned coal to heat their homes. Those supplying railway markets generally worked on a year-round basis, although output in the Crowsnest Pass peaked in late summer as railways stockpiled coal for fall grain shipments. The boom in western settlement during the 1890s meant stronger urban markets for both heating and steam coal across the region. While major mines were linked to railways, small quantities of coal were mined at dozens of sites throughout the western interior for local consumption. Unlike Vancouver Island and Nova Scotia, control of the industry on the prairies during this formative period was very dispersed. A large number of independent producers served localized markets and supplied larger consumers of coal such as the railroads.

Summary

This brief discussion of political and economic factors in the development of the coal industry in the post-Confederation era serves to introduce major technological transformations that occurred then. Production factors directly affected the cost of mining coal in the deep underground coal mines — virtually all of the coal mined during that period. Placing more technology at the point of production was high on the agenda of the technocrats who organized the industry at the turn of the century. Improvements that were made over the course of the century in hoisting, pumping and ventilation had not been matched with changes in the methods of mining and haulage of coal to the pit-bottoms. Easing the introduction of new mining techniques and overcoming the engineering problems associated with deep-coal mining was a critical feature of the capitalist take-over of the industry that provoked dramatic responses by governments and labour unions.

51. Sally Anne Hamilton, "A Historical Geography of the Coal Mining Industry of the City of Edmonton" (M.A. thesis, University of Alberta, 1971), 31–38; *Canadian Mining Review*, 1903, 30–31; NAC, RG 84, Vol. 1399, f. HS10-47. See as well the summaries of the Edmonton area mines in Dick, *The Conservation of Coal....*

52. *Canadian Mining Review*, 1889, 72. A comprehensive history of the early Galt mines at Lethbridge is A.A. den Otter, *Civilizing the West: The Galts and the Development of Western Canada* (Edmonton, 1982). Galt's collieries were later incorporated as the North Western Coal and Navigation Company, the largest single producer in Alberta for many years. *Canadian Mining Review*, 1898, 35. At the village of Anthracite, near Banff, the only anthracite coal found in Canada was mined for a brief period at the turn of the century. *Canadian Mining Review*, 1902, 246.

53. Babaian, *Coal Mining Industry in the Crow's Nest...*; *Canadian Mining Review*, 1898, 31; William Sloan, "The Crowsnest Pass During the Depression" (M.A. thesis, University of Victoria, 1968); and Robert Strachan, "Coal Mining in British Columbia," *Transactions of the Canadian Institute of Mining and Metallurgy* (1923), 70–72, 99–100.

Chapter 4

Limits of Technology and Labour in Semi-Mechanized Coal Mines, 1867–1920

Perhaps the most prominent characteristic of Victorian coal mines was their uneven adoption of new mining technologies. By the end of the 19th century larger firms like the Dominion Coal Company and the new Vancouver Island Coal Mining and Land Company had introduced mining techniques that met world standards. Yet smaller coal pits still employed older mining techniques and continued to operate well into the 20th century. The high cost of transporting coal allowed these smaller mines to remain profitable; they had captive markets in isolated areas. The cost advantages of upgrading were uncertain without dramatic increases in output, which depended on the application of elaborate organizational structures to ensure that the mine could operate efficiently. Owing to the persistence of technical bottlenecks, even larger collieries seldom fully realized economies of scale. The major technological challenge in 19th century collieries centred on underground haulage. Better hoisting and ventilation systems had permitted larger mines; more working places and the introduction of gunpowder raised the level of productivity. But, in the absence of adequate means of transporting coal underground, much of the potential for increased productivity could not be met. Only those mines able to adopt a range of new techniques were able to maximize productivity. Because so many innovations challenged the miners' independence underground, the promise of more consistent work at these larger mines had to be balanced against their loss of control over processes they had dominated for so long.

Ventilation

Early mines were so small that ventilation was not a big problem, but to exploit deeper seams, a means of ensuring an adequate supply of oxygen and removing noxious and/or explosive gases was required. These gases, trapped in the coal itself when it was formed, were given off when the coal was mined or occasionally without intervention. The presence of these gases, mostly forms of methane or carbon monoxide, was always a factor when mining a seam of coal, although they were not always present in the same levels in any given mine, or even at different levels within a given mine.

Initial efforts to deal with problems associated with gas had uneven results. The first problem was detection; many of the most dangerous gases were odourless and colourless. In certain circumstances miners relied on natural ventilation — two shafts were sunk into the same seam at different positions on the side of a hill, and differential air pressure would create a current through the mine. This method was feasible only in smaller mines and was unreliable wherever there were complicated bords and pillars. Mines could not always be placed on a hillside, and when the air temperature outside was the same as that inside a mine, circulation ceased. In Nova Scotia, by 1863, all mines were ventilated with underground *furnaces* placed at the bottom of an *upcast shaft*. By heating the air, they created an artificial current, a system with major drawbacks — not the least of which was danger of the furnace itself causing fires or explosions. If the same shaft was also used for hoisting, furnaces could damage equipment. In addition, the fumes were objectionable to mine workers entering and leaving the pit.[54]

As mines grew, an innovation in the structure of ventilation systems popularized in Britain by John Buddle earlier in the 19th century, called *compound ventilation*, was commonly adopted. By dividing, or *splitting*, air currents at a number of points underground, a mine could be sub-divided into a series of independent ventilating systems. No longer did a single current ventilate an entire mine. This shortened air-courses and helped keep air velocity at a maximum, allowing gases to be dispersed while adequate levels of oxygen for miners and horses were maintained.

In larger mines, young boys were given the role of operating ventilation doors, or *traps*, situated along the main haulage roads. These *trapper* boys kept these doors closed to prevent any short-circuiting of air currents, and opened them to allow the passage of horses and drivers:

> *When he hears the sound of a footstep or wagon approaching his door his duty is to pull on a string, one end of which is attached to the door and the other secured where he can grasp it in a moment, when the door will open. After the passengers or cars have safely passed, by slacking the rope, the door shuts of its own accord.*

54. Caleb Pamely, *Colliery Manager's Handbook* (London, 1893), 385; Nova Scotia, *Mines Report*, 1863, 11–24.

Such a system was in place by 1852 at the Albion Mines and was commonly used throughout Canadian coal fields well into the 20th century. Many practical miners began their working lives as trapper boys.[55]

Over the last half of the century, however, as one mining engineer argued, "rapid extension of the workings render[ed] a more efficient ventilation power imperative." Mechanical fans provided that more efficient power. These were employed successfully in Britain from 1850, either to push air down the *downcast* shaft, or to pull it up an upcast shaft. The GMA introduced one of these fans at its Albion Mine in 1867 and another at the Queen Pit in Sydney Mines about the same time. By the 1880s fans were also in use at the two largest collieries on Vancouver Island, the No. 3 mine at Wellington and the No. 1 Esplanade colliery at Nanaimo. A decade later, fans as large as 20 feet (6 metres) in diameter capable of delivering 100 000 cubic feet (2 138 m^3) of air per minute were operating all across Nova Scotia, though furnace systems still operated in some of the shallower mines, or where gas was less of a problem.[56]

Attempts were made to dispense with ventilation doors, but only when bord and pillar mining was discontinued were they finally removed. Caleb Pamely's 1893 textbook for mine managers described a self-acting ventilation door that was used in conjunction with rope haulage systems. Such mechanized colliery doors were advertised in the *Canadian Mining Review* in 1899, but their acceptance was not widespread since boys were readily available and trapping served as entry-level employment for the children of miners. Although the Coal Creek colliery in the Crowsnest Pass experimented with canvas curtains instead of trapper boys, managers were in no great rush to find expensive mechanical substitutes for trappers.[57]

While doors were the principal means of directing ventilation currents through a mine, they were only used on main haulage roads. In untravelled parts of a mine or in the actual bords, *stoppings* were erected to block a current permanently or direct it to where miners were more active. Alternatively, a form of bratticing, a dense cotton material, could be used to guide the air current to the coal face by deflecting part of it towards the miners' working areas, while allowing the main air-flow to continue through other parts of the mine.[58]

Mining and Underground Haulage

As the major hindrance to increased coal output, underground haulage was a persistent concern for mine managers. The potential increase in mine productivity that steam-powered hoisting allowed could only be realized if antiquated means of transporting coal underground were upgraded. Improvements were particularly pressing because gunpowder was introduced into British North American mines about the same time as steam, during the middle third of the century. Blasting was by loose black powder, fired by *squibs*.[59] While hand picks remained indispensable to shearing and undercutting a working coal face, use of gunpowder to dislodge the remaining coal increased a miner's productivity by perhaps 40%. Eventually, the introduction of mechanical coal cutting machines reduced the dependence on powder and increased the productivity of the miners many times over. This increased output of coal in bords threatened to overwhelm existing haulage systems.[60]

A first step in removing this bottleneck was the introduction of animals to haul coal underground. Horses had been used underground to pull tubs laden with coal in British collieries since the late 18th century. The GMA, priding itself on adopting the most advanced mining practices, introduced horse haulage underground shortly after its arrival in Nova Scotia. Initially horses pulled skips, sled-like vehicles that were pulled over wooden roads made up of logs laid horizontally along the levels. The skip was gradually replaced with a wooden coal tub or *box* bolted to an iron frame that was fitted with a wheeled undercarriage,

55. Brian Lewis, *Coal Mining in the Eighteenth and Nineteenth Centuries* (London, 1971), 51; Neil K. Buxton, *The Economic Development of the British Coal Industry* (London, 1978), 131; Galloway, *Annals of Coal Mining*, Vol. 2, 269; Tyro, "A Visit to the Albion Mines," *The Provincial or Halifax Monthly Magazine*, 1, No. 5 (May 1852), 177; R.A.H. Morrow, *The Story of the Springhill Disaster* (Saint John, 1891), 293; Nova Scotia, *Mines Report*, 1888.

56. E. Gilpin, "Coal Mining in Nova Scotia," *Transactions of the Canadian Society of Civil Engineers*, II (1888), 363–64; Lewis, Coal Mining..., 51; British Columbia, *Mines Report*, 1883, 416–18. Judith Ryan, *A Physical Description of Coal Mining in Nova Scotia, 1800–1980* (Nova Scotia Museum of Industry Reports, 1990), 39–55; "Coal Mining in Cape Breton..." *Canadian Mining Review* (August, 1893) lists the variety of ventilation systems operating in every one of the Cape Breton pits described. Four used steam driven fans; three were still ventilated by furnaces.

57. *Canadian Mining Review*, (August, 1899), 99; Galloway, *Annals of Coal Mining...*, 203. *Canadian Mining Review*, (February, 1901), 60–67. An injured trapper boy was reported by the *Maritime Labour Herald*, 3 May 1924. For detailed discussion of the use of boy labourers in the pits see Robert G. McIntosh, "'Grotesque Faces and Figures'...."

58. MacLeod, "Miners, Mining Men and Mining Reform...," 368.

59. By early in this century compressed powder or "pellets" were used in damp mines. The charge was fired initially by an ordinary squib; subsequently, the safer powder fuses (fired by electric batteries) were introduced. By the same time, in dry and dusty mines, or in gaseous mines, only "safety" or "permitted" explosives such as Excellite or Monobel were used. These were fired by electric battery and a fulminate of mercury detonator. Francis W. Gray, *The Coal-Fields and Coal Industry of Eastern Canada: A General Survey and Description* (Ottawa, 1917), 40.

60. B.R. Mitchell, *The Economic Development of the British Coal Industry, 1800–1914* (Cambridge, 1984), 75–76.

designed to run over underground rails. While wooden rails were used at smaller mines, rails were generally made of iron imported from Britain and shaped in the foundry of each large mine. By 1871 the GMA had several miles of light underground railway in place in its Cape Breton and Pictou mines.[61] Similar attention was paid to underground haulage in British Columbia. At Nanaimo in 1856, underground passageways were enlarged to allow the use of horses to haul coal along the levels to the pit-bottom. Mules were introduced in B.C. mines to compensate for a shortage of Indian labourers, who were initially used to move coal from the deeps to the surface in the shallow mines. Coal companies were able to increase or reduce the number of horses they had underground as coal production fluctuated. The ease with which this could be done accounts for the use of horse haulage long after there were more mechanical methods of moving coal underground.[62]

Driving a horse through the intricate tunnels underground required both finesse and strength. It was often the second job adolescent boys had underground, considered a learning experience that exposed young miners-to-be to the different environments of the mine. Perched between the horse and the tub or tubs being pulled, often with "his foot against the horse's rump to hold back the tub[s]," a *driver* led the horse along dark underground travelling roads, collecting tubs loaded with freshly cut coal and transporting them to a point where they could be hoisted to the surface. He then had to return the empty tubs to the working places. The driver's role was critical to efficient mining in the widely dispersed bords. Since a miner's earnings depended on his productivity, the efficient movement of coal to the surface for processing was essential; empty boxes had to be ready when he was ready to load the coal and coal had to be delivered to the pit-bottom with a minimum delay and loss.[63]

As late-Victorian mines grew in size, underground roadways lengthened and mine managers looked to supplement or replace horse haulage. Horses were exhausted travelling long distances and expenses associated with maintenance of roads climbed. Roads had to be kept well drained of pit water, which could be particularly corrosive in Cape Breton's submarine mines where it was quite acidic and salty. Sitting water could interfere with the movement of coal tubs underground and aggravated cuts on the horses' hooves. Roof-brushing, i.e. raising the level of the *roof* to

Driving a level, Inverness, Nova Scotia, 1906. *Miners responsible for developing travelling roads in a mine were crucial to its success. In the early stages of the industry, such work was done primarily by hand, as in this photo. Later, it became highly mechanized, as huge boring machines drove deep into the seams. Levels, in spite of their name, had to be carefully constructed to run parallel to the strike of the seam, but had to take advantage of gravity by always seeking the upward plane down which the coal could travel. These levels, and there would be several in a fully developed mine, were the main link between the various working places, where coal was produced, and the slope or shaft, where coal and materials were taken out of and into the mine. Faulty design could effect the success of a mine. (Courtesy of the National Archives of Canada, PA29182).*

permit freer passage of horses, was expensive in lengthy underground travel-ways, as was *roof-buttressing*, the placing of wooden props at regular intervals. As well, rails had to be well ballasted to prevent the tubs from tipping over and injuring the horse and driver.[64]

Horse-haulage remained the principal means of transporting coal underground until well after the turn of this century — larger mines could have several dozen horses operating at a given time. The design of the mines helped the horses before steam power was used to transport the coal. Where seams pitched

61. Gilpin, "Coal Mining in Nova Scotia...," 395; Richard Brown, *The Coal Fields and Coal Trade of the Island of Cape Breton* (Stellarton, 1899), 113.
62. William Burrill, "Class Conflict and Colonialism: The Coal Miners of Vancouver Island during the Hudson's Bay Company Era, 1848–1862" (M.A. thesis, University of Victoria, 1987), 126.
63. J.C. Mitchell, "Early Mining of Coal in Glace Bay District, Cape Breton," *Canadian Mining Journal*, 1912, 551.
64. C.B. Kingston, "The International Colliery," *Transactions of the Canadian Society of Civil Engineers* V, No. 1 (January–June 1891), 21; Edwin Gilpin, "Notes on Nova Scotia Pit Waters" (Halifax, c.1877).

steeply, as in Springhill Nova Scotia, gravity was used. If the grade was sufficiently steep, freshly cut coal could be brought down to travelling roads using wooden slides or *shoots* lined with sheet iron. A driver filled a tub with coal by lifting a door at the mouth of the shoot. If the grade was not quite steep enough, boys called shovers-down were employed. In August 1901, 68 shovers-down were on the payroll at Springhill.[65] *Chutes* were commonly used in the Crowsnest Pass, where coal seams, like those at Springhill, often pitched sharply. On Vancouver Island shovers-down were not used, though slides were sometimes used in the steeply pitched Cumberland fields. To clear a jam there, the miner himself would jab at the coal or climb into the chute, brace himself, and kick the coal.[66]

Back-balances also made use of gravity. Two mine cars (one carrying ballast) were attached to a pulley at the top of an inclined underground road. Using a lever, an empty car could be brought to any point along the *incline*, and could be removed to the bords. When it was filled with coal, the car was returned to the back-balance, where gravity and the balance provided by the weighted car would lower it to a principal underground road in a controlled fashion. There it could be attached to a horse for haulage to the main hoisting shaft. A back-balance was in use at Albion Mines in 1865, where it was estimated that, during a ten-hour shift, one boy could brake down 275 to 300 boxes of coal, each weighing 1 500 pounds (680 kg). By the early 1870s back-balances were in use at a number of Cape Breton mines.[67]

Hoisting

After the loaded tubs were brought to the base of a shaft or slope, or to one of the many *landings*, where tubs were assembled before they were transported out of the mine, they were prepared for hoisting to the surface. At some smaller drift mines, full tubs were brought directly out of the mine using either gravity or horse power to transport them along level or near level planes. With the GMA's steam-powered hoists, wire rope or chains replaced the horse *whim* that was used in the more primitive shafts. In sloped mines, they were assembled in long trains by a landing tender to await dispatch. In shaft mines the *bottomer* (another job often held by adolescent boys or older or injured miners) was responsible for shifting tubs of coal hauled to the shaft bottom by horse to the hoist. The coal cars loaded onto hoists were often stacked several deep for the ride to the surface.[68] The actual hoisting of coal was only part of the job that hoisting staff had to perform. In deeper mines, they were also responsible for coordinating the movement of huge quantities of materials and many men. Every horse in the mine required vast amounts of feed each day, and pit props, machinery and track all had to be brought to the men who were working at the face.

Great technological advances were made to hoisting engines during the 19th century. The deeper the mine, the larger the engine required to hoist coal out and move men and materials into and out of the pits. Coal mines, unlike factories where steam engines also powered machinery, were constantly changing their size and shape as new areas were mined. While main haulage engines were always on the surface, in deeper pits there were also intermediate engines located at strategic points along the main slope. The delivery of power to this vast labyrinth of tunnels and rooms was a continuing problem and engineers became vital to the successful planning of mines. By the end of the century, steam powered hoisting engines often drove double drums more than ten feet (3 metres) in diameter. Most of them came from foreign suppliers, but a surprising number were made by local manufacturers, at least in Nova Scotia where large engineering works had emerged. Soon most of these steam engines were replaced by more efficient and dependable electric motors, though some were powered by coal powered steam generators. By 1900 the hoisting equipment at some shaft mines featured a dumping cage or *tipple*. Pit tubs rested on a pivoted platform and:

> *as the cage approache[d] the bank, the platform [was] pressed by a spring against a curved termination to the shaft guides, thereby deflecting the platform, tilting the tub and dumping the contents through an end-door into an automatic weigh-tank, from which, after being weighed, the coal passes on the screens.*[69]

The massive *head-frames* or *bank-heads* housing those engines were among the largest industrial structures in the country at the time, reaching high into the air to allow the coal to be transported to an elevation that allowed it to move directly to railway cars for shipment. The constant noise around the bank-head gave the collieries their distinctive feel; the coal dust they threw out gave them their characteristic odour. Whistles sounded to announce the beginning and end of the day's work and to punctuate various mine operations.[70]

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65. Springhill Miners' Museum, Springhill, Nova Scotia, Cumberland Railway and Coal Company, Time Books, August 1901; J.C. Nicholson, "Past and Present Methods of Working No. 2 Mine, Springhill, Nova Scotia," *Canadian Mining Journal*, 1922, 468–70.
66. Sharon Babaian, *Coal Mining in the Crow's Nest...*, 40–45.
67. Gilpin, "Coal Mining in Nova Scotia..."; Geological Survey of Canada, *Reports on Progress*, 1866–7, 94; Nova Scotia, *Mines Report*, 1873, 18–19 indicates use of back-balances at the Caledonia and Gowrie mines; Edwin Gilpin, "Coal Mining in Pictou County," *Transactions of the Royal Society of Canada*, IV (1896), 175.
68. MacLeod, "Mining, Mining Men and Mining Reform...," 307.
69. Gray, *Coal-Fields and Coal Industry...*, 41.
70. *Ibid.*, 307.

Safe operation and maintenance of the hoisting machinery was one of the most important jobs in the mine — a non-working hoist meant a non-working mine. Cars on the hoist could travel a couple of kilometres and there could be several places along a slope where mine cars had to be picked up or off-loaded. With two main haulage-ways in operation at any given time it was important that the system be coordinated. The number of engineers on staff increased to meet the requirements of deep pits. After World War I, the move toward a 24 hour working day, with three eight-hour shifts, necessitated that operations be structured to maximize the benefits of complex systems that were being introduced. Without question, the most significant technological advances that occurred over the last decade of the century were in the haulage systems. The desire to use the full capacity of the new above-ground facilities had created much of the pressure to improve techniques underground.

Preparation of Coal

Once coal was hauled from the deeps it had to be prepared for market. The coal was cleaned and sorted on the basis of size and quality, and then loaded for shipment. Coal was sold either as *run of mine*, with none of the slack removed, or as screened coal, with the slack of small coal removed. Any number of impurities could be sent to the surface along with the coal, so dirt, slate and other rock had to be removed before coal was shipped. At smaller mines, miners were responsible for cleaning the coal before sending it to the surface; either the miner himself or a helper removed the impurities before filling the tubs for dispatch. Too many impurities in the coal resulted in fines and had a direct impact on a miner's earnings. It was a constant source of disagreement between miners and managers; the determination of the weight and grade of coal was sometimes rather arbitrary. Eventually the miners got the right to employ their own representatives to work beside the company officials who assigned value to the coal they sent to the surface. There was usually some consideration given to where in the mine the coal came from, and to the stage of development of a mine, which could have an impact on the purity of the coal.

Riddles (metal sieves of various dimensions) were used underground if there was a lot of slack to be removed. Until at least the 1860s, coal was riddled exclusively by hand. Coal was not cleaned on the surface at most Vancouver Island mines until 1891, when the storage of slack underground was linked to explosions at Nanaimo in 1887 and at Wellington in 1888. At Nanaimo, either pitch forks or screens were used underground until the 1870s, after which picking tables were installed on the surface.[71]

71. MacLeod, "Miners, Mining Men, and Mining Reform...," 312.

At picking tables, the coal passed slowly over moving belt lines and workers on either side of the belt removed the impurities by hand. In Nova Scotia, picking tables were adopted after the 1870s, and it was mostly young boys and ex-miners who worked at them, but on Vancouver Island, the pickers were often Chinese. In 1897 the *Canadian Mining Review* praised the new *picking belts* and *shaker screens* installed at collieries by the Dominion Coal Company for "distributing the coal over the belt area, giving the boys and men every opportunity to pick out the impurities." Bill Johnstone started work at a picking table at the age of 13. He recalled it as:

> *the most mind-stifling occupation that can be imagined. Our job was to pick out the pieces of shale from the coal as it passed on a conveyer. The boredom of watching a slow-moving conveyer passing one's eyes for eight hours a day, six days a week, was enough to drive one crazy.*[72]

Final preparation of coal for market was mechanized when surface screens and mechanical washers were adopted, though neither removed the need for picking belts immediately. Screens simply sorted the coal and whatever impurities remained by size. Coal was passed over a series of screens — relatively large coal continued on, while smaller coal fell through the screen. Washers were used initially only with slack coal.

The inventory of mines taken by the Commission of Conservation at the height of steam-powered mining, just before World War I, provides a comprehensive view of cleaning and grading practices at Canadian coal mines. At the smallest mines, coal was cleaned exclusively at the face, leaving enormous amounts underground. At larger collieries, picking tables or belts were used. Even at the largest collieries where surface installations had been entirely updated, such as Dominion No. 2 in 1910 or the Albion Mines in 1912, picking belts remained. The picking table at the Coal Creek colliery in the Crowsnest Pass was still in use in the 1920s. Well into the 1930s and even during World War II in some places, it was at picking tables "where practically all of the cleaning of Nova Scotian coals takes place." Only when mechanical loaders became common after the war was mechanical cleaning generally adopted.

The transformation in the markets for slack or crushed coal was of great significance in cleaning and processing coal. In most areas slack coal had been

72. John Douglas Belshaw, "Mining Techniques and Social Division on Vancouver Island, 1848–1900," *British Journal of Canadian Studies*, I, No. 1 (June 1986), 51, 55; Gallacher, "Men, Money, Machines...," 206; MacLeod, "Miners, Mining Men, and Mining Reform...," 331; J.S. McLennan, "The Screening of Soft Coal," *Transactions of the Canadian Society of Civil Engineers*, IV (1890), 86; *Canadian Mining Review*, 1897, 219; Bill Johnstone, *Coal Dust in My Blood* (Victoria, 1980), 12.

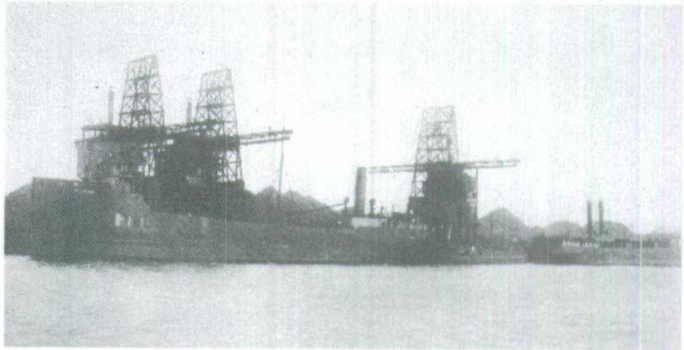
considered worthless or at best much less valuable than lump coal. Leaving it in the mine after riddling was typical, though this practice led to the build up of coal dust in the mine, which was linked to the explosions that occurred so frequently at end of the century. With the location of coking ovens near the mines themselves, a vast new market for slack coal emerged.[73] To prepare slack to produce metallurgical coke, it had to be washed. The "Baum" washer, which forced water through jigs agitated by compressed air, was in use by Dominion Coal and the Nova Scotia Steel and Coal Company soon after its development in the U.S., just prior to World War I. With the ready market for slack coal a number of other mechanical innovations were introduced that further transformed the nature of the industry.[74]

Shipping Coal

At early GMA mines, coal was taken from pit heads by small local rail lines directly to dockside, where it was loaded onto smaller skiffs that transported it to waiting ships. This process involved the coal being handled several times between being mined and reaching its final market. Handling the coal increased its cost and took its toll on the much preferred lump coal that was so important to urban markets during the early period. The technological response was to develop large loading docks where ocean-going vessels could be loaded directly with their coal. By the 1860s such docks were being planned and built in and around the several mines operating in Cape Breton. The GMA built a massive pier on the landward side of the sand bar that protected the north side of Sydney Harbour; shortly after that, in 1871, the International Coal Company built another on the opposite side of the harbour. Over the ensuing years, several more were built, each one bigger and more efficient than the last, until the process was largely automated. These shipping piers were among the most impressive engineering achievements of the era. They allowed the direct movement of the coal onto the loading piers where it was held in massive pockets. The actual loading of the coal was an engineering marvel; a system of chutes fed the coal directly into the waiting holds of vessels. This reduced turn-around times for the vessels and the handling costs.

73. W.J. Dick, *Conservation of Coal in Canada with Notes on the Principal Coal Mines* (Toronto, 1914); *Canadian Mining Journal*, 1910, 764; 1912, 653; Robert Strachan, "Coal Mining in British Columbia," *Transactions of the Canadian Society of Mining and Metallurgy* (1923), 118; Discussion of J.B. Morrow, "The Preparation of Coal," *Transactions of the Canadian Institute of Mining and Metallurgy*, 1932, 280–81; NAC, RG 81, Vol. 125, file 77-6-1.

74. This variety of washer yielded a very high recovery of fine coal and required relatively small amounts of water. Gray, *Coal-Fields and Coal Industry...*, 36.



Shipping piers, Louisbourg, Cape Breton, 1925. *Shipping coal from its point of production to where it was to be consumed was always a burden. A commodity with a value relatively low compared with its bulk, coal was shipped most effectively by water. Shipment was always a problem since our coal reserves are located on the eastern and western extremities of the country. The huge dereks and cranes necessary for loading and unloading coal boats were a common site in most large urban centres until very recently. Coal was essential to many industrial processes and had to be efficiently stored and delivered so that it was available when needed. These shipping piers at Louisbourg were free, year round, of the hard drift ice that closed more northerly ports. Similar docking facilities were built in Sydney and North Sydney, as well as in most large urban centres that received coal shipments. (Courtesy of the Beaton Institute, University College of Cape Breton).*

The workers responsible for loading a ship were *trimmers*. Because coal ports were only open about 160 days annually in Nova Scotia, trimmers had to work at a feverish pace. At Little Glace Bay in 1888, 14 men were required to trim a ship of 1 000 tons in a single day. "The work is very hard," one trimmer claimed, "and sometimes begins at 3 or 4 a.m. to suit the tide." He continued: "The dust is sometimes very bad, and there is no time to use a sponge, to keep it from the lungs, or to come on deck for fresh air." The development of automated shipping piers did away with much of the manual labour associated with the hand-loading of vessels, and cut costs, since railway workers and pier workers were among the most highly paid in the whole structure.[75]

Coal boats were, at first, not much different than other vessels that plied the North Atlantic routes, and were usually among the older vessels operating at any given time. For the coastal trade, smaller schooners were commonly used, though many larger vessels were involved as well. The introduction of steam power to navigation did not immediately lead to the large scale movement of coal aboard steam-powered vessels. By the end of the century however, special steamers, called colliers, were built for the Dominion Coal Corporation, which put them on their Quebec and Montreal runs. Nova Scotia coal was only shipped by rail to markets inside the Maritime region.

75. "Condition of Trimmers, by Superintendent of Trimmers, Little Glace Bay," in C. Ochiltree Macdonald, *The Coal and Iron Industries of Nova Scotia* (Halifax, 1909), 51.

Making Miners

The history of the training of miners for the exacting work underground was marked by a shift from informal to formal means of examination. In spite of these interventions, the industry remained one of the bastions of on-the-job training well into the 20th century. At early Victorian mines, adolescent boys — sometimes after a period of employment as trappers or drivers — apprenticed at the coal face as an assistant or loader to an experienced collier who was often their father or another relative. Miners considered it an almost exclusive right to select who would be trained for mine work in their workplaces. Gradually, however, skilled colliers lost the authority they had to mine owners, who rejected the miners' right to control who entered the mine work force. Miners also lost authority — although not particularly regretted — to provincial governments. In the form of Mines Acts, provincial governments stipulated that boys be of a minimum age and education before performing mine work. In addition, largely because of a concern for safety, provincial legislators enacted provisions for miner certification, a step lobbied for and approved by miners' unions, who saw it as a recognition of their special skills. Mine owners deeply resented such legislation, which they viewed as impinging on their authority to regulate who would work in their mines. Some who disapproved sufficiently simply ignored provincial regulation, but the negotiated relations between miners, mine operators and governments became a part of the reality of coal mines at the end of the 19th century.

British miners upon whose skills the early coal industry had depended brought with them a wide range of skills and attitudes. In the early 19th century, they were often seen as something akin to independent commodity producers, who sub-contracted "the labour power of himself *and his family* to the capitalist who had opened the pit" [emphasis added]. A family-based organization of labour committed these miners "to the ideal of the hereditary closed shop."[76] Womens' roles within this structure, since there was no tradition of them working underground, was to reproduce the labour power of men and boys. For the capital-intensive collieries of the later 19th century, a steady and flexible supply of mine labourers was crucial, so housing and credit were provided to the mining families. The company store was a common feature of the coal mining community.[77] This was problematic in an era when coal mining was seasonal and when markets could fluctuate wildly from year to year. Miners and their families had to be carried when work was in short supply in order to ensure their availability when work was plentiful.

Into the 1850s at Nova Scotian collieries, and into the 1870s on Vancouver Island, skilled work was the domain of experienced immigrant miners from Britain, who trained future generations of miners by apprenticing their sons. Operating within a closed monopolistic situation operators of those mines recruited carefully and attempted to maintain a balance between the skilled colliers and the more common labourers who were needed to support the activities at the coal face. When the HBC recruited for its Vancouver Island mines, it made a point of seeking mining families. The first contingent of miners was John Muir, his four sons, two nephews and their wives and younger children. Muir's nine year old son was the youngest to receive a working contract. As more groups were recruited, the company continued this practice. "Muir," Chief Factor James Douglas reported from Fort Victoria in 1852, "calculates that each head of a family is to have the assistance of two or three boys each of whom he supposes capable of performing half a man's work." Accordingly, when the Hudson's Bay Company's mining agent in Scotland, David Landale, was asked the next year to recruit a contingent of 40 colliers, he was instructed that:

> *[t]hey should all be married men, but not with numerous families... it is desirable that none of the children should be very young. Families in which there are boys, two of whom can do work equal to that of one man are to be preferred.*[78]

The GMA recognized the special skills of miners in bringing them out from Great Britain. They offered British miners rates of pay equivalent to that of skilled artisans, higher rates than were available in Britain at the time.[79] Their offspring were fully expected to constitute future generations of miners.

76. Alan Campbell and Fred Reid, "The Independent Collier in Scotland," in Royden Harrison (ed.), *The Independent Collier: The Coal Miner as Archetypal Proletarian Reconsidered* (Sussex, 1979), 64; Paul Edward Hedley Hair, "A Social History of British Coalminers, 1800–1845" (Ph.D. dissertation, University of London, 1955), 51; Walter R. Johnson, *The Coal Trade of British America* (Washington, 1850), 21. Sometimes, on payment of a fee, other boys would be taken as apprentices to the mines. J.S. Martell, "Early Coal Mining in Nova Scotia," in Don Macgillivray and Brian Tennyson (eds.), *Cape Breton Historical Essays* (Sydney, 1980), 52–53.

77. While it would help to "tide miners over" slack periods, miners' dependence on the company store would also be employed as a weapon by coal companies at times of conflict in the coalfields when necessary credit could be withheld.

78. Daniel T. Gallacher, "John Muir," *Dictionary of Canadian Biography*, XI (Toronto, 1982), 626–27; HBC Archives, A.11/73 of. 652, Douglas to Barclay, 7 December 1852, cited in Burrill, "Class Conflict and Colonialism...," 66; NAC, MG 20, A.5/18 of. 88-9, Barclay to Landale, 9 April 1853. See as well Lynn Bowen, *Boss Whistle* (Lantzville, B.C., 1982). Chs. 1–3.

79. Keith H. Ralston, "Miners and Managers: The Organization of Coal Production on Vancouver Island by the Hudson's Bay Company, 1848–1862," in *The Company on the Coast*, E. Blanche Norcross (ed.) (Nanaimo, 1983, 42–55; Burrill, "Class Conflict and Colonialism...," 102.

As a consequence of these traditional patterns of apprenticeship in the early Victorian collieries of British North America, unskilled mine work that did not require excessive strength was done by boys. On Vancouver Island, native Americans and Asians, who were exploited as unskilled workers, competed with the boys for work, although they did not have the opportunity to eventually become miners that the miners' sons had. When the GMA had a monopoly over Nova Scotia's mines, management was left in the hands of experienced mining engineers for long periods. Between them, Richard H. Brown and his son, also Richard Brown, managed the GMA's workings in Cape Breton for the entire 70 years they operated there. Both were trained mining engineers who participated in mining association meetings in England and contributed regularly to the professional development of the mining community.[80]

With the breaking of the monopoly and the entry of less experienced mine operators into the coal fields, there was a concern that the coal reserves would not be cared for in the same fashion as before. The Ministry of Mines, established to oversee the province's interest in the coal fields, monitored the activities of companies and employed professional mining engineers to inspect mines and advise the government on the development of the industry. Generally speaking, they collaborated with mine operators to maximize output and protect the interests of the province, whose dependence on coal royalties grew dramatically over the final third of the century.[81]

It became evident that as mines grew larger, managers supervising the many more working spaces needed to be schooled in more than the basics of mining. Toward the close of the 19th century, in the name of safety, provincial governments began to certify all mine officials who were above a certain level. This initiative was aimed particularly at underground officials who had control over work conditions and managed areas within a mine. Nova Scotia pioneered technical education in Canada, well before other provinces in some instances. In 1881 legislation was passed requiring every *overman* and underground official to pass a special examination set by a provincially appointed Board of Examiners. Certification requirements became more stringent in 1884 when a manager's certificate was required before taking control of any mine employing more than 30 workers. By 1890, certificates of competence required officials to have three years of experience underground and pass a competency test. Mine managers had to have five years' experience. While the wording and intent of the regulations appears to have been derived from a desire to regulate the affairs of the mines, in fact the bureaucracy for implementing the system remained rudimentary and training and certification of mine supervisors remained largely in the hands of the operators, who were empowered to certify their employees.

To some extent at least, this initiative was sponsored by the miners' new union, the Provincial Workmen's Association, which, after 1880, concerned itself with responsible operation of mines in the interest of its members. Robert Drummond, the Grand Secretary for over two decades, was anxious to demonstrate the viability of his union by pressuring the government to ensure that safe and acceptable practices were followed in all provincial mines. In December 1888, seven men were hired to teach mining classes in colliery towns. These instructors, generally mine officials already employed by the companies, gave instruction in mine safety and rudimentary mining engineering.[82] The following year, recognizing the limited formal education of many miners, instruction was also offered in basic reading, writing and arithmetic, although these courses were not considered nearly as successful as mining courses. Although initially oversubscribed, the men for whose benefit the courses were offered were soon displaced by younger students. At the same time, mining companies and colliery officials began to sponsor miners' lyceums to supplement the work of mining schools.[83]

At more advanced levels, mining engineers were being educated in Nova Scotia since 1871, at King's College in Windsor. In 1900, with encouragement from the provincial government, mine engineering programs were introduced at a number of Nova Scotia universities. Throughout this period, the Mining Society of Nova Scotia, an association made up primarily of mining officials and engineers established in 1887, lobbied the province to offer technical education.[84]

80. The Brown Papers (PANS, MG 1, Vol. 151) contain correspondence between the father and son following the elder's retirement to England. They reflect the concern of both of them for adherence to the best available mining practices in the name of both safety and productivity.

81. Nova Scotia offers the most striking example. Coal royalties accounted for 21% of provincial revenue in 1892 and 32% by 1896. See C.B. Fergusson, *W.S. Fielding: The Mantle of Howe*, Vol. 1 (Windsor, N.S., 1970), 128–29.

82. MacLeod, "Colliers, Colliery Safety and Workplace Control...," 241–44; Donald MacLeod, "Practicality Ascendant: The Origins and Establishment of Technical Education in Nova Scotia," *Acadiensis*, XV, No. 2 (Spring 1986), 68–69.

83. Drummond, *Minerals and Mining...*, 351; MacLeod, "Colliers, Colliery Safety and Workplace Control...," 243; MacLeod, "Practicality Ascendant...," 82. A sensitive discussion of the experience of one miner who progressed through this system is offered in Ian McKay, (ed.) "C.W. Lunn: From Trapper Boy to General Manager: A Story of Brotherly Love and Perseverance," *Labour/Le Travailleur*, 4 (1979), 211–40.

84. MacLeod, "Practicality Ascendant...," 53–59; 80–88. The formation of mining societies was evidence of growing professionalization among mining engineers. The Nova Scotia association was the oldest in Canada. By 1896, when the British Columbia Association of Mining Engineers was formed, associations had also been organized in Ontario and Quebec. *Canadian Mining Review*, 1896, 38. See also David Pigot, *The Mining Society of Nova Scotia, 1887–1987* (Halifax, 1987).

Mining schools did not offer the training in advanced engineering necessary for the complex new mining technologies that included *longwall* systems, electrification, mechanized coal cutting, ventilation, let alone such basic subjects as geology.[85] As a result larger corporations, such as the newly organized Dominion Coal Corporation, still operated on a version of the grand tour that had been common earlier in the century. Key officials were encouraged to travel widely to coal fields in the U.S. especially, where demonstrations of new machinery and techniques could be observed in operation.

Provincial certification provisions produced the threat of a shortage of qualified managers for provincial mines. Pressure from the Mining Society contributed substantially to passage of Nova Scotia's *Technical Education Act* in 1907, which established the Nova Scotia Technical College in Halifax, where the final two years of a four-year program in engineering was offered in a more systematic manner. It also recommended that local technical schools be established to teach courses at the secondary level and that coal mining and engineering schools be established for active miners anxious to advance to mine management positions.[86] By 1913, there were more certified mine officials than there were positions available in mines, and interest in mining schools waned. Demand dried up altogether with the decline of the coal industry in 1920s, leaving the schools to dwindle away, though there was later a renewed interest in certifying the miners themselves, who were increasingly expected to know basic information about the organization of a mine before they were allowed to take their place at the coal face. This concern had become more acute as legislation prohibited the employment of young boys in the pits.[87]

Boys and Mines

The experience of boys in mining, as a principal means of training future miners, is worthy of special discussion.[88] The longest direct testimony regarding boys' work in the mines occurred when members of the Royal Commission on Relations Between Capital and Labour (known as the Labour Commission) toured Nova Scotia's coal fields in 1888. Mine managers were unanimous in claiming that parents asked them to find work for their boys; all witnesses — managers, miners and boys — reported that this request was made at the urging of the boys themselves. Springhill miner Henry Rea, for instance, testified that his boys had started work at 12 or 13 years of age. "[T]hey felt as if they would sooner work than go to school; they were not doing much at school, so I let them go in." The manager of the Drummond colliery in Pictou County, Robert Simpson, maintained he had "never heard of boys being forced to come; it is their inclination." Twelve year old Robert McTagarth was asked if he would not prefer to be in school: "I would rather work in the pit," he responded.[89]

One may wonder if boys felt free to express their true views in front of parents and royal commissioners, but elderly retired miners, interviewed by Ian McKay in the 1970s, reported that they initiated their work in the mines when they were boys. One recounted his boredom with school and the attraction of the mine. Another recalled "putting on two overcoats to convince a mining manager that he was 14, when in fact he was only 12." Nova Scotia's Director of Technical Education, F.H. Sexton, unhappily noted the eagerness of boys in colliery towns to leave school and enter the pits.[90]

Various rites of initiation accompanying a boy's entry into the mine labour force, helping mark a major life transition. One miner recalled that, as a young trapper, passing drivers routinely spat tobacco juice at him. He continued:

> *And there were lots of tricks played on you by the older fellows. Someone would send you to pick up a "roofing-down-taker" or some foolish thing like that which didn't exist. They would send you to some old cross fellow. Well, he'd chase you out if he was in a cranky mood, but if you met some jolly fellow who understood the game he'd hand you something big and heavy and you'd take it back, and then you'd be directed somewhere else.... This was your introduction into what was called mining sense.*

Even if abuse from older boys was somewhat disturbing, the descent underground, the noises of the mine and the utter darkness were powerfully unsettling. Then followed the tedium, discomfort and isolation of what was commonly the boy's first job in

85. MacLeod, "Practicality Ascendant...," 69–70.
86. By way of comparison, not until 1914 were night classes established in British Columbia — and these were directed simply towards certification of mine officials. *Canadian Mining Journal* (November, 1920), 424.
87. Janet Guildford, "Coping with De-Industrialization: The Nova Scotia Department of Technical Education, 1907–1930," *Acadiensis*, XVI, No. 2 (Spring 1987), 70–73; MacLeod, "Practicality Ascendant...," 86. See also MacLeod, "Colliers, Colliery Safety and Workplace Control...," 243.
88. This section draws heavily on Robert G. McIntosh, "'Grotesque Faces and Figures'...."
89. *Labour Commission, Nova Scotia Evidence*, 304, 381, 301.
90. Ian McKay, "The Realm of Uncertainty: The Experience of Work in the Cumberland Coal Mines, 1873–1927," *Acadiensis*, XVI, No. 1 (Autumn 1986), 26; Frederick H. Sexton, "Industrial Education for Miners," *Transactions of the Canadian Mining Institute* (1912), 594.

the mine, trapping. Yet well informed observers generally agreed that boys matured rapidly in the pit. As one miner explained:

> *there are no children working in the mine. They may be children when they go in at ten or twelve years of age, but a fortnight or so thoroughly works that out of them. They then become very old fashioned boys. They get inured to all sorts of danger and hardship; they have, in a word, to think for themselves, as regards their work. As a matter of necessity, and as a matter of course, they soon presume to think for themselves on all matters.*[91]

Pit boys expected to gradually rise though the workforce hierarchy. Young boys performed light work such as trapping; older boys were soon driving a horse. Those on the threshold of adult strength performed the most arduous of boys' jobs: loading and unloading tubs from mechanized hoists, or filling tubs with coal in the bords. On reaching physical maturity, most pit boys expected to become miners and work alongside their relatives. Some would rise further to become mine officials.

Boys negotiated their conditions of work for the most part individually or in conjunction with their sponsoring parent or relative, though a boy could approach a responsible official to bargain over his pay, or negotiate a promotion. Miner Elisha Paul saw the promotion of boys within the mine workforce to be largely a function of intelligence and size. Customarily, promotion from trapper to driver was "according to whether he is smart or not, or whether he is a big boy or not." When 15 year old driver William Terrance wanted an increase in his daily earnings of 55 cents, he approached Springhill mine manager Henry Swift, who agreed to increase the boy's pay to 70 cents. Such actions were arbitrary and seldom involved extensive discussion.[92]

Members of the Labour Commission heard, in 1888, of the variety of work boys performed in the course of informal apprenticeships. Robert McTagarth, a veteran of the mine at 12 having started work at the age of 10, had recently started to work as a driver. William Terrace, 15, had worked turning a fan at the age of 10, and had also recently started driving. Murdock McLeod, a 29 year old miner, had entered the pit at nine as a trapper and had "worked himself up," spending many years as a driver before becoming a full-fledged miner. Elisha Paul's path to *coal cutter* was even more varied. Employed first as a trapper, Paul graduated to the position of driver within a few months. Next he worked on a balance, supervising the movement of empty boxes up to miners' workplaces and the passage of boxes full of coal down to the levels. By the time he was 16, he was a *cage runner* — placing full boxes on the hoist and taking empty ones off for the return trip to the miners. Later he was employed as a loader, filling boxes with the coal freshly cut by the miner. It was in the bord that Paul learned a "great deal as to how to work the coal from seeing the men he [was] working for and how they [did] it." At 19, Paul became a cutter.[93]

This practice extended to the newer mines of the western interior, as members of the Royal Commission on the Coal Mining Industry in Alberta discovered in 1907. An adult mine worker at Lethbridge, William Davis, was asked by the commissioners whether there is a time in the life of every miner when he is not a practical man. He answered:

> *Take this mine for instance, a little lad of twelve or thirteen years of age goes down to do trapping. During his term he learns gripping, driving and such like. When old enough they put him driving. Well when he gets driving he is going into working places and learning all the time and every day's work brings him near the practical miner. When I started working first I commenced right in with my father loading.*[94]

To be sure, much of the boy's early experience did not contribute directly to acquiring the technical skills of the miner, but rather amounted to pit-hardening, i.e. the acquisition of a general body of knowledge about success and survival in the mine.[95]

A growing interest in children's education produced special criticism of coal communities and added a new dimension to training miners.[96] School legislation passed at the end of the 19th century required compulsory attendance, which postponed entry into the labour market. The details of the legislation varied from province to province but had the same effect. British Columbia, for instance, first enacted provisions for compulsory education in 1876, whereby all children aged seven to 12 were compelled to attend school for at least six months annually. In 1901 urban children in this age bracket were required to attend

91. Dan J. MacDonald, "Farewell to Coal: Into the Mines — As a Child," *Atlantic Advocate* (August 1967), 21. See also *Journal and Pictou News*, 21 October 1891; *Halifax Morning Chronicle*, 4 December 1890; and *Stellarton Journal*, 21 January 1891.

92. *Labour Commission, Nova Scotia Evidence*, 269–70, 302. Henry Swift was not unusual among Victorian mine managers in so far as he himself had started work in the mine as a boy. See *Canadian Mining Review*, 1891, 75.

93. *Labour Commission, Nova Scotia Evidence*, 301–2, 288, 269–70.

94. See Provincial Archives of Alberta, Acc. 76.396, *Report of the Royal Commission on the Coal Mining Industry in the Province of Alberta, 1907* [Sessional Paper No. 1], Arthur L. Sifton (chairman).

95. See Bill Williamson, *Class, Culture and Community: A Biographical Study of Social Change in Mining* (London, 1982), 29.

96. "Public Schools Report, 1875–76," British Columbia, *Sessional Papers*, 1877. "Annual Report for the Public Schools of Nova Scotia, 1907–08," in Nova Scotia, *Journals and Proceedings*, 1908, 81.

throughout the school year; in 1912 rural boards were given this discretionary power as well. Province-wide compulsory attendance to the age of 14 was enacted in 1920; the following year the school-leaving age was raised to 15. Across Canada, there was a steady move in all provinces to require more children to attend school for longer periods of time.[97]

Mines Acts also added to the requirements boys had to meet if they wished to work in the mine. The first *Nova Scotia Mines Act*, passed in 1873, introduced age restrictions; boys under ten could not be employed in or about coal mines, boys were prohibited from operating steam-hoists, and a boys had to be 12 to operate a horse-gin. The Act also limited the hours boys under 16 could work; ten daily and 60 weekly, and 54 hours weekly for boys under 13.[98] Subsequent revisions to the child labour clauses of the *Nova Scotia Mines Act* could be largely attributed to the efforts of organized miners. The topic of educational requirements for pit boys beyond those stipulated in school legislation was raised at the annual meeting of Nova Scotia's Provincial Workmen's Association Grand Council in October 1890, where Robert Drummond moved a resolution, later submitted to the provincial legislature, calling for the prohibition of boys under 12 years of age being employed underground, and stipulating that "a boy before being permitted to work should be able to read, write and count, as far as fractions." This resolution was passed virtually verbatim by the House of Assembly in 1891, although it did not apply to boys already underground.[99]

Although miners generally approved of these legislative restrictions on boys working, mine owners did not. The clause of the 1873 Mines Act limiting boys under 12 years to 60 hours of work weekly prompted objections from several mine managers. The subsequent 1891 legislation was called both ambiguous and discriminatory. They argued that the clause "to 'count to fractions' made too indefinite an x on the school book to please the managers, who feared suits at law for possible inattention to the Act's numerous requirements." It was also pointed out that "no similar legislation has yet been introduced with reference to child labor in factories, where the atmosphere and the monotony of work are much more injurious to health than in mines."[100] It would be a generation before the Act was amended. Only in 1923, when boys had been largely excluded from mines for other reasons — the crisis of employment, technical change and compulsory schooling legislation — was the minimum age of employment raised to 16, where it would have excluded large numbers of boys from Nova Scotian mines. This followed once again an initiative from organized miners.[101]

In British Columbia the relationship between the child labour clauses of mining legislation and the expressed wishes of miners was less evident. When the provincial House of Assembly debated its first Mines Act in 1877, miners met in Nanaimo and agreed on "the necessity of educating boys, and limiting the time they should be underground." They passed a resolution recommending a minimum age of 12 for a boy to work underground, to a maximum of eight hours daily. This resolution dove-tailed with provincial education requirements enacted the previous year.[102] Despite the government's claim that the bill had "the sanction of the Nanaimo miners," the first *British Columbia Mines Act* had curtailed child labour far more sharply than even the miners wished. It was so restrictive — no boys under 12 were permitted to work; boys under 16 were limited to six hours work per day underground and five days' work per week — that it impeded recruitment to the minefields. In 1911 the minimum age of employment was raised to 15 underground and 14 on the surface. Special ministry approval, on the grounds of thin seams, was required to hire boys under 14. In effect, mine managers had little incentive to employ boys. If Nova Scotia's legislation had sought to raise standards of elementary education before a boy was trained to mine coal, British Columbia's made clear efforts to legislate boys out of the pits altogether.[103]

While the coal fields of Nova Scotia and Vancouver Island were major sites of child labour in Canada, other coal-producing provinces also ultimately drafted child labour clauses into their Mines Acts. The *Alberta Coal Mines Act* of 1906 stipulated that females and

97. A synopsis of provincial legislation on child labour and education is found in the Department of Labour, *The Employment of Children and Young Persons in Canada* (Ottawa, 1930), 98.
98. *The Revised Statutes of Nova Scotia, Fourth Series* (Halifax, 1873), Chap. 10, "Of the regulation of mines," Part 1, Sec. 4. By this legislation women lost the legal right to work in provincial collieries. It is unlikely, in any case, that they ever did labour in provincial coal mines.
99. *Labour Commission, Nova Scotia Evidence*, 351; PWA Grand Council, *Minutes*, October, 1890, 221. The 1891 revisions also stipulated that no boy under 16 years of age would normally be employed more than ten hours daily or 54 hours weekly. *Statutes of Nova Scotia* (Halifax, 1891), 54 Vic., Chap. 9, "An Act to amend Chapter 8, *Revised Statutes*, 'Of the regulation of coal mines'," Secs. 3 and 4. The minimum age for underground employment was raised to 17 in 1947, *Statutes of Nova Scotia* (Halifax, 1947), 11 Geo. VI, Chap. 39, "An Act to Amend Chapter 1 of the Acts of 1927, 'The Coal Mines Regulation Act'," Sec. 7] and to 18 in 1954 *Statutes of Nova Scotia* (Halifax, 1954), 3 Eliz. II, Chap. 56, "An Act to Amend Chapter 4 of the Acts of 1951, 'The Coal Mines Regulation Act'," Sec. 14.
100. Nova Scotia, *Debates*, 1873, 258.
101. *Canadian Mining Review*, 1891, 115; *Labour Gazette*, 1923, 353.
102. *Victoria Daily British Colonist*, 8, 11 February 1877.
103. *Statutes of British Columbia*, 1877 (Victoria, 1877), 40 Vic., No. 15, "An Act to Make Regulations with Respect to Coal Mines," Sec. 2. *Statutes of British Columbia* (Victoria, 1911), 1 Geo. V, Chap. 33, "An Act to consolidate and amend the 'Coal-Mines Regulation Act' and Amending Acts," Sec. 3.

boys under 12 were not permitted to work at mines. Boys under the age of 16 had to demonstrate an ability to ready, write, and do simple arithmetic to be eligible to work in a mine.[104] New Brunswick was the last coal-producing province to have coal mining legislation. Its *Mines Act* of 1933, among other things, abolished child labour and made nominal stipulations for certification.[105]

Life and Death in the Mine

All too frequently, the routine of mine labour was broken by tragedy. Even though minor accidents killed and maimed more mine workers over the years, great explosions that killed hundreds at a stroke seized public attention. Much of the training miners received was directed toward preventing all varieties of mine accidents. "Pit workers tell of 'getting a feeling' that makes them stop and investigate," wrote Stuart McCawley, "it may be a change in the air pressure, a queer odour, a crack or creep in the rock."[106] Hazards underground, even for the most experienced miners who knew how to sound roofs and walls in their workplaces, were difficult to detect. The threat of roof collapse was unrelenting around the coal face, even when wooden props were used. Both *pot-holes*, lens-shaped masses of stone lying flush against the roof, and chaldron bottoms, fossilized stumps of prehistoric trees, threatened to fall from the roof onto the miner. There was also the threat of lypes, vertical or near vertical fractures in the seam that could meet obliquely and allow huge masses of coal to roll forward onto the kneeling miner.[107]

Every year had its share of deaths. Over the last decades of the 19th century, an average of four workers per 1 000 in the industry died annually in Nova's Scotia's mines. Many times that number annually would be disabled for at least some portion of the year, though few statistics were kept on such incidents. It was the fortunate miner who completed his working life unscathed.[108] To illustrate: five mine workers died in Cape Breton mines in 1890, a relatively quiet year for accidents. Nineteen year old loader Frank McDougald fell in front of a full *trip* while riding up the slope and died the next day. An 18 year old driver, Alex McCosh, was killed by a fall of stone from the roof. A 12 year old errand boy, Murdoch Morrison, was killed when he was run over by an empty trip. The same fate subsequently befell a 70 year old mine labourer. Finally, a 37 year old miner, William McLutchy, had his back broken by a fall of stone and died five weeks later.[109]

Even the youngest trapper boys, were not immune from the ever-present dangers underground. Although pulling a chord to open a door when asked was not in itself dangerous, the tedious ten-hour work days and their immature judgement could lead boys to harm. One mines inspector called "familiar" accidents where

> *the "trapper boys" [were] either jammed by boxes, or trampled on by horses. The cause is in many instances leaving their doors to gratify their curiosity, or in visiting the next trapper, but more frequently by going to shift points [on the rails, to move trips from one rail line to another] or some other duty for the driver.*[110]

Yet, even if injuries were frequent, very few trappers died in the mines. As the inspector noted, accidents generally occurred away from the door:

> *Edward Jones was employed to keep a door [at the Albion Mines] at the foot of a slope up which the coal was drawn by horse-gin. On the last tub of the day having passed, he followed behind, and the rope breaking, the tub came upon him, and crushed his leg so severely that it had to be amputated.*

A trapper boy at Nanaimo "was injured about the head by a kick from a mule" in 1891. Thomas McLeod, who died in November 1867 at Lingan, was much less fortunate:

> *McLeod was employed in the Lingan Colliery as a door-keeper. It appears he had left his door for the purpose of having a ride in the empty tubs, one of which, on his attempting to get into it, had ended up and got off the way; it had then come in contact with the props by the wayside, which were knocked out, and a portion of the roof falling upon him crushed him to death.*

Albion Mines trapper Robert Harvey "left his post, and was injured at a counter-balance" in 1882. James McClellan was killed at the same mine in January 1884 when he "[l]eft his door and was killed by the rake striking him." Even though, according to the mines inspector, "[McClellan] was provided with a safety hole, and with a rope to open the door... he had left his post." The youthfulness of trapper boys was not perceived as the problem, rather, it was making bad decisions.[111]

104. den Otter, *Civilizing the West...*, 272.

105. Allen Seager, "Minto, New Brunswick: A Study in Class Relations Between the Wars," *Labour/Le Travailleur*, 5 (Spring, 1980), 96, 114. Perhaps not coincidentally, during the 1920s and 1930s there were relatively far more accidents at New Brunswick mines than elsewhere in Canada.

106. Cited in David Frank, "Contested Terrain: Workers' Control in the Cape Breton Coal Mines in the 1920s," in Craig Heron and Robert Storey (eds.), *On the Job: Confronting the Labour Process in Canada* (Kingston and Montreal, 1986), 106.

107. MacLeod, "Colliers, Colliery Safety and Workplace Control...," 230.

108. *Ibid.*, 226.

109. Nova Scotia, *Mines Report*, 1890, 23.

110. Nova Scotia, *Mines Report*, 1891, 12.

111. Nova Scotia, *Mines Reports*, 1866, 40–41; 1868, 34; British Columbia, *Mines Report*, 1891, 559; Nova Scotia, *Mines Report*, 1882, 12; 1884, 34.

Drivers were also liable to a particular type of accidents. In 1890 William Dunbar, was "severely hurt" when he was kicked by a horse in the McGregor Pit in Pictou County. Another boy, a few years earlier, had had his nose split. Mules were the beast of choice on Vancouver Island. In the Extension mine, Lewis Mackenzie, "the unfortunate victim of the mule's kick," was badly shaken when he was struck in 1901. "The uncertainty of the mule is proverbial," editorialized the *Nanaimo Free Press*, "and in that instance a little too much confiding trust was violently repaid with the usual compliment." Sometimes accidents were much more tragic. A mule driver was killed at Nanaimo in 1887 "by falling off a run of cars drawn by a mule, the cars running on top of him." Another boy died at Sydney Mines after a horse bolted in 1867.

> *The horse he was driving, from some cause, ran off and upset the tub in which [he] was riding. Being unable to extricate himself, he was unfortunately jammed between the tub and the timbers by the way-side, and was found in that position. Although no bones were broken, he appears to have suffered internal injuries, which caused his death.*[112]

On other occasions, the immature judgement of boys certainly contributed to the death of older mine workers. Youngsters called *spraggers* were employed to place *sprags*, or durkeys — short pointed wooden stakes that trailed from the rear of tubs designed to prevent a tub from running backwards by derailing it. When a bottomer forgot to include a durkey in 1883, his neglect resulted in a serious accident when the crash of a timber wagon killed eight mine workers.[113]

Although most mine accidents occurred underground, the mine surface also had its dangers. In 1879 Edward Hall, a driver working on the surface at Lingan, was mortally injured. When his horse bolted, Hall had jumped but his foot caught in the reins; "he was dragged along the ground for some distance." Screen boy Daniel Morrison was killed at Sydney Mines in 1886 when a rope broke and a tub ran back on him. Frederick Sullivan, a boy employed on the surface at the Drummond colliery, suffered a broken wrist when two coal cars collided in 1899. Andrew Neary, a 17 year old splint-picker at Dominion No. 2, was killed in 1913 when he fell under a moving car.[114]

If each mine worker faced dangers specific to the task he performed, all mine workers faced the common threat of explosion. It had long been understood that coal mines contained gases that were not simply poisonous but also explosive. This was the rationale for ventilating mines. Late in the 19th century another cause of mine explosions was identified: the ignition of the very fine coal dust particles suspended in the air.[115] Until the last third of the 19th century, only a small number of mine workers had been killed or seriously injured in isolated explosions.[116] On Vancouver Island, a Victoria newspaper reported a mishap in 1867.

> *A man named James Hamilton, and his son, a young lad, were very badly burned about the face and body . . . at Nanaimo, from the effects of an explosion of gunpowder, which Hamilton had taken with him for use in the coal pit. He fancies that a spark from a light which he held in his hand ignited the powder.*[117]

As mines deepened, became larger and employed more miners, explosions increased in frequency and severity. The first major mine explosion in Canada was at Pictou's Drummond colliery in 1873. According to one description:

> *The noise was terrific, the bank-head and other buildings over ground were shattered, impeding attempts at rescue. A cage in a shaft with its living contents was shot up into the air [cages were like elevators, used to bring men in and out of mines]. Smoke came rolling out the slope mouth in great dense volumes. Explosion succeeded explosion. The houses in the villages were shaken at intervals well on into the night. The explosion was caused by a fire, originating from a shot, which was uncontrollable, though heroic attempts were made to extinguish it.*

Fifty-nine men and boys died.[118]

Others followed. Fifty-three died in an explosion at the Foord Pit in 1880.[119] On Vancouver Island, an explosion at Nanaimo in 1887 killed 148; one at Wellington the following year killed 77.[120] Perhaps the most famous explosion ever to befall a 19th-century Canadian colliery occurred at Springhill, where, in the early afternoon of 21 February 1891, in one of the working places

112. Nova Scotia, *Mines Report*, 1890, 17; *Trades Journal*, 28 February 1883; Nanaimo *Free Press*, 25 January 1901; British Columbia, *Mines Report*, 288; Nova Scotia, *Mines Report*, 1867, 33.

113. *Trades Journal*, 7 February 1883, cited in MacLeod, "Miners, Mining Men and Mining Reform...," 385.

114. Nova Scotia, *Mines Reports*, 1879, 17; 1886, 36; 1899, 16; 1914, 75.

115. H.C. Hovey, "Coal Dust as an Element of Danger in Mining; Shown by the Explosion in the Albion Mines, Nov. 12, 1880," *Proceedings of the American Association for the Advancement of Science*, Vol. XXX (Cincinnati Meeting, August 1881).

116. MacLeod, "Colliers, Colliery Safety and Workplace Control...," 248; Robert Drummond, *Minerals and Mining, Nova Scotia* (Stellarton, 1918), 340. At Vale Colliery the general use of safety lamps was adopted in 1885 following an explosion, prompting at least one old miner, no longer permitted the use of his pipe, to quit. Mine safety had its price. *Trades Journal*, 26 March 1885.

117. Victoria *Daily British Colonist*, 19 September 1867.

118. Drummond, *Minerals and Mining...*, 341.

119. *Ibid.*, 341.

120. British Columbia, *Mines Report*, 1887, 1888. See also the Nanaimo *Free Press*, 11 May 1887.

of the No. 1 (East) Slope, a charge of gunpowder was lit in a bord to dislodge coal. On this occasion things went terribly wrong; the powder triggered an explosion that raged through the entire district of the mine. The first people to enter the mine afterwards encountered a grisly scene of death: "Falls of stone and coal, cars all blown to pieces, rails bent like hoops, and general destruction — very smoky, and dead men and boys lying in all directions." Among the 125 workers killed, 21 were boys under 18 years of age. Many not killed outright by the force of the blast died from exposure to the poisonous gases unleashed by the explosion.[121]

Major explosions continued into this century. In the Crowsnest Pass, the Fernie explosion in 1902 claimed 102; an explosion at Bellevue in 1910 killed 21.[122] In Nova Scotia, 68 died at Dominion Coal's No. 12 mine in New Waterford in 1917; two years later, 88 died at the Allan Mine in Pictou.[123] Even though tragedies on such a massive scale were uncommon, they continue as long as coal is mined underground. Ironically, perhaps most famous mining disaster in Canadian history, the Frank (Alberta) slide of 1903, did not occur in the mine. A tremendous landslide swept down Turtle Mountain and engulfed a portion of the mining community of Frank, killing 70 men, women and children. Coal mining is alleged to have weakened the mountainside.[124] The worst mining disaster ever to have occurred in Canada was at Hillcrest, Alberta, in 1914.[125] Sparks from falling rocks ignited coal dust and killed 189 mine workers.[126] Disasters could permanently close mines. At Springhill, an explosion in 1956 left 39 dead and permanently shut the No. 4 mine. Two years later, another bump — a tremendous buckling of subterranean layers — killed 75 miners at No. 1 mine and shut down the last mine operating in Springhill.[127]

Class Conflict in the Coal Fields

The level of conflict in coal mining was unrivalled in most other industrial settings. Epic battles — strikes were often violent and prolonged — have been waged wherever coal was mined. Wages and working conditions figure prominently as strike issues, but the major conflict in the period up to 1900 was control of mine labour supply; just who was qualified to work in a mine was disputed again and again. During the 19th century, there were three means by which British miners sought to restrict access to the coal mines they dominated: implementing systems of apprenticeship; limiting mine work to miners' offspring; and encouraging emigration during times of slow work. All three were attempted in Canada's coal fields, where the British norms were accepted.[128]

Formal associations of miners were organized late in the 19th century as miners responded to the sense that they were losing control over vital aspects of their work. Miners' earliest efforts were directed against mine owners. Subsequently, they enlisted the state's authority to establish formal rules of mine labour recruitment and promotion.

The fragility of miners' claim to special skills ensured that their control over entry into the mine labour force could be compromised by unfavourable labour markets, particularly when heavy immigration and a flood of inexperienced workers from over-crowded rural areas produced a chronic over-supply of potential mine workers. This situation tended to be exacerbated when demand for coal was on the decline, such as during the extended depression of the 1870s and 1880s, when the capacity of the mines had grown far beyond the market's ability to absorb available coal. In such circumstances mine operators could be particularly aggressive about imposing control over labour processes and working conditions, as well as over rates of remuneration, for it was here that they could exert the most pressure on individual miners.[129]

By going to the expense of bringing miners from Britain, employers acknowledged the value of their skills, but those skills were ultimately far more valuable to the miners themselves than to the coal companies.

121. The principal accounts of this disaster are R.A.H. Morrow, *The Story of the Springhill Disaster* (Saint John, 1891); H.A. McKnight, "The Great Colliery Explosion at Springhill, Nova Scotia, February 21, 1891" (Springhill, 1891); and the Nova Scotia *Mines Report*, 1891; and Ian McKay, "Industry, Work and Community...."

122. David Jay Bercuson, "Tragedy at Bellevue: Anatomy of a Mine Disaster," *Labour/Le Travailleur*, III (1978), 221. See also Joseph G.S. Hudson, "Investigation of the Coal Mine Disaster at Bellevue Mine near Frank, Alberta," Canada, *Sessional Papers*, 1911, 26a.

123. Drummond, *Minerals and Mining...*, 341.

124. The entrance to the mine was buried, trapping the night shift within the mine. Fourteen hours later, they all had dug themselves to the surface. *Canadian Mining Review*, 1903, 102–3. See also William Blakemore, "The Frank Disaster," *Canadian Mining Review*, 1903, 121–22; Raoul Green, "The Frank Disaster," *Canadian Mining Review*, 1903, 103–10.

125. A.A. Carpenter, *Report of the Commission appointed for the investigation and enquiry into the cause and effect of the Hillcrest Mine Disaster* (Edmonton, 1914).

126. Babaian, *Coal Mining Industry...*, 39. See also, the Fernie *District Ledger*, 27 June 1914, "Hillcrest Mine Disaster" and PAA, Acc. 87.195, Hillcrest Mine Disaster.

127. See Ian McKay, "Springhill 1958," in *People, Resources, and Power: Critical perspectives on underdevelopment and primary industries in the Atlantic region*, Gary Burrill and Ian McKay (eds.) (Halifax, 1987), 162–85.

128. Joel Michel, "Politique syndicale et conjoncture économique : la limitation de la production de charbon chez les mineurs européens au XIX[e] siècle," *Le mouvement social*, no. 119 (avril–juin 1982), 65.

129. McKay, "The Crisis of Dependent Development...."

Although inexperienced mine workers were more often the victims of accidents and earned less as datal workers than miners, they nonetheless were useful to employers. The costs of training neophytes were borne not by the company, which received any extra coal they produced at reduced rates, but by the more experienced workers, who were unable to restrict output by new miners. As well, neophyte miners were more likely to be injured or killed on the job. Miners argued that the state, which lost royalties on poorly cut coal or when accidents tied up operations, had an interest in ensuring that only experienced miners cut the coal or used gunpowder or machinery.[130]

Unlike other workers who claimed special status as craftsmen, miners could scarcely claim such status by pointing to chunks of coal as evidence of their highly refined skills. McKay explains the limitations of the miner's claim to skill:

> *The independent judgement and caution required for work in the small rooms and bords of the sprawling nineteenth century mines, the payment of wages according to output — these gave them cause to see themselves as skilled trades workers. The roughness of colliery work and the intangibility of its skills, the conditions of stark dependence in colliery towns, and (most crucially) the fact that the collier's most precious skill, the ability to tell a safe from an unsafe workplace, had no easily measured exchange value, meant that their claim to be considered skilled and respectable workers was frequently not honoured in the outside world.*[131]

Early Miners' Unions in Nova Scotia

The most important of the 19th century unions was Nova Scotia's Provincial Workmen's Association (PWA). Before its formation, no formal miners' associations existed, although pit miners were known to unite for common short-term objectives, such as to resist a reduction in pay.[132] The PWA was formed from a nucleus at Springhill in 1879. Buttressed by a successful strike there, within a few months it had extended beyond Cumberland County, organizing branches at Westville, Stellarton and Vale in Pictou County and spread into Cape Breton's larger fields shortly thereafter.[133] The following year, the PWA announced it was prepared to organize all workers in the province. Despite this resolution, it remained exclusively a miners' union, except for a brief period between 1903 and 1907.[134]

The PWA has been commonly characterized as a moderate, craft-oriented institution. Harold Logan emphasized its "sense of responsibility to the industry." For him, PWA success at lobbying for legislative reforms was its "outstanding feature."[135] The PWA's interest in self-help projects such as accident benefit funds, cooperative stores and friendly societies has also been noted.[136] Sharon Reilly stressed three aspects of early PWA activity: strikes; government lobbying; and electoral activity. She describes the non-confrontational nature of PWA leaders by demonstrating that all four major strikes sanctioned prior to 1900 — at the Drummond colliery in 1880, at Lingan over the winter of 1882–83, across Pictou County in 1887, and at Springhill in 1890 — were conducted as a last resort when the PWA's survival appeared dependent on this action.[137] All four strikes were over threatened wage reductions by coal operators. More recently, Ian McKay highlighted the distinction between the official rhetoric of the PWA and the militant activity of individual lodges. Despite the traditional view of the PWA as a conservative union, it was never centralized, and never just the personification of its Grand Secretary, Robert Drummond. While leaders talked of enhancing the social status of miners, PWA locals (by one estimate) fought 72 strikes over the 20 years of its existence before 1900.[138]

The PWA's efforts at lobbying, unlike its occasional electoral activity that mostly ended in failure to elect any sympathetic representatives, also had an impact on working conditions. Legislation pertaining to safety, certification of officials, apprenticeship and miners' relief funds all introduced tangible improvements to life and work within mining communities. A period of turmoil during the 1890s, when internal discord over policies and practices was exacerbated by a challenge from the American-based Knights of Labor, nearly resulted in PWA dissolution. By 1901, however, it had re-established itself as the only legitimate representative of the Nova Scotia miners.[139]

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130. McKay, "'By Wisdom, Wile or War'...;" Alan Campbell, "Skill, Independence, and Trade Unionism in the Coalfields of Nineteenth-Century Britain, with Particular Reference to Scotland," CHA *Historical Papers* (1981), 155–62.
131. McKay, "'By Wisdom, Wile or War'...," 29.
132. There was an early effort to found a union at Cow Bay (Port Morien) in 1868. See David Frank, "The Cape Breton Coal Miners, 1917-1926" (Ph.D. dissertation, Dalhousie University, 1979), 294. At least as early as 1874 workers at Sydney Mines were organized in a committee that performed many of the functions of a trade union. McKay, "Crisis of Dependent Development...," 36.
133. McKay, "'By Wisdom, Wile or War'...," 17–18.
134. *Trades Journal*, 31 August 1881; Sharon Reilly, "The Provincial Workmen's Association of Nova Scotia, 1879–1898" (M.A. thesis, Dalhousie University), 1979.
135. Harold Logan, *Trade Unions in Canada* (Toronto, 1948), 165–72.
136. Paul MacEwan, *Miners and Steelworkers* (Toronto, 1976), 9–22.
137. Reilly, "The Provincial Workmen's Association...."
138. See "'By Wisdom, Wile or War'...," 14–17.
139. Eugene Forsey, *Trade Unions in Canada 1812–1902* (Toronto, 1982), 349.

The issue on which miners throughout the country felt their most acute sense of degradation was worker recruitment. In Nova Scotia, entry into mines of inexperienced workers after mid-century was a continuous irritant. During periods of expanding demand, such as the early 1860s, mine managers did not discriminate whom they permitted to mine too closely, a practice that generated persistent complaints from experienced colliers, who legitimately feared for their own safety as well as for their earnings, which were always subject to severe strains because of seasonal swings in demand for their labour. Although early in the 1880s at least 18 months' experience was normally required to be employed as a miner, it was reported in 1884 that on the Nova Scotian mainland "at one of the mines lads verging on manhood and who had been brought up in the mine and were capable of mining were denied the picks, while those about whom the officials knew nothing were given them." Concern continued to be expressed by miners. "Spring Hill will be able to boast of having produced more coal smashers than any other district in the province," complained one miner, "men fresh from the back woods are being given the picks." The practice was so widespread that Robert Drummond, testifying before the Labour Commission in 1888 claimed that "under the present system an inexperienced stranger will be given the better paid work of cutting in preference to a trained boy."[140]

Another aspect of the erosion of worker authority was the corporate success in wresting control over use of helpers from the miner. Controversies arose at many mines in the 1880s over a miner's right to employ his sons as helpers. A delegate to the PWA Grand Council complained in 1880 to that effect. Later in the decade, controversy arose over the amount companies deducted from contract miners' pay for loaders, effectively dictating the sums miners paid their helpers. The question of certification arose early, when Patrick Neville, Deputy Inspector of Mines, outlined the consequences of the seasonal influx of rural workers into Cape Breton's mines in 1884:

> *It often happens that a young man from the country starts to work as a loader with a miner for a summer. He returns home in the autumn when mining slackens for the season, then returns in the spring with his own loader. The result is this inexperienced man and his loader make dust of the coal, and are not capable of taking care of themselves.*

Neville advocated, as a means of improving mine safety, a provincial law stipulating that three years' experience in the mine was required to get a working place.[141]

The PWA sought unsuccessfully to win legal recognition for the apprenticeships that the sons of miners continued to practise into this century. Robert Drummond, PWA Grand Secretary, argued before the 1888 federal Labour Commission that to "learn mining takes three or four years." Legal requirements for apprenticeships would orient recruitment of mine labour to sons of miners, while protecting their jobs from newcomers, who threatened experienced miners' monopolies of colliery work. In Drummond's expression, legal mine apprenticeships "would exclude people from other places" whose inexperience threatened the miner's ability to earn his livelihood.[142]

Before 1890 the PWA fought successfully to extend principles of certification to miners, a step that colliery operators disputed bitterly. By this law, a worker would need two years' experience underground before receiving charge of a working place; one year's experience was necessary to be entitled to cut coal with a miner supervising. A miner also had to pass oral exams addressing such subjects as mine gases, proper methods of working a coal face, ventilation, timbering, the use of safety lamps and mining regulations. Only to this extent was a boy's prior experience in the mine recognized as having value beyond that of inexperienced outsiders.[143]

As was the case with much Victorian social legislation, these amendments to Mines Acts were made in the absence of the adequate administrative machinery to ensure compliance, much of which was left to the strength and vigilance of the miners. Even after state-set province-wide standards established nominal control over access to mine work, mine labour recruitment and promotion were decided, often through confrontation, at the pit. Although a prominent colliery manager criticized PWA efforts "to make [it] as [if] it were a guild and prevent the employment of strangers at a time when labor below may be required," the union was far from resolute. Indeed, the PWA permitted flagrant non-compliance with certification provisions for operators of mechanical coal cutters when they were introduced later in the 1890s. If the union failed to insist on the strictest observation of the law, mine managers certainly did not either. For

140. MacLeod, "Miners, Mining Men and Mining Reform...," 435; PWA Grand Council, *Minutes*, April 1881, 21; April 1884, 59; Macdonald, *Coal and Iron Industries...*, 213; *Trades Journal*, 11 May 1887. *Trades Journal*, 20 April 1880; 9 November 1887; 30 October 1887; *Labour Commission, Nova Scotia Evidence*, 366.

141. Nova Scotia, *Mines Report*, 1884, 19–20.

142. Macdonald, *Coal and Iron Industries...*, 213; *Labour Commission, Nova Scotia Evidence*, 367. For Drummond, higher educational standards offered another not insignificant benefit: "If we can get a law passed, ordaining that miners must hold certificates it will have a tendency to keep uneducated men out of the mines, and thereby raise the status of miners." PWA Grand Council Annual Meeting, *Minutes*, 1890, 221.

143. MacLeod, "Colliers, Colliery Safety and Workplace Control ...," 244–45, 252.

Miners at the pit mouth, Fernie, British Columbia, 1911. *The dramatic increase in the capacity of Canada's coal industry between 1867 and 1917 was achieved by putting more and more men and boys underground. This photo — one of dozens of the type — reflects the absence of heavy technology for the miners themselves. The newly developed safety lamps they all carry and their tin lunch-buckets were all they took underground. It was largely their skill and strength that unlocked the wealth of the coal that was taken to the surface. Miners came from everywhere in the world, but the dominant group were the English and Scottish colliers, who were imbued with the lore of centuries of experience in their homelands and easily adapted to the circumstances of the local communities, wherever they arrived. (Courtesy of the National Archives of Canada, c 21076).*

much of this period of rapid expansion in the Nova Scotian coal industry, mine operators rode roughshod over the law.[144]

British Columbia and Alberta Unions

Union recognition was far more elusive on Vancouver Island, where two employers continued to dominate coal production through to the end of the century. The Dunsmuir family, operating collieries at Wellington, Cumberland and Extension, refused to recognize miners' organizations in any form, a policy that was continued by the subsequent owners of their mines, Canadian Collieries Ltd. Miners at Wellington formed a Miners' Mutual Protective Association in 1877 in the course of a strike against wage reductions.[145] The Dunsmuirs then unveiled a classic form of labour strategy; union organizers were fired, strikers were blacklisted and evicted from *company housing* and strikebreakers were employed. Those workers who particularly displeased Dunsmuir were hauled into court on a variety of charges, while the militia was called in to protect property and to uphold these union-busting practices. Chinese workers were also introduced into Dunsmuir mines to reduce labour costs and further divided the mine workforce. In short, the Dunsmuirs refused categorically to negotiate collectively with their workers.[146]

As a consequence, some of the most bitter coal strikes in Victorian Canada were fought with the Dunsmuirs: in 1877, 1883, 1889 and 1890. The last of these strikes closely resembled the others. It started at Wellington in May 1890 over the question of union recognition. Evictions from company houses soon followed. The first strikebreakers were in the mine by August, about the same time the militia arrived. The

144. *Canadian Mining Review*, 1896, 30; McKay, "'By Wisdom, Wile and War'...," 58; MacLeod, "Colliers, Colliery Safety and Workplace Control...," 252.

145. Eric Newsome, *The Coal Coast: The History of Coal Mining in British Columbia, 1835–1900* (Victoria, 1989), 80–101.

146. Jeremy Mouat, "The Politics of Coal: A Study of the Wellington Miners' Strike of 1890–91," *B.C. Studies*, 77 (Spring 1988), 8; Newsome, Coal Coast, 162. See also John Douglas Belshaw, "The Standard of Living of British Miners on Vancouver Island, 1848–1900," *BC Studies*, 84 (Winter 1989–90), 53.

strikers received some strike pay from their union, but many drifted away or found work at Nanaimo. Of the original 700 who went out in May, only 200 remained out at end of August. Trials in the autumn of 1890 accused strikers of intimidating strikebreakers. By New Year's 1891, production was back to normal levels and the miners' organization crushed, for the time being at least.[147]

Organized miners were recognized in 1891, when S.M. Robins, manager of the New Vancouver Coal Mining and Land Company at Nanaimo, signed a collective agreement with delegates of the Miners' and Mine Labourers' Protective Association. Founded in 1890, this union sought unsuccessfully to organize throughout the coal mines of Vancouver Island. Even at Nanaimo recognition was withdrawn after Robins' departure. International unions, despite a series of attempts, were even less successful. A short-lived Knights of Labour chapter was formed at Nanaimo in 1883. Efforts by the Western Federation of Miners in 1903 to gain recognition there failed as well. The first coal miners' union in the interior of British Columbia was an independent local organized at Fernie in 1899, called the Gladstone Miners' Union. The Western Federation of Miners subsequently made efforts to organize in the Crowsnest Pass area of Alberta, but it was forced out of the district by 1903, leaving the entire area without collective bargaining of any sort.[148]

The rules of mine labour recruitment and promotion were made more important on Vancouver Island because of the of large number of Chinese workers there. Chinese workers were first employed at Nanaimo in 1867, over the objections of white miners, who were locked out for seven weeks. A compromise was reached whereby miners tolerated the presence of Chinese workers on the mine surface. "The colliers threaten with violence," reported the *Victoria Daily Colonist*, "the first Chinaman who forgets his Celestial origin so far as to descend to the 'bottomless pit' of a coal mine." By the end of the 1860s, however, white miners were employing Chinese labourers underground to clean their coal, but paying them far less than they would white helpers.[149]

Over the 1870s, a clearly segmented labour market developed on Vancouver Island. Coal was cut by whites while non-whites were restricted to labourers' jobs. Sixty-two Chinese worked on the surface at Nanaimo in 1871; their presence underground as runners, pushing coal tubs, was also recorded that year. Likewise, they worked at Wellington when the colliery there was opened in 1871. By 1879 they were employed underground as both loaders and runners. By the early 1880s, at Dunsmuir's West Wellington mine, white miners "employ[ed] each of them a Chinese labourer." Similarly, at Nanaimo, "the miners [were] white men, with Chinese labourers."[150] The use of Chinese as strikebreakers had been rumoured as early as 1871 during a lengthy strike at Nanaimo. Dunsmuir canvassed San Francisco for Chinese workers during the 1877 Wellington strike, but, while other strikebreakers were employed, no Chinese appear to have been used at that time. White miners' sense of urgency was almost certainly heightened by the presence in British Columbia of thousands of Chinese navvies (unskilled workers), who would join the labour market when the Canadian Pacific Railway was completed. The lot of Asian labourers was improved in 1883 when miners at Wellington struck for an increase in pay. Dunsmuir immediately employed Chinese labour to cut coal and broke the strike. Having lost their monopoly over skilled mine work, white miners resolved to exclude the Chinese altogether from the mines.[151]

Subsequently, Chinese exclusion was a key element of major strikes throughout the 1880s at both Nanaimo and Wellington in 1888, and at Cumberland in 1889. White miners won a major victory in 1888 when both the New Vancouver Coal Mining and Land Company, at Nanaimo, and Robert Dunsmuir and Sons, at Wellington, agreed to withdraw the Chinese workers from underground employment. This followed a series of explosions at Nanaimo in 1887 and at Wellington in 1888, where the loss of 225 lives was successfully blamed on inexperienced Chinese workers. Nonetheless, Chinese workers continued to be employed on the surface at Nanaimo-area mines, as well as underground at Dunsmuir's large new Union colliery at Cumberland, where they accounted for a majority of underground workers. Chinese strikebreakers were

147. Mouat, "The Politics of Coal...."

148. Royal Commission on Mining Conditions in British Columbia, *Report* (Ottawa, 1900), 274; Paul A. Phillips, *No Power Greater: A Century of Labour in British Columbia* (Vancouver, 1967), 6–8, 12–16; Allan D. Orr, "The Western Federation of Miners and the Royal Commission on Industrial Disputes in 1903 with Special Reference to the Vancouver Island Coal Miners' Strike" (M.A. thesis, UBC, 1968), 113; Seager, "Socialists and Workers...," 36; Charles J. Macmillan, "Trade Unionism in District 18, 1900–1925: A Case Study" (M.A. thesis, University of Alberta, 1969).

149. Victoria *Daily British Colonist*, 27 April, 3 May, 8 May, 13 May, 24 May, 27 May, 15 June, 18 June, 24 June, 1 July. The quotation is from the issue of May 8th. See also Richard Brown, *On the Geographical Distribution and Physical Characteristics of the Coal-Fields of the North Pacific Coast* (Edinburgh, 1869), 12.

150. Victoria *Daily British Colonist*, 28 April, 7 May, 23 June 1871; 29 April 1879; Edward Watkin, *Canada and the States: Recollections, 1851–1886* (London, 1887), 70–72.

151. Patricia Roy, *A White Man's Province: British Columbia Politicians and Chinese and Japanese Immigrants, 1858–1914* (Vancouver, 1989), 53–54. Victoria *Daily British Colonist*, 20 Jan, 12 March 1871; British Columbia, *Sessional Papers*, 1879, 525–34. The Victoria *Daily British Colonist*, 24 February 1877, reported the presence in Wellington of American strikebreakers.

used as well during the 1903 strike and again in the United Mine Workers Association recognition strike of 1912–14.[152]

Miners and the State

Unable to enforce their earlier control over access to mines in direct negotiations with their employers, miners turned to the state to intervene on their behalf late in the 19th century. Their major concern was to secure restriction on workforce supply from both federal and provincial governments. Nationally, they lobbied for limits on immigration. Provincially, their object was to restrict access to the mine by means of miner certification or by apprenticeship programs that allowed them some control over selection. In an age where governments were reluctant to impinge on employers' authority to find workers where they wished and on their own terms, the first Mines Act reflected the concerns of management, though employers generally objected to clauses restricting child labour.

In Nova Scotia, the initial 1873 Mines Act simply supported the mine owners' position of control, entitling them to establish Special Rules at each mine that were to have the force of law. Managers were directed to post such laws prominently in the hope that new workers would exercise more care in daily work practices.[153] In addition, managers could lay charges against miners for safety infractions, but miners could not lay charges against managers for safety infractions; a practice that continued until well into this century. Only the provincial Mines Inspector could lay charges against mine operators — and he was exceedingly reluctant to do so unless there was a repeated refusal to comply with safety regulations. Their imperfections notwithstanding, the first Mines Acts established the principle that provinces were entitled to regulate conditions of work in mines in the name of safety.[154]

In the wake of explosions at the Foord Pit (Pictou County), deputy mines inspectors were appointed in Nova Scotia in 1881 and the Mines Act was amended to enhance miners' rights in safety issues. Three working men were appointed to each coroner's jury and miners at each colliery were entitled to appoint two-man safety committees to inspect the entire workings of all mines at least once a month in the company of managers and provincial safety inspectors. Miners' committees were also entitled to visit the scene of any accident and to report their findings to any subsequent hearings. Miners also gained the right to begin prosecution of management by affidavit, but it was never successfully implemented.[155]

Issues of mine safety and miner certification were fought in British Columbia largely with the intention of excluding Chinese from mine work. The provincial Mines Act was first amended to exclude the Chinese from underground employment in 1890, largely on the strength of white miners' claim — given credence in the wake of explosions at Nanaimo and Wellington — that the Chinese were a threat to safety. As early as June 1890 the courts were refusing to enforce Chinese exclusion, so the legislation never obtained legal force. Although unanimously upheld by the Supreme Court of British Columbia in 1897, this Act was ultimately declared *ultra vires* (beyond the powers granted by authority or law) by the Judicial Committee of the Privy Council in 1899, when an application for an injunction against Wellington colliery by the Attorney General of British Columbia, on the grounds that their employment practices contravened the most recent statute against the employment of Chinese workers underground, was rejected. Annual amendments to the Mines Act to exclude Asians from work underground followed over the first decade of this century, legislation that was fought in the courts, especially by the Dunsmuirs. It was never effective as a means of Asian exclusion. At the outbreak of World War I, Asians continued to be employed underground at Union collieries, and on the surface elsewhere on Vancouver Island.[156]

Provision for miner certification addressed the common interest of miners and provincial governments in mine safety. Miners saw it also as a means to restrict access to the mine. In British Columbia, Asian exclusionists often appealed to requirements of workplace safety. In 1894 the Inspector of Mines was empowered to examine and remove from the mine:

> *any person who, by reason of want of understanding or owing to mental or physical incapacity or incompetency for the performance of the particular task or duty upon which he is engaged, is a source of danger to his co-labourers or to others who may be in the mine, and whose presence and employment threaten or tend to the bodily injury of any person.*

An amendment to the Mines Act in 1901 established a five-man Examination Board to grant certificates of competency to both miners and mine officials. While requiring miners to have one year's experience in the mine and to be knowledgeable about the Act and mine safety, this amendment also stipulated that

152. Phillips, *No Power Greater...*, 8; British Columbia, *Sessional Papers* (1903), 62; Canada. *Royal Commission on Coal Mining Disputes on Vancouver Island, Report* (Ottawa, 1913), 24; British Columbia, *Mines Report*, 1887–8.

153. Copies of these announcements are preserved at the PANS, RG 21, Series "A," Vol 35.

154. MacLeod, "Colliers, Colliery Safety and Workplace Control...," 233–34.

155. *Ibid.*, 239–40.

156. Roy, *A White Man's Province...*, 80–81, 135, 141, 172; Mouat, "The Politics of Coal...," 25–26. British Columbia, *Sessional Papers*, 1897, 441–44; *Labour Gazette*, 1903, 483.

candidates be "sufficiently conversant with the English language." Widely viewed as a means to exclude Chinese from skilled mine work, these amendments were of uncertain legality. Their effectiveness as a means of Chinese exclusion is doubtful.[157]

Summary

As the 19th century ended, H.S. Poole, Nova Scotia mine manager and former provincial Inspector of Mines, reflected on the changes that occurred in mining over the previous 80 years. He pointed to a number of technical advances in mining: ropes had progressed from hemp or iron wire to steel; and winding from the slow hoisting of "skips swinging free" to "the rapid winding-in cages with guides and perhaps springs and safety catches."

At early Victorian mines, shafts were numerous and close together, reflecting the limitations of underground haulage systems. By the end of the century, far fewer — but considerably deeper — shafts had to be sunk. Ventilation techniques had moved from fire lamps and furnaces to high speed mechanical fans. Open lights had given way to the general use of safety lamps[158] and low pressure boilers had been supplanted by high pressure ones. Pit boxes "with chilled flanged wheels shrunk on round steel axles" had replaced skips; on the surface, techniques had advanced from skips tipped by main strength on banking, "the iron rings tumbling, with the coal on the screens to be gathered and carried up again to the pit head" to cages that automatically discharged cars to automatic tipplers "which discharge[ed] over moving screens and picking belts, all engine driven."[159]

Notwithstanding these improvements, Poole could not help but express his sense of loss. Earlier in the century, in his words, "coal cutting was an art, the collier took pride in his ability to handle the pick, to cut a straight and narrow shearing, to make a low holeing deep." By the end of the 19th century, he felt, "a neat wall is only seen in old workings; rough ragged and irregular sides are accepted with the urgent demand for large outputs."[160] With technical improvement, skills had deteriorated.

Despite Poole's concerns, the Canadian miner at the turn of this century continued to express high levels of pride in his craft, viewing himself as a contractor, paid piece rates. Prices were negotiated on the basis of the place he worked. The collier remained master of his pace of work, while retaining both his workplace authority and his intellectual parity with management both in planning and executing his work.[161] Rapid growth of Victorian collieries made the manager's task of supervision more difficult. The miner remained master of his room, even if that room was adjacent to another mined by a coal smasher, or if the prospect of a long walk out of the mine served to keep miners working on managerial time. While miners enjoyed mixed success in restricting access to the mine, their collective strength provided the basis for "organic control, common attitudes and practices of the coal miners' daily work-life [that] favoured the growth of a limited but significant tradition of workplace authority."[162]

Only with mine work being mechanized and new divisions of labour being introduced did the implications become evident: the miner's traditional workplace authority was being seriously challenged. These challenges provoked, in turn, fresh responses on the part of miners and their unions that would plunge the industry into crisis once again — but only after a period of unbridled expansion and the turbulence of a World War.

157. *Statutes of British Columbia, 1894* (Victoria, 1894), 57 Vic., Chap. 5, "An Act to amend the 'Coal Mines Regulation Act' and Amending Act"; *Statutes of British Columbia*, 1901 (Victoria, 1901), 1 Ed. VII, Chap. 36, "An Act to amend the Coal Mines Regulation Act."

158. It should however be noted that many miners resisted safety lamps, preferring an open flame (which threw greater light), feeling that the risk of explosion was less than the risk of accidents from poor light. Babaian, *Coal Mining Industry...*, 47.

159. H.S. Poole, "Mechanical Appliances Past and Present," cited in Macdonald, *Coal and Iron Industries...*, 158.

160. *Ibid.*

161. McKay, "The Realm of Uncertainty...," 38.

162. Frank, "Contested Terrain...," 102.

Chapter 5

The 20th Century Industry

Demand for coal — from industrial and domestic consumers in growing urban centres, from railways and ocean steamers, and from the growing metallurgical sector — grew greatly over the late 19th century and into the 20th. Canadian coal consumption, perhaps 750 000 tons at Confederation, stood at 3 500 000 tons by 1886, 10 000 000 tons in 1902, and nearly 27 000 000 tons in 1912.[163] Such rapidly expanding markets encouraged heavy investment in new technologies and a level of corporate concentration within the industry that linked production of coal to its final consumers.

Federal policies including tariffs and other subsidies, such as bounties on steel production or rebates on freight rates, had been significant factors in stabilizing the market during the most expansive phase of the industry prior to the World War I. Among these, the tariff was by far the most important. Protection had always been strongly supported by Nova Scotian coal operators, who had even opposed Laurier's proposal to renew the free trade of raw materials with the U.S. in 1910–11. There, affiliation of the local coal industry with the steel-making activities, of both Dominion Iron and Steel and Nova Scotia Steel and Coal, had the effect of fully integrating the regional coal industry with the economy of Canada.[164] In British Columbia, where coal operators had depended on export markets during the 19th century, they could not enlist the help of the Canadian state in the same way. But by 1913, 70% of Vancouver Island coal was sold in British Columbia for domestic consumption, manufacturing, or to ocean-going steamers. Only 20% went to California and 10% went elsewhere, mainly to Mexico. By 1924, coal markets in California had been permanently lost and coal operators in British Columbia also aligned themselves on the side of higher coal tariffs.[165]

As Canadian coal producers came to share a common interest in the tariff, steadily falling levels of real protection at a time of industrial crisis considerably raised the political profile of the industry. E.R. Forbes calculates that the effective protection on coal fell by two-thirds between 1879 and 1924. By 1912 bounties on iron and steel production had been abandoned; by 1914, Ontario steel producers were entitled to import bituminous coal virtually tariff-free.[166] Concern over the level of the tariff was all the more understandable in light of growing American dominance of the Canadian market. In 1913, for instance, 57% of the coal consumed in Canada was mined in the U.S.[167] While some of Alberta's domestic coal reached Ontario, steam and gas coal from the west only got as far east as Winnipeg.[168] Maritime coal traditionally found markets no further west than the easternmost tip of Ontario. Canada's industrial heartland, its centre of population and factories, was supplied by foreign coal while domestic industry stagnated. All coal producers were in agreement — the tariff had to be increased — but the major political debates of the 1920s only confirmed the reluctance of the federal government to tamper with powerful Ontario interests that demanded free access to cheaper American products.[169] The only response available to the mining industry was to attempt to meet the challenge to their productivity by increasing levels of mechanization to improve the competitive position of their coal relative to American producers. This predicament would dominate developments throughout the industry for most of the 20th century.

Corporate Structure

Two companies continued to dominate the Vancouver Island coal industry through the turn of this century. The Dunsmuir family operated mines at Wellington, Union and Extension; the Western Fuel Company had purchased the Nanaimo mines from the New Vancouver Coal Mining and Land Company in 1902.[170] Corporate concentration was even more evident in

163. Edwin Gilpin, "Coal Mining in Nova Scotia," *Transactions of the Canadian Society of Civil Engineers*, II (1888), 383; Dominion Bureau of Statistics, *Coal Statistics for Canada, 1927* (Ottawa, 1928), 27.
164. *Canadian Mining Journal*, 1911, 2.
165. *Canadian Mining Journal*, 1913, 672; Graham, "Problems of the Vancouver Island Coal Industry...," 475.
166. Ernest R. Forbes, *The Maritime Rights Movement, 1919–1927: A Study in Canadian Regionalism* (Montreal, 1979), 66–67.
167. David Frank, "The Cape Breton Coal Miners, 1917–1926," (Ph.D. dissertation, Dalhousie University, 1979), 19.
168. F.W. Gray, "The Development of the Coal Industry in Canada, from 1920 to 1935," *Transactions of the Canadian Institute of Mining and Metallurgy*, 1936, 217–34, esp. 226.
169. Charles W. Villiers "Problems of the Coal Industry in B.C.," *Transactions of the Canadian Institute of Mining and Metallurgy*, 1936, 567–72; W.J. Dick "Coal Problems of Alberta," *Transactions of the Canadian Institute of Mining and Metallurgy*, 1936, 573–84.
170. *Report of the Royal Commission on Industrial Disputes in British Columbia*, Canada, *Sessional Papers*, XXXVII, No. 13, 36a, 1903, 35.

Nova Scotia where the Dominion Coal Company (DOMCO) had brought the important southern Cape Breton coal field under a single corporate umbrella in 1893.[171] The Dominion Iron and Steel Company, established at Sydney in 1899, gained control of DOMCO in 1910, the same year it acquired the large mines of the Cumberland Railway and Coal Company at Springhill.[172]

When the Nova Scotia Steel and Coal Corporation — which had absorbed GMA properties at Sydney Mines in 1900 and the Acadia collieries in Pictou County in 1919 — and the Dominion Steel and Coal companies were amalgamated as the British Empire Steel Corporation (BESCO) in 1921, control over Nova Scotia coal mines, with a few small exceptions, was complete.[173] This pattern has continued to the present. BESCO was reorganized, following a series of crises during the 1920s, as the Dominion Steel and Coal Company (DOSCO) in 1928. After 40 years of sometimes tumultuous operation, DOSCO's coal mines were taken over by the Canadian government in 1966. Since then they have been operated under the umbrella of the Cape Breton Development Corporation (DEVCO), although today the number of mines and miners and the output of the east coast industry is a tiny fraction of what it had been a century earlier.

Development of the coal industry of the western interior was concentrated in Alberta, where output grew spectacularly until World War I. Over 150 mines operated there in 1912; by 1918, there were 263.[174] Alberta's output of coal finally surpassed Nova Scotia's during the war. Because Alberta coal continued to be consumed largely as a domestic fuel and by railways, patterns of consumption were strongly seasonal, a fact reflected in similar patterns of employment there, even with the inflated wartime markets. In January 1917, the coal industry employed 8 550; in June, 1918, 3 091; by December 1918, employment was back up to 9 812.[175]

In the coal fields of the western interior, ownership was more diverse than in either British Columbia or Nova Scotia, just as average mine size was quite a bit smaller. New coal fields continued to open, often in response to railway construction. Around 1900, several new mines opened in the East Kootenays. The largest, owned by the Crowsnest Pass Coal Company, operated at Fernie, Morrisey and Michel.[176] On the Alberta side of the Crowsnest Pass small mines opened at Frank (1901), Coleman (1903) and Hillcrest (1905).[177] The construction of two new transcontinental railways early in this century provided a tremendous impetus to coal mining. The Grand Trunk Pacific began to build the Alberta Coal Branch Railway in 1911 to tap the bituminous fields of northern Alberta. The Coal Branch, as it was called, boomed on the strength of railway contracts.[178] In 1914, the Brazeau Collieries, southwest of the Coal Branch, were opened by the German prospector Martin Nordegg to supply the Canadian Northern Railway.[179]

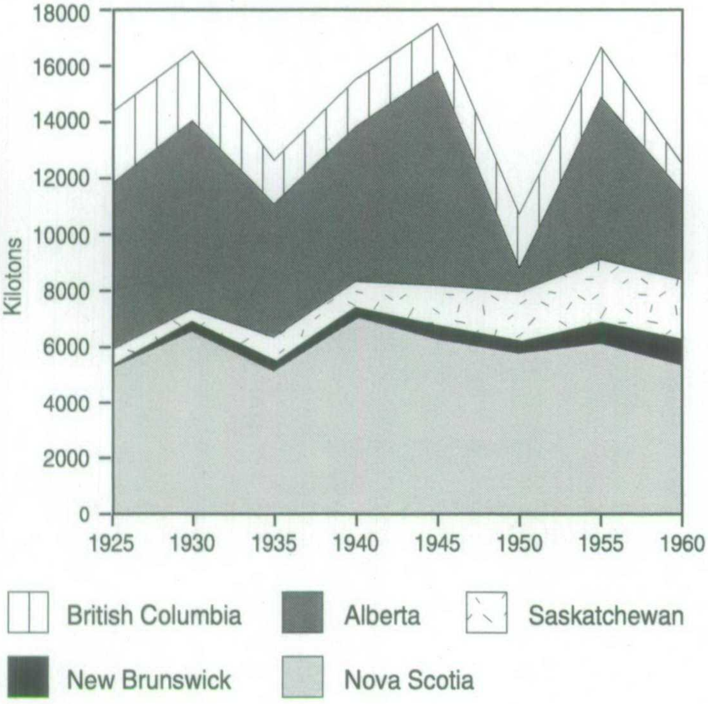
The Decline of Coal

After World War I, coal mining entered a period of crisis from which it has never fully recovered. Hardest hit were the older coal fields in Nova Scotia and on Vancouver Island. There were two dimensions to this crisis. One was short term, largely a function of the disruption of both wars. The second was far more ominous — a permanent loss of markets reflecting a secular trend away from coal as a primary energy source.

Because of the emphasis during the war on increased, uninterrupted output, at many mines long-term planning and development had been sacrificed. Kris Inwood has argued that even by 1913 Nova Scotia coal was becoming significantly more costly to extract than American bituminous. The war years also saw sharp declines in the proportion of workers actually mining coal, as many miners enlisted for service overseas. This was followed by a wartime drop in output, when problems in securing new plant and equipment also contributed to postponement of development work. The *Canadian Mining Journal* claimed in 1920 that no development work had been undertaken in Nova Scotia for seven years.[180] In 1913, 7.3 million tons

171. Macgillivray, "Henry Melville Whitney Comes to Cape Breton...."
172. New mining regions were also opened in Nova Scotia over this period by virtue of railway development, most notably the Inverness district. See Danny Samson, "The Making of a Cape Breton Coal Town: Dependent Development in Inverness, Nova Scotia, 1899–1915" (M.A. thesis, University of New Brunswick), 1988.
173. The largest collieries remaining outside BESCO were the Intercolonial, in Pictou County, the Inverness Railway and Coal Co. and the Maritime Coal, Railway and Power Co. in Joggins. Others included the Port Hood Collieries Ltd. and the Bras d'Or Coal Co. Ltd. See David Frank, "The Cape Breton Coal Industry and the Rise and Fall of the British Empire Steel Corporation," *Acadiensis*, Vol. VII, No. 1 (Autumn 1977), 3–34. Acadia had been reorganized by a Belgian syndicate in 1910, which sold out to Scotia in 1919.
174. *Canadian Mining Journal*, 1912, 75; 1918, 420.
175. *Canadian Mining Journal*, 1919, 73; 1918, 157.
176. The East Kootenay coal mines were also stimulated by the smelter markets in the region. See Sharon Babaian, *The Coal Mining Industry in the Crow's Nest Pass* (Edmonton, 1985), 3.
177. *Ibid.*, 10–38.
178. See A.A. den Otter, "Railways and Alberta's Coal Problem, 1880–1960," in A.W. Rasporich (ed.), *Western Canada: Past and Present* (Calgary, 1975), 89.
179. See *Ibid.*, 89–90. See also PAA, Acc. 70.416, Martin Nordegg, *Pioneering in Canada, 1906–1924*, Mss. Copy, New York, 1948.
180. Kris E. Inwood, "Local control, resources, and the Nova Scotia Steel and Coal Company," CHA *Historical Papers* (1986), 265–66; *Canadian Mining Journal*, 1920, 828.

Coal Output (by province), 1921–1960



Source: Canada Year Books.

Coal output (by province) 1921–61. *Stagnation was the feature of the inter-war and post-World War II years. The rise and decline of output was a function of the depression of the 1930s, followed by an artificial war-demand and a sharp decline as coal was replaced by oil and other forms of fuel on the railroads and elsewhere.*

of coal had been mined in the province; in 1918, output was estimated at 5.4 million tons; 1919 was the sixth consecutive year of falling output. Difficulties in procuring shipping because of Admiralty requisition of ships for wartime service, and delays in returning these ships to the coal trade, further hampered Nova Scotia's efforts to displace cheaper American coal from St Lawrence markets, which it had entered during the war.[181] High wartime demand for coal and artificially inflated prices delayed the impact of increasing production costs, which was particularly severe in these older coal fields. In British Columbia, mainland coal was undercutting Vancouver Island coal even on the Island itself, by 1925.[182] Many marginal mines closed altogether shortly after the war.

A large consumer of coal in these years had been the metallurgical sector. In Cape Breton, local sales to the iron and steel industry accounted for over one-half of total sales in the years immediately prior to the war. In 1913 the Dominion Iron and Steel Corporation operated five blast furnaces at Sydney and a large establishment operated at Sydney Mines as well, where Nova Scotia Steel and Coal had coke ovens, a blast furnace and open hearths. A pre-war depression had hit the industry extremely hard, although the demands of the war effort provided a temporary respite. Nova Scotia Steel and Coal's blast furnace at Sydney Mines closed permanently in 1914, though there continued to be a fair amount of steelmaking there for some time. After the war, Cape Breton collieries lost major markets with the "practical cessation" of pig-iron and ingot steel manufacturing in Cape Breton. At about the same time, the closing of western smelters, caused largely by the prohibitively high U.S. Fordney-McCumber tariff schedules, sharply reduced demand for Crowsnest Pass coal. The major smelter markets at Grand Forks and at Greenwood were lost by 1921.[183]

More ominous for the coal industry was the emergence of a secular trend away from coal, as alternative energy sources came into use. From the turn of this century, coal was gradually displaced as the fuel of choice among a number of major consumers. As early as 1902, directors of the New Vancouver Coal Mining and Land Company warned shareholders that "[t]he competition of Fuel Oil is assuming a more serious aspect."[184] It was estimated in 1921 that petroleum was displacing over 600 000 tons of Vancouver Island coal annually.[185] The example of the shipping industry clearly illustrates petroleum's threat to coal. In 1833 the Royal William, the first vessel to cross the Atlantic by steam, had bunkered at Pictou and inaugurated a major market for coal. In 1910, 80% of the world's shipping industry still used coal. By 1924, as ships adopted oil fired diesel engines, the figures were reversed and soon virtually all vessels were powered by the more efficient and more economical oil.[186] Railways also abandoned coal. In British Columbia the switch to oil was underway even before World War I, a process aided along by a Railway Commission requirement that on the "forested sections of the Pacific slope" oil rather than coal be used, to avoid setting forest fires.[187] Collieries in the Crowsnest Pass lost their railway market shortly after World War I

181. *Canadian Mining Journal*, 1919, 616.

182. *Western Canadian Coal Review*, 8, No. 2 (Feb., 1925), 26.

183. *Canadian Mining Journal*, 1914, 593–94; 1921, 45; 1922, 54; *Transactions of the Canadian Society of Mining and Metallurgy*, 1923, 72; *Canadian Mining Journal*, 1920, 359 and William Sloan, "The Crowsnest Pass During the Depression: A Socio-Economic History of Southeastern British Columbia, 1918–1939" (M.A., University of Victoria, 1968), 12–13. The peak year of western coal production, until World War II, remained 1920. F.W. Gray, "The Development of the Coal Industry in Canada, from 1920 to 1935," *Transactions of the Canadian Institute of Mining and Metallurgy*, 1936, 226.

184. *Canadian Mining Journal*, 1902, 135.

185. *Canadian Mining Journal*, 25 February 1921, 145.

186. Charles Graham, "The Problems of the Vancouver Island Coal Industry," *Transactions of the Canadian Institute of Mining and Metallurgy*, 1924, 474.

187. *Canadian Mining Journal*, 1912, 390.

when the Great Northern switched to oil. Ultimately, all railway markets in Canada were lost to diesel fuel, though it was not until the 1950s that the last of them converted.[188]

The Great Depression of the 1930s made a bad situation worse. Declining industrial activity, particularly in the manufacture of pig iron and steel products, and in world trade generally, weakened the traditional markets for coal. Industrial consumers in Ontario and Quebec converted from coal to hydro-electricity wherever possible. Nation-wide, many domestic consumers switched to electricity, natural gas or oil. The more energy-efficient use of coal and the adaptation of alternate fuel sources also tended to erode demand within remaining markets. It was observed that "the average fuel efficiency of industry and railway transportation [had] risen by no less than 33 percent in the period 1909–29."[189] In 1935 Canadian consumption of coal stood at 75% of its 1920 total. In the process, per capita consumption had dipped far below pre-World War I levels.[190]

With reductions in demand, employment in coal mining also stagnated, particularly in older coal fields. On Vancouver Island, an industry that had employed 4 005 in 1911 was employing just 3 281 in 1926.[191] Between 1910 and 1934, nearly 5 000 British Columbia coal miners lost their jobs.[192] In Nova Scotia, 12 522 workers laboured 3 527 149 days in 1911; 15 years later, 12 622 workers worked only 2 988 281 days.[193] At the end of World War II, even after employment had been bolstered by six years of heavy wartime demand, only 25 000 worked in all Canadian coal mines; about half in Nova Scotia, one-third in Alberta, and most of the rest in British Columbia.[194]

It must be emphasized, however, that falling levels of employment were not entirely attributable to weakening demand for coal among consumers. It was also a deliberate corporate strategy, at a time when the major portion of the cost of producing coal was in wages, to adopt new techniques in mining that would reduce the industry's need for labour.

188. den Otter, "Railways and Alberta's Coal Problem...," 84.

189. T.L. McCall, "Modern Trends in Mechanized Mining," *Transactions of the Canadian Institute of Mining and Metallurgy*, 1938, 395.

190. Gray, "Development of the Coal Industry...," 20–21; Forsey, *Economic and Social Aspects....*, 112; "Is Coal Losing Ground as a Fuel?," *Western Canadian Coal Review*, 6, No. 12 (Dec., 1923), 14.

191. British Columbia, *Mines Report*, 1911; Dominion Bureau of Statistics, *Coal Statistics for Canada, 1927* (Ottawa, 1928), 87–88.

192. Villiers, "Problems of the Coal Industry in B.C...," 572.

193. Nova Scotia, *Mines Report*, 1911, xxi; Dominion Bureau of Statistics, *Coal Statistics for Canada, 1927*, 44.

194. Logan, *Trade Unions in Canada...*, 164.

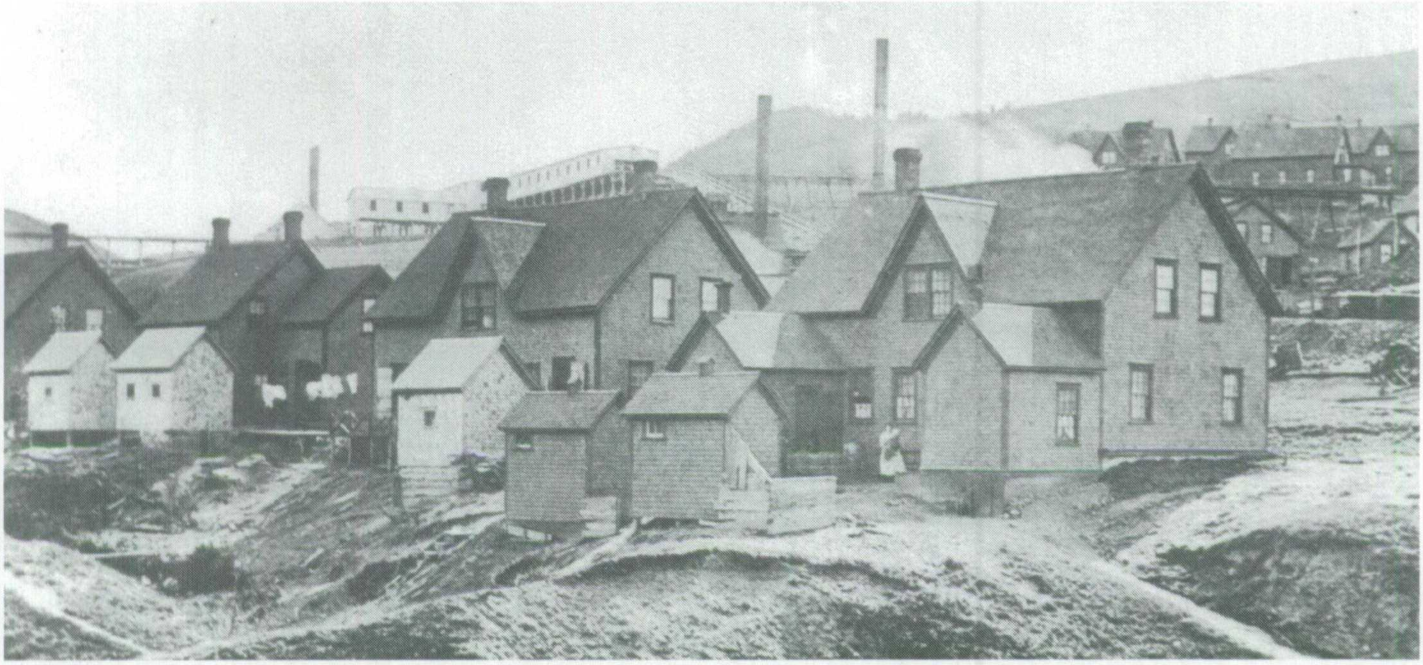
Beyond Steam: Longwalls and Mechanization

The first technical revolution in Canadian coal fields had brought skilled colliers and steam-powered deep-coal mines, organized on the bord and pillar system, to British North America's coal mines over the middle third of the 19th century. The second, which stretched over the decades surrounding the turn of this century, brought mechanization and longwall mining along with new forms of power — compressed air and electricity. Both mechanization and the use of longwall mining called for radical reorganization of work underground and both ended up compromising the authority of colliers within their defined workplaces underground. Aspects of this more modern form of mining — mechanized underground haulage in the 1880s, mechanical cutters in the 1890s and experiments with mechanical loaders as early as the 1920s — had been introduced unevenly over the period of active expansion. In the period of declining coal output after World War I, their use became imperative to the survival of the industry.

By its nature, the mining of coal discouraged major technical advances over much of the 19th century. The process of mining coal involved a series of interdependent systems: removing coal from the seam; moving it from the mine — which involved loading it onto a means of conveyance; maintaining the mine — i.e. road-building, drainage, ventilation, etc.; and preparing coal for market by shipping. Mines functioned only as efficiently as the weakest link in this complex production process. Improvements in one area of the operation might have a limited impact on the over-all performance of a mine. The rate of adoption of technologies was affected by their uncertain profitability compounded by the tendency of mine properties to become economically exhausted, or for geological quirks such as faulting to appear, which, in some circumstances, discouraged extensive fixed investment in mechanized mine operations.

Rapidly expanding demand for coal had challenged Victorian patterns of relatively low levels of investment in technology associated with the industry by drawing on vast new reserves of capital early in this century. Large investments, even if they were sometimes less than they appeared within the corporate manoeuvring associated with the expansion of North American capital, brought pressure to increase profitability by improving both the regularity of output, and the productivity of the individual miner at the coal face. A further impetus to mechanization, felt increasingly over this century, was the rising cost of mining, brought on by exhaustion of many of the best and most easily accessible coal deposits. As early as 1938, a colliery engineer from Nova Scotia commented that "coal seams of medium height, good quality, and readily accessible have been largely depleted."[195]

195. McCall, "Modern Trends in Mechanized Mining...," 389.



Mabou coal mines, Cape Breton, ca 1904. *It is the very nature of the coal mining industry that resource exhaustion inevitably follows exploitation. Not all coal mining operations left a permanent legacy; there was a considerable amount of speculation during the formative stages of the industry. The seam on which this mine was built proved faulty and the mine was abandoned shortly after the photo was taken. But it captures the rawness of frontier mining sites. The sophisticated houses in the foreground would have been reserved for skilled miners and underground officials. They were factory-built by large construction companies operating in the province at the time and became common throughout Nova Scotia mining towns during that era. To the right are a series of bunkhouses for the single men who came to work in the mine. In the background, close to the houses, is the mine's bankhead looming over the landscape and dominating the tiny community. The entire site was stripped of all the buildings and reusable mine equipment. Most of it was hauled to nearby Inverness. (Courtesy of the Beaton Institute, University College of Cape Breton).*

Continued colliery operations within aging coal fields would have had to involve mining less desirable seams, or extending existing seams beyond what had been considered economic distances from the surface, usually by adopting technologies that would improve productivity. At the same time, the productivity levels of aging mines were lowered simply because of the greater distances that men, materials and coal had to travel underground.

Longwall Mining

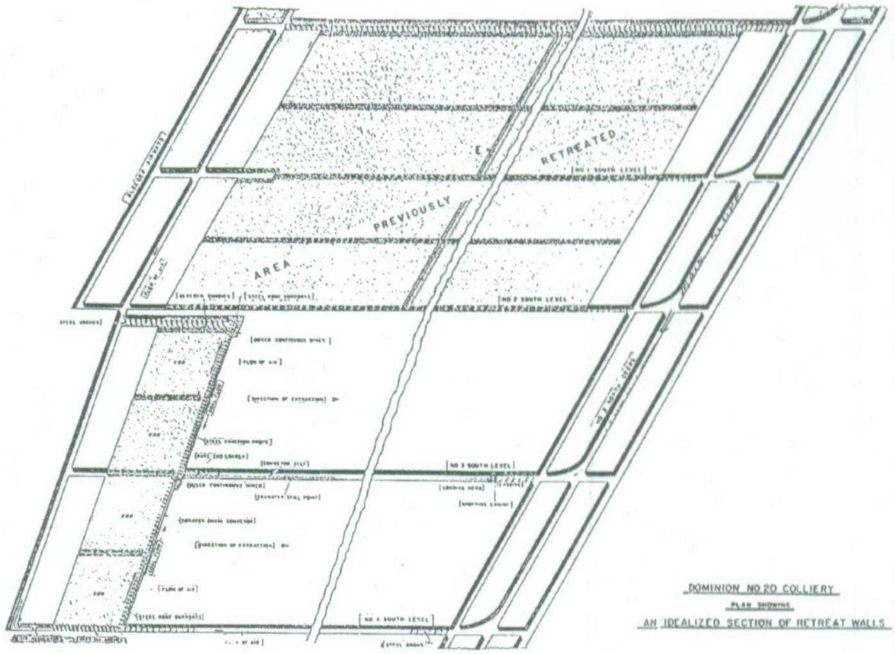
In contrast to bord and pillar systems, where coal was removed from bords, and then supporting pillars robbed of their coal in two distinct phases, longwall mining meant all coal in a given section of the mine was removed in a single operation. Longwall methods had been experimented with as early as the 1880s in a number of mines and a number of variations were attempted at various pits. There are two primary variations of longwall mining. In *retreating longwall*, two parallel roads are driven from the level to the edge of the seam, the coal is then mined along a continuous face back to the level, with the roof being allowed to settle behind the face workings. In *advancing longwall*, coal is worked from the level to the edge of the seam being mined and travelling roads are built and maintained in the goaf (the refuse left after the roof has collapsed in mined out areas). The tremendous pressures that were encountered while attempting to maintain a complex series of roadways was overcome, and the dangers of allowing coal pillars to stand in place for long periods, with the associated problems of gas accumulation, could be avoided.[196]

Seams that were thinner, free of faults and that had a firm roof were particularly appropriate to longwall mining. Other geological circumstances required its use; bord and pillar mining was impracticable beyond a certain depth. In Cape Breton, for instance, at approximately 300 metres the superincumbent strata, particularly where seams sloped under the sea, could no longer be supported by any practical size of pillar. Larger and larger pillars of coal would otherwise have been wasted, slowly crushed by the weight above.[197]

A number of other technical grounds impelled managers and owners to adopt longwall mining. The cost of maintaining the extensive travelling roads necessary for bord and pillar mining was high. Because longwall mines required just two roadways per wall, while bord and pillar demanded seven or eight over

196. Hugh Millward, "A Model of Coalfield Development," *The Canadian Geographer*, 29, No. 3 (1985), 243.

197. H.F. Bulman and R.A.S. Redmayne, *Colliery Working and Management* (London, 1925), 163.



Longwall retreating method of mining, Dominion No. 20 colliery, Glace Bay, Nova Scotia. *The major objective of the 20th century was mechanization of the actual mining of coal, as opposed to its transportation. As long as the mining process was carried out in individual rooms controlled by pairs of miners, the technological limits were enormous. Longwall mining meant that an entire block of coal was carefully identified and a more simplified plan of extraction developed to extend working faces where cutters and conveyors could be used to extract the coal. Eventually the introduction of these mechanical cutters and loaders revolutionized work underground. In retreat longwall mining, travelling roads were driven to the extent of the working, thereby putting all development work up front. Coal was extracted moving back towards the main slope of the mine, allowing mobile conveyors to carry coal first from the working face and then to the surface. (Courtesy of the Beaton Institute, University College of Cape Breton).*

an equivalent area, maintenance costs could be dramatically reduced. Ventilation was also much simplified, air no longer had to be coursed through the honeycomb workings of bords and pillars. It also generally involved less blasting, consequently less coal dust was produced, reducing the risk of explosion. Most importantly, longwall required fewer and less skilled workers, who could be more easily supervised, and more easily replaced. If bord and pillar called for a multiplicity of skills, longwall called for mine work to be broken into component parts, each of which was performed in rigid succession. These discrete tasks were often spread over two or three eight-hour shifts each day. By 1920 virtually all DOMCO mines, even those that still worked on the bord and pillar system, were blasting exclusively on the *night shift*, and the preparatory work, including the boring of blasting holes, was performed during the day. Over time, mine work came to resemble the factory techniques of mass production that were becoming common in the 20th century economy.[198]

On Vancouver Island a large supply of unskilled Asian labourers encouraged longwall use in the late 19th century. It was most evident at Robert Dunsmuir's collieries on Vancouver Island, where Chinese workers were employed extensively at both the Union mine and at Wellington.[199] In Nova Scotia the move away from bord and pillar was both slower and later. At Joggins, where seams were generally more narrow than elsewhere, longwall was in use from about 1900 onward. In Cape Breton a number of early experiments were attempted with this method, one as early as 1899 at the Princess colliery and another at the Gowrie where modified bord and pillar systems and one section of longwall was working as early as 1893.[200] The most successful longwall trial in Cape Breton was in the lower seam at the Jubilee colliery, on the north side of the field, toward the end of World War I. In the mainland fields, the switch was also well underway by the 1920s. Longwall was adopted at Springhill after 1925 as a means of avoiding bumps there. Experiments had been attempted with longwall in Pictou County as early as 1899, where it was used in sections of both the Drummond and Acadia collieries, although its use there was not common until after World War I. Although there was a delay in introducing longwall to Nova Scotia's mines, when it was finally introduced it arrived with a bang. Between 1925 and 1935 the amount of coal mined on longwalls increased

198. T.L. McCall, "Some Coal Mining Practices of the Dominion Steel and Coal Corp., Ltd.," *Transactions of the Canadian Institute of Mining and Metallurgy*, 1936, 490; Alexander Sharp, "Some Notes on the Longwall Method of Mining Coal," *Transactions of the Canadian Institute of Mining and Metallurgy*, 1913, 417–33; *Canadian Mining Journal*, 1920, 170. On the Cape Breton experience see Frank, "Contested Terrain...." Much research on the impact of longwall on the workforce was undertaken by the Tavistock Institute in postwar Britain. See E. Trist and K. Bamforth, "Some Social and Psychological Consequences of the Longwall Method of Coal Getting," *Human Relations*, 41 (Feb 1951), 3–38; E.L. Trist et al., *Organizational Choice: Capabilities of Groups at the Coal Face under Changing Technologies* (London, 1963).

199. At the turn of this century longwall was in use in the upper seam at Union; "considerable" longwall was used at No. 5 Shaft, Wellington. Both were Dunsmuir mines. *The Canadian Mining Manual and Mining Companies Year Book* (1899), 594, 627. Belshaw, "Mining Technique and Social Division...," 49.

200. "Coal Mining in Cape Breton," *Canadian Mining Review*, 1893.

from just 2.6% to nearly 50%. In 1935, 97% of Nova Scotia Steel and Coal's coal, the company most dependent on submarine seams, was mined longwall.[201]

Mechanized Coal Cutters

The reorganization of work, most evident in the new divisions of labour associated with longwall operations, was only one way in which work was transformed within coal mines at the turn of this century. At Canadian mines, other elements of operations were also mechanized. Basic to mine mechanization was the ability to supply power to the coal face. The limitations of steam-power became more evident as mines got deeper. A great deal of energy was lost in transit to condensation and when steam-engines were placed underground, too much heat was produced to make mine operations efficient. As well, steam interfered with ventilation currents and weakened roofs and walls.[202]

By the 1880s, two alternative power sources were coming into use. Considerable improvements had been made in the efficiency of compressed air engines, but there were problems transmitting power over long distances. Electricity was defined as the motive power of the future in mines. It had been introduced during the 1880s in U.S. mines, and somewhat later in Canada. The *Canadian Mining Review* cited the New Vancouver Coal Mining and Land Company as the first colliery to use electricity as a source of motive power — in 1891. That same year the successful use of electric coal cutters was reported at the Union mines in Comox. Although safe methods of electric power transmission had been developed by the 1890s, electricity was viewed for many years with deep suspicion; there was a perceived threat that sparks would cause explosions. For this reason, when Dominion Coal embarked on an extensive program to mechanize its mines, shortly after it was organized in 1893, it selected compressed air to power its machine cutters and drills underground. Debate continued among mining engineers and planners for many years about the relative merits of electricity versus compressed air.[203]

The single most consequential mechanical devices introduced to collieries were the mechanized coal cutter and the drills that were associated with them.[204] Although a British invention, having been tested as early as 1861 at a colliery in West Yorkshire, mechanical cutters were most widely applied in North America. It might have taken a miner between three and six hours to undercut coal by hand-pick before a coal face was prepared for its charge of powder. By machine, perhaps one quarter of this time was needed. The first mechanical undercutters depended on compressed air for power. Problems relaying power over long transmission lines were only overcome at the turn of this century, when electricity was used to power the compressors. The Newcastle seam, opened at Nanaimo No. 1 colliery in the 1890s, used coal cutting machines for longwall mining at least as early as 1893. By 1894, four electric cutters were in use at the Union colliery. DOMCO adopted the mechanical cutters very rapidly once they began installing them. By 1902, 76% of its output, about half of Nova Scotia's total, was machine-cut. At the same time, in the U.S. the figure stood at just 25%; in the United Kingdom, only two percent of coal was machine-cut.[205] In Alberta, the adoption of machine cutters came somewhat later than in Nova Scotia. The percentage of coal mined by machine stood at 22.5% in 1913, and 40.6% in 1924.[206]

Mechanical cutters were used in the first phase of bord and pillar mining, but for the task of drawing pillars, where there was considerable danger of falling roofs, miners were anxious to "listen" to the coal and the hand-pick had remained indispensable. The daily production of coal by a miner in the bords increased sharply with the introduction of mechanical cutters and led to the enlargement of areas of operations and

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201. F.W. Gray, "Mining Coal Under the Sea in Nova Scotia," *Transactions of the Canadian Institute of Mining and Metallurgy*, 1927, 1007; J.J. McDougall, "Longwall Operations, Sydney Mines, Nova Scotia," *Transactions of the Canadian Institute of Mining and Metallurgy*, 1925, 480; McCall "Modern Trends in Coal Mining ...," 470–71, 484–91; Nova Scotia, *Mines Reports*, 1899, 7–8; 1900, 9. A valuable summary of the methods of mining and machinery in place in all Cape Breton collieries is provided in "Coal Mining in Cape Breton: The History and Organization of the Companies — The Collieries Operated and their Equipment — Statistics of Output and Shipment, etc.," *Canadian Mining Review* XIII, 8 (August, 1894), 140–143.
202. H.S. Poole, "Pumping with Compressed Air," *Canadian Mining Journal*, 1896, 56–57.
203. B.R. Mitchell, *Economic Development of the British Coal Industry, 1800–1914* (Cambridge, 1984), 79; *Canadian Mining Review*, 1888, 90; 1891, 85, 162, 196; 1901, 160–61.
204. Andrew Bryan, "Coal-Mining," in Trevor I. Williams (ed.), *A History of Technology*, Vol. VI, Part I (Oxford, 1978), 359–75.
205. On the adoption of mechanical cutters, see J.G. Hudson, "Notes on Coal Cutting Machinery at the Collieries of the Dominion Coal Company," *Canadian Mining Review*, 1894, 156; Mitchell, *Economic Development...*, 81–82; British Columbia, *Mines Report*, 1891, 587; *Canadian Mining Manual*, 1894, 491; *Canadian Mining Review*, 1903, 59–60; Keith Dix, "Work Relations in the Coal Industry: The Handloading Era, 1880–1930" in *Case Studies in the Labor Process*, Andrew Zimbalist (ed.), (New York, 1979), 160–61. Curtis Seltzer estimated that undercutting machines reduced by 75% the time required to undermine a coalface by hand-pick. See Seltzer, *Fire in the Hole: Miners and Managers in the American Coal Industry* (Lexington, Ky., 1985), 12.
206. Kenneth W. Tingley, *Coal-Mining in Alberta: An Introduction to Changes in Coal-Mining Technology in the Plains and Parkland Areas, 1872–1955* (Edmonton, 1985), 18.

Miner operating punching undercutting machine, ca 1900. *The introduction of mechanical cutters marked a change in the organization of work underground. Perhaps most important, apart from the ease with which previous hand work could now be done, was the necessity to deliver power to hundreds of places underground. Large compressors were developed above ground to provide compressed air to drive the machines. Miles of pipe and regulating equipment were required to deliver air to miners' working places, an investment that demanded much higher levels of productivity if the mine was to be profitable. Once established, such systems were prone to breakdowns, a source of constant complaint from the miners, whose earnings were directly tied to their productivity. (Courtesy of the Beaton Institute, University College of Cape Breton).*

the specialization of work at the coal face. But mechanical cutters were more closely associated with the adoption of longwall techniques, where they permitted the undercutting of long coal faces and the mechanization of the blasting and loading functions that were the critical elements in the process of mining.

The first mechanical cutters were percussive *punchers*. Subsequent cutters had teeth set along a rotating wheel that advanced as the cutting progressed. Other models had teeth set in a rotating bar. Chain-type cutters were also widely used. These had rows of teeth attached to an *endless chain* revolving in one direction.[207] In Nova Scotia, the punchers continued to be used in development work and for undercuts in bords until World War I. Otherwise, radial cutters, "a percussive cutter of rock-drill type mounted on a column, fitted with a worm-gearing which enables the machines to cut either vertically or horizontally," were coming into use. They were less difficult to operate (lighter, more mobile and easily manipulated), and could be operated by comparatively unskilled men. Because radial cutters were more often electric, the use of electricity increased at the expense of pneumatic power after their appearance.[208]

207. *Ibid.*, 13–14.

208. Gray, *Coal-Fields and Coal Industry*, 40.

Underground Haulage

For coal companies to reap the benefits of mechanization at the coal face, better means of underground haulage were required (although the pressure was lessened somewhat by the bottleneck produced by the continuing need to load coal tubs by hand). The first innovations in this area, once again pioneered in Great Britain, were based on the systematic use of steam. Stationary steam engines were used to a limited extent underground in Britain from about 1900 to haul coal tubs up inclines. They had been used for this purpose in British North America as early as the 1850s at the Queen Pit at Sydney Mines. Their level of employment underground was restricted principally because of the problem in transmitting power and of the strength of the ropes necessary underground. Only with the introduction of efficient wire ropes underground, which had been experimented with in Great Britain as early as the 1840s, were these problems overcome.[209]

Three varieties of mechanized rope haulage came into use. With *main rope* — sometimes called direct haulage — steam-power was used to pull loaded tubs up underground railways that were sufficiently steep to allow empty tubs to run back by gravity. Main and tail haulage was identical except that now trips — i.e. groups of tubs of various dimensions — could be pulled up a road and, by virtue of a pulley at the end of the line opposite the engine, back down. This was necessary where roads undulated and power had to be provided to move the coal. The third system of underground haulage developed at this time was *endless rope*, which was particularly attractive to mine managers because it required just half the manpower of the other two rope systems. In the other systems, the *chain-runner* — the person in charge of underground mechanized haulage systems — stood idle until a trip returned to him, while with endless rope haulage the full and empty cars were constantly being moved back and forth. The principal drawback of endless rope was that it required a double track. The rope, to which trips could be attached at any point, travelled endlessly around a narrow, oval-shaped course. For this reason, endless rope was commonly used on major underground roadways.[210]

Although mechanized underground haulage was available and familiar to British-educated mine officials of 19th-century Canada, these techniques were not readily adopted. They were costly; the cost of preparing roadways had to be added to the expense of the machinery. To a greater extent than with horse-drawn haulage, mechanization demanded fairly straight,

209. Nova Scotia, *Mines Report*, 1858, 376; Mitchell, *Economic Development...*, 77.

210. *Historical Review of Coal Mining* (London, c.1924), 94–98; William Blakemore, "The Introduction of Endless Haulage into Cape Breton," *Canadian Mining Review*, 1894, 151–54.

well-ballasted roads. Moreover, existing systems of underground haulage were perceived by managers to adequately meet the demands placed on them. Indeed, in Britain debate over the relative advantages of horse-powered versus mechanized haulage continued throughout the second half of the 19th century, although it became increasingly apparent that, on *main roads* at least, rope haulage was preferred. As a rule, B.R. Mitchell has argued, the larger the quantity of coal, the longer the distance, and the steeper the inclines, the more evident the advantages of mechanical haulage. At the same time, even in Britain, auxiliary roads were seldom mechanized. In some instances young workers pushed coal tubs in thin seams; more often, it was simply more economical to continue to use the flexible horse haulage.[211]

Long, underground roads first encouraged the use of mechanized underground haulage in Canada, where the use of mechanical cutters hastened the mechanization of haulage. The first system of mechanized rope haulage in Nova Scotia was introduced in the early 1880s at the GMA's Princess colliery at Sydney Mines, where longer levels could extend for over a mile. At all other provincial mines, coal continued to be hauled on the levels by horses until the end of the 1880s. By the early 1890s, however, rope haulage had become more common in larger mines. On the mainland these included endless rope systems on the main levels at Springhill and at the Drummond colliery in Pictou County. At the Intercolonial Coal Mining Company at Westville, a main and tail system on one level "with 22 boxes on each trip" was in use by 1891. By 1896 Dominion Coal was using endless rope haulage with a variety of smaller stationary engines at half a dozen Cape Breton mines. By the 1880s rope haulage had also come into use on the slope at two Vancouver Island collieries, the No. 3 shaft at Wellington, and the South Field mine at Nanaimo. Others would follow over the ensuing decades.[212]

Rope haulage, in displacing horses, also displaced their adolescent drivers. As described by one mines inspector, it:

> *has proved an economical feature in underground haulage, and from the success obtained in its use I would wish to draw to it special attention, as with it in this district one boy can alone do the work that hitherto 8 horses and as many drivers were required to do.*[213]

Springhill's endless rope system also "[did] away with a large number of horses" at the Drummond Colliery where "the management has curtailed boy and horse labour very much by a system of endless rope haulage underground which gives great satisfaction."[214] Mechanization of underground haulage at Sydney Mines, noted John Johnston, "has altogether done away with the necessity of employing horse drivers."[215]

Like other aspects of technical change in mining, mechanization of underground haulage, which continued well into this century, was an uneven process. Even after World War I, miners continued to push coal tubs to the nearest underground road, where the height of the seam did not permit the use of horses.[216] At smaller pits, older techniques of horse haulage remained in use even on main underground roads. Well after effective means of transmitting power had been applied to rope haulage, problems persisted in laying track in mines designed for hand-pushing and/or horse haulage. For instance, although horses had been entirely removed from three pits at Sydney Mines by 1910, such mines were the exception until the third or fourth decade of this century. Indeed, the last horse was not out of Cape Breton mines until 1960.[217]

A further refinement to underground haulage came with the introduction of small diesel or electric powered locomotives underground; their potential usefulness had been debated as early as the 1880s. Debate was all the more pointed because underground haulage was recognized as the most likely area of cost reduction in overall operations. Increasingly after World War I, rope haulage came into disrepute. It was considered to use more power than necessary owing to friction and inertia, and also involved the trouble and expense of maintaining ropes and roadways, especially in wet mines.[218]

Because local conditions varied widely, mining engineers advocated a variety of means of underground haulage. Horses and mules remained common in smaller mines. At larger mines, several different means of haulage were often used simultaneously. At the turn of the century, the Crowsnest Pass Coal Company used electric primary haulage, while horses and drivers still operated on secondary underground roads.[219]

211. Mitchell, *Economic Development...*, 78–79.
212. "Coal Mining in Cape Breton," *Canadian Mining Review* (1894) includes descriptions of the haulage systems in operation in 1894. British Columbia, *Mines Report*, 1883, 416–18.
213. Nova Scotia, *Mines Report*, 1891, 5–6.
214. See Gilpin, "Coal Mining in Nova Scotia...," 363; Brown, *The Coal Fields and Coal Trade....*, 143; *Canadian Mining Review*, 1896, 2–3; 1893, 2; 1891, 209.
215. John Johnston, "Description of Haulage System Installed to Take the Place of Horses at No.3 and No.4 Collieries," *Journal of the Mining Society of Nova Scotia*, XV (1910–11), 92.
216. NAC, RG 27, Vol. 141, file 611.04:6, "Minutes of Quirk Board of Investigation, Glace Bay, 20 July 1920."
217. *Cape Breton's Magazine*, 32 (1983), 42.
218. *Canadian Mining Review*, 1889, 2; Even the design of coal tubs was much discussed. See Marcus L. Hyde, "Mine Car Design," *Transactions of the Canadian Institute of Mining and Metallurgy*, 1916, 226–41. A. Rotteleur, "The Use of Gasoline Locomotives in Coal Mines," *Transactions of the Canadian Institute of Mining and Metallurgy*, 1913, 506–9.
219. *Canadian Mining Review*, 1901, 61.

More typical of larger collieries by this century were complex systems of underground haulage, by which coal tubs were removed from a colliery in a series of distinct steps. At the No. 1 Esplanade mine at Nanaimo, long underground roads encouraged the installation of an electrically powered trolley locomotive to displace mules as early as 1892. Within a year, three of these locomotives were in use on the two main levels. For secondary haulage, self-acting inclines were employed, mules and drivers moving the coal tubs from the workplaces to the inclines. This system was largely intact as late as 1923, except that mechanical hoists had replaced self-acting inclines.[220]

After World War I new means of underground haulage, based on more integrated systems of conveying, were introduced. These systems were developed in response to problems in longwall mines, where coal had to be shovelled a considerable distance from the point it was mined along the longwall to the road heads, where it could be loaded into mine cars for conveyance to the surface. This work sometimes involved two or three casts of the coal. To replace this labour, a longwall face-conveyer was developed to receive coal from all the miners along the longwall face and deliver the coal directly into cars placed to receive it on the main level. In some of the larger DOSCO mines, conveyors had been introduced for this purpose as early as 1925. Conveyers were particularly well suited to the mining of thin seams of coal where longwall was commonly employed, because they required less roof-brushing than other means of haulage.[221]

By 1928 conveyor pans were used behind mechanical cutters at Sydney Mines to move coal from working areas to *gate*-roads, where it was dumped into boxes, which were still pulled by horses. Subsequently, a main-and-tail rope brought boxes to the main level, where a rope hoisting system brought them to the surface. During the 1930s conveyers were adapted for use in mechanized mining in bord and pillar work "as a connecting link between the loading machines and the mine cars, thereby eliminating a considerable amount of coal handling and also the costly delays during which the loading machine is waiting whilst the full car is being removed and the empty car spotted." At some American mines, linked conveyor systems extending from the coal face to the surface were in place by the 1930s. Canadian collieries were less successful in adopting such systems, which did not become common until the 1970s.[222]

Loading Coal

The sole remaining element of mine operations to be mechanized was the task of loading the coal, which had changed little over the decades. As a consequence, it had become the single most expensive item in mining by the 1930s. By one report, the first use of mechanized loaders in Canada was in Saskatchewan. These were Joy loaders, which had been pioneered in the U.S. during World War I. But it was many years before they were widely adopted in Canadian mines. DOSCO experimented unsuccessfully with duckbill loaders between 1928 and 1932 but it was not until 1947 that a satisfactory system of mechanical loading was in place. Mechanical loading could either occur where

DOSCO Miner in action, DOSCO No. 18 colliery, 1953.
Most of the technology applied to Canadian coal mining was transferred and adapted from outside. The British influence had been superceded by the American in the course of the 20th century. After World War II, it was apparent that a major technological push was required if the price of Nova Scotia coal was to be competitive with the American product. The DOSCO Miner was an attempt to meet the needs of the local community with a uniqely designed automatic miner that was developed within Canada. In reality, the DOSCO Miner was a adaptation of mobile cutting machines that had been in evolution in the U.S. for the previous two decades. It took the components of the machinery — most of it from the Joy Manufacturing Company of Cleveland — and designed and assembled the machines in the DOSCO factory at Trenton. After a great deal of experimentation and considerable expenditure of money, it was widely applied across the Nova Scotia industry throughout the 1950s and 1960s, though it was subsequently replaced by more advanced machinery from Europe. (Courtesy of the Beaton Institute, University College of Cape Breton).

220. H.M. Lamb, "The Coal Industry of Vancouver Island," *British Columbia Mining Record*, IV, No. 2 (February 1898), 14–19 and No. 3 (March 1898), 29–32; British Columbia, *Mines Report*, 1892, p. 550; S.P. Planta, "The Coal Fields of Vancouver Island, B.C.," *Canadian Mining Manual*, 1893, 435; Robert Strachan, "Coal Mining in British Columbia," *Transactions of the Canadian Institute of Mining and Metallurgy*, 1923, 78–79.

221. The Staff of DOSCO, "Mechanization in the Collieries of the Dominion Steel and Coal Corporation," *Canadian Mining and Metallurgical Bulletin*, 42 (1949), 466; McCall, "Modern Trends...," 393–94.

222. McDougall, "Longwall Mining at Sydney Mines...," 428–30; McCall, "Modern Methods...," 394.

the coal was cut, or it might be moved by "a scraper, shaking conveyor with a duckbill, or some other means" before being loaded into cars.[223]

Subsequently, development of the continuous miner-loader brought coal mines to near complete automation. Three distinct components of mining — undercutting, blasting overhanging coal and loading — were supplanted by one operation, whereby mechanical shearers ripped coal from the seam, letting it fall directly onto a conveyor which removed it from the area. These machines, introduced shortly after World War II, are, after considerable adaptation, still in use. One of the major innovations of coal mining in Canada was the development of the "DOSCO Miner," a uniquely Canadian invention that was designed by DOSCO engineers and constructed at its Trenton, Nova Scotia works. At advanced mines in the post-World War II period, human hands never touched the coal.[224]

Cleaning Coal

Into the 1930s, cleaning of coal consisted of two or more operations. All coal, once on the mine surface, was passed over shaking screens, which sorted coal on the basis of size. Larger pieces would not fall through the screens and would be moved aside for shipment. At a time when the main market demand was for lump coal, large coal would be hand-cleaned of any impurities, and the rest would be washed mechanically. Mechanical cleaners were not widely used; even at large mines, picking tables were still used until the end of the 1930s, when a number of trends encouraged complete mechanization of the cleaning process. First, particularly at older mines, development of lower grade seams, which often contained bands of impurities, meant that a higher degree of cleaning was required. Second, adoption of mechanical loaders, which did not discriminate between coal and impurities, had the same effect. Finally, changes in market demand, which was moving towards "carefully prepared smaller sizes," just as efficient in burning and easier to handle than larger lumps, encouraged the use of mechanical cleaners.[225]

Implications of Mechanization for Miners

From the turn of this century a conviction has grown that traditional mining skills were being threatened by new divisions of labour and new kinds of machinery. Whereas in the past the miner had, as one mining engineer put it in 1938, been "an artisan skilled in all the branches of his calling," the 20th century miner could boast a far narrower range of skills. The specialization of functions that mine managers instituted in order to maximize mine productivity considerably eroded the sphere of a collier's control. Even before the turn of this century, state of the art machinery meant that, apart from those employed to operate the machines, "the work can be done by unskilled labour."[226]

Extension of divisions of labour had the effect of narrowing the range of activity a miner would perform during a given work day. As larger numbers of datal workers entered the mine to work exclusively maintaining underground roads, or to do timbering and perform dozens of ancillary mine tasks, the proportion of men underground who were actual miners decreased sharply. For instance, miners had made up half the workforce underground at Cape Breton pits in 1880; by 1920 they accounted for fewer than one third. A Board of Conciliation report in 1920 listed 300 distinct job classifications in the Cape Breton mines.[227]

While miners retained the right to hire their own loader, at least until the adoption of mechanized loaders, most unskilled mine workers were datal workers, paid by and answerable to the colliery company rather than the miners. As a consequence, the organization of mining underground was increasingly the task of systems analysts — most frequently, trained mining engineers responsible for coordinating the installation of different mechanical systems. In the process, the miners faced a continuing struggle to maintain their share of the income generated by their work underground. Pressure for more efficient mining techniques that called for larger amounts of mechanization and fewer men at the face meant that the basic preoccupation of mining engineers was to introduce systems that would reduce the number of men needed to operate the machines.[228]

223. Discussion of R.S. Bigelow, "Progress in Mechanical Loading," *Transactions of the Canadian Institute of Mining and Metallurgy*, 1932, 271–72; *Western Canada Coal Review*, IV No. 4 (April 1921), 34–5; Hugh B. Gillis, "The Use of Mechanical Loading Machines in Mines," *Transactions of the Canadian Mining Institute*, 1916, 310; *Western Canadian Coal Review*, 4, No. 4, 34–35; Staff "Mechanization in the Collieries...," 463; R.S. Bigelow, "Progress in Mechanical Loading," *Transactions of the Canadian Institute of Mining and Metallurgy*, 1931, 455–68, esp. 462.

224. Biglow, "Progress in Mechanical Mining...," 487; Irving C. Wynot, "Mining Machine Produces 10 Tons of Coal a Minute," *Halifax Mail*, 11 Dec. 1953. A detailed discussion of the development of the DOSCO Miner, including an extensive photo-documentation of both its development and operation, is found in the Dominion Steel and Coal Corporation Papers, Beaton Institute MG 14, 13, 8A.

225. McCall, "Modern Trends...," 392–93; Discussion of Bigelow, "Progress in Mechanical Loading," 273.

226. McCall, "Modern Trends...," 389; W.D.L. Hardie, "Machine Mining at Lethbridge, N.W.T.," *Canadian Mining Review*, 1899, 248.

227. *Labour Gazette*, February 1920, 128.

228. David Frank, "Coal Masters and Coal Miners: The 1922 Strike and the Roots of Class Conflict in the Cape Breton Coal Industry" (M.A. thesis, Dalhousie University, 1974), 49.

Adoption of longwall techniques and associated mechanization subjected mine workers to far greater levels of supervision. As mines grew in size, miners also found their traditional right to come and go as they pleased restricted. At deeper mines *riding rakes* were used to transport mine workers into and out of the pit. Managers would refuse to put these on before they felt a day's work had been put in. Miners were faced with the lengthy walk out of mines or a dangerous ride aboard a filled coal tub if they wished to dispute this stricter definition of managerial time. To a large extent, the pace of work was dictated by the operation of a number of mechanized systems.

With these changes the entry of young men into the mines was increasingly controlled by new factors. With younger boys excluded from the pits, it was necessary to introduce potential miners to the underground workforce as adults. Mining schools were developed during the inter-war years, designed to teach basic mining principles to neophyte miners. Literacy and numeracy were important components of this training, which also included basic safety considerations. The new elites within the mines were the technicians who maintained and operated the new machines being introduced. Electricians and mechanics were increasingly found underground, where they became the most important participants in the structure, often progressing to the intermediate management positions that had previously been the objective of miners, who had learned the lore of mining at the coal face.

Even more revolutionary mining techniques — although they were rare until after the World War II — involved open-pit mining, whereby coal was dug directly from the surface. In Cape Breton, experiments with strip mining were conducted in the 1920s north of Florence, but not undertaken extensively until 1974, when areas at Alder Point and on Boularderie Island began to be stripped.[229] At the Minto mines in New Brunswick, strip-mining techniques were gradually adopted in the 1940s, using "Ohio draggers."[230] Almost from the outset of coal mining on the prairies, strip mines were operated, initially on a very small scale. The lignite mines in Saskatchewan were invariably surface mines.[231] In Alberta, the small Milk River mines operated as strip mines; the Tofield mines during the 1910s included some of the earliest and most heavily mechanized strip mines in the province.[232]

229. Millward, "Mine Locations...," 245.

230. Allen Seager, "Minto, New Brunswick: A Study in Class Relations Between the Wars," *Labour/Le Travailleur* 5 (Spring 1980), 127–28.

231. For instance, a large strip mine was opened by Truax-Traer Coal Company of Chicago in the Estevan area in 1930. Tingley, *Coal-Mining in Alberta...*, 41.

232. *Ibid.*, 37, 106.

Unions in the 20th Century

Coal miners' unions faced a new set of challenges with the mechanization of mines. Decline of the industry over much of this century produced a steady downward pressure on wages and worker independence at the coal face. Industrial unions, such as the American-based United Mine Workers of America (UMWA), which after a period of struggle finally came to represent most of the coal miners in the country, also faced threats from more radical alternatives, particularly when they were forced to accept relatively unfavourable contracts. It was also a problem for the union representatives to negotiate effectively terms for the introduction of new technologies and to moderate the reductions of the workforce that were part of that process.

Nova Scotia

In Nova Scotia, after the turn of this century, the PWA was, after a period of crisis, once again well established throughout the coal fields. Economic circumstances — industrial expansion and labour shortages — and aggressive organizing led to rapid growth. At its height in 1904, it had 42 lodges and 8 000 members. The union's composition had changed markedly in the process, when railway workers, retail clerks and steel workers entered the Association. After 1904, however, when a PWA-sponsored steelworkers' strike at Sydney failed disastrously, the Association retrenched; by 1907 it was composed once again exclusively of coal miners.[233]

In the wake of the Sydney steel strike, the PWA was anxious to divest itself of its non-mining lodges and refrain from similar confrontations. By this time, organizers from the UMWA had arrived in the provincial coal fields to a warm reception, partly at least because it appeared to have the financial resources and the will necessary to conduct major strikes, which was a shortcoming of the PWA in the opinion of many miners. As well, the UMWA enjoyed a reputation for militancy, a position towards which a number of the miners' leaders were increasingly pushed in the face of the aggressive restructuring at DOSCO.

Defections from the PWA followed. The Pioneer lodge at Springhill, the original PWA lodge organized back in 1879, formed the first UMWA local in 1908. More secessions ensued, culminating in the founding convention of UMWA District 26 (Nova Scotia) in March 1909 at Sydney. In 1908, the PWA executive had somewhat reluctantly approved a referendum on affiliation with the UMWA. Although a solid majority approved

233. Logan, *Trade Unions...*, 176; Ron Crawley, "Class Conflict and the Establishment of the Sydney Steel Industry, 1899–1904," in Kenneth Donovan (ed.), *The Island: New Perspectives on Cape Breton's History, 1713–1990* (Fredericton, 1990).

the proposal in the spring of 1909, the executive repudiated the results of the vote and refused to negotiate affiliation. The ensuing split among the miners was important in the long term because there was some thought that the PWA, dominated by the more traditional skilled workers within the coal field, was operating on a narrowly defined notion of relations between capital and labour and its goals as a trade union. The UMWA, on the other hand, promised to put more energy into representing the interests of datal workers as well those of the miners.[234]

A series of strikes between 1909 and 1911 were fought for the recognition of the UMWA as the miners' bargaining agent.[235] These were in part provoked by coal companies' discrimination against UMWA organizers and sympathizers. In Cape Breton, the Dominion Coal Company went so far as to close down pits where a majority of mine workers had voted for UMWA affiliation. At Inverness, UMWA members were simply discharged by the Inverness Railway and Coal Company. By mid-summer 1909, strikes were underway at Springhill, Inverness and numerous Dominion Coal collieries. In Glace Bay, 2 500 mine workers struck, curtailing but not fully stopping Dominion Coal's production there. At Springhill, all 1 700 workers struck, bringing mining to a halt. The Inverness strikers, largely Belgian, remained out until December.[236]

Strikers in the Glace Bay district capitulated unconditionally at the end of April 1910. The Springhill strikers, less affected by the ready availability of PWA strike-breakers, remained out until 27 May 1911. But the final defeat of these strikes, which were easily the most extensive and violent in all of Canada to that date, represented a sharp reversal for UMWA organizers, who eventually withdrew from the Nova Scotian coal fields for a period. Although the union continued to try to organize in the province — miners at the Albion and MacGregor collieries in Pictou briefly but unsuccessfully struck for recognition in 1913 — UMWA membership dwindled to such an extent that the district charter was finally revoked by the international in 1915.[237]

Wartime demand and a reduced pool of available workers, owing to armed forces recruitment, enhanced the bargaining strength of the miners. Radical leaders such as Silby Barrett, Robert Baxter and James B. McLachlan were encouraged enough by the support they were receiving to form another rival to the PWA, the United Mine Workers of Nova Scotia (UMWNS). Although its membership was soon made up of half of the province's coal miners, it encountered difficulty winning corporate recognition. In an effort to forestall conflict in 1917, a Royal Commission under Nova Scotia Supreme Court Justice J.A. Chisholm inquired into conditions in the coal industry. When Chisholm recommended amalgamation of the rival unions, the PWA leadership, "actuated in large measure by feelings of obligation to keep industry running in war-time," agreed to the unification of the PWA and the UMWNS. The Amalgamated Mine Workers of Nova Scotia (AMWNS) was formed in 1917. In 1919 UMWA affiliation was regained when the old UMWNS leaders, which had supplied the vital leadership for the new union, won control of the AMWNS executive.[238]

The period between 1921 and 1925 was marked by the most protracted and fractious period of labour struggle in an industry noted for violence and strife. David Frank points to a conjuncture of two large secular trends. Wartime reference to a "new social order" had raised worker's expectations, but a post-war depression, when wages still constituted 60% of the cost of coal extraction, brought further challenges to miners' positions in a setting where the main imperative of mine managers was to reduce the cost of coal. In January 1922, the British Empire Steel Corporation (BESCO) initiated the struggle with its announcement of a pay cut of approximately one third. This compounded existing grievances concerning working conditions and company housing. Cape Breton locals responded with 100% approval of a strike — a step not adopted by union leaders in Pictou County because the large amounts of gas in mines there could have resulted in explosions unless the fans were maintained. Short of actually damaging mine property, this was the most powerful weapon at the miners' disposal, since withdrawal of maintenance workers meant mines would gradually fill with water and gas, making the resumption of mining difficult, if not impossible.[239]

Once again, troops were dispatched to Cape Breton, where negotiations were resumed at the behest of Premier G.H. Murray, and a new agreement was ratified by a small margin in September. The result was that the wage reduction was limited to approximately 20% across the board, though there was a general feeling that this was only the opening salvo of a struggle over the industry. The situation was aggravated by BESCO's shaky financial structure and relations between BESCO and its miners remained strained — the union claimed that the corporation had reneged on their contract.

234. Paul MacEwan, *Miners and Steelworkers...*, 26.

235. For unusual perspective on one of these strikes, see William M. Baker, "The Personal Touch: Mackenzie King, Harriett Reid, and the Springhill Strike, 1909–1911," *Labour/Le Travail*, 13 (Spring 1984), 159–76.

236. *Labour Gazette*, September 1909, 383–86; Dan Moore, "The 1909 Strike in the Nova Scotia Coal Fields" (unpublished paper, Carleton University, 1974), 94–119.

237. *Montreal Star*, 2 May 1913. See NAC, RG 27, "Strikes and Lockouts file," Vol. 301, #51A; Cameron, *The Pictonian Colliers...*, 148–49.

238. Logan, *Trade Unions in Canada...*, 190.

239. David Frank, "Class Conflict in the Coal Industry: Cape Breton 1922," in G.S. Kealey and Peter Warrian (eds.), *Essays in Canadian Working Class History* (Toronto, 1976), 163.

When Sydney steelworkers, employees of the BESCO subsidiary the Dominion Steel Corporation, struck in June 1923 in an effort to gain recognition for their local of Amalgamated Association of Iron, Steel, and Tin Workers of America, coal miners struck in sympathy, though only after there was a violent confrontation in the streets of Sydney following a demonstration. Once again troops were dispatched to Cape Breton and eventually both strikes collapsed, but not before the international office of the UMWA had suspended the autonomous leadership of District 26 on account of its radicalism, though ostensibly it was because the leaders had walked out when they had an operational contract. In the aftermath of the suspension of district autonomy, the Westville local in Pictou seceded from the union. Subsequently, in November 1924, the majority of its members approved affiliation with the One Big Union (OBU), a syndicalist organization formed in western Canada in 1919 dedicated to the use of general strikes as an instrument for radical social change. But the move towards alternative unions was unsuccessful at this point.[240]

Strikes in 1924 and 1925 were sparked by further attempts by BESCO to reduce wages. The 1924 strike settlement, orchestrated by provisional district president Silby Barrett, was rejected in a March referendum. This vote was overturned by the international office of the UMWA in April, and miners were forced by their union to return to work. Over the following winter several Cape Breton mines with radical UMWA locals were worked very infrequently or closed altogether.[241]

BESCO's announcement of another ten percent pay cut early in 1925 was accompanied by suspension of credit at company stores. The miners charged that starvation was being used as a weapon by the corporation. A lengthy, five-month strike was initiated March 5th when 14 000 mine workers failed to report for work. Government offers of mediation were rejected by one or both parties. The UMWA's announcement of picketing by 100% of the miners on June 4th precipitated a struggle for control of the New Waterford power and pumping station, which, although owned by BESCO, also served the town. In a clash at the pumping station on June 11th between strikers and BESCO police, miner William Davis was shot and killed and a number of others were wounded by company policemen. The military appeared once again in Cape Breton, triggering a wave of rioting, looting and incendiarism directed at BESCO property, particularly its company stores. Negotiations were finally resumed at the urging of Nova Scotia's Premier-Elect E.N. Rhodes. His proposal for a Royal Commission and a six-month interim contract, whereby wages would be reduced by just six to eight percent from the 1924 levels, was acceptable to both sides; the fact that he waived 20% of coal royalties over a period of one year sweetened the offer for the company.[242]

The Duncan Commission, named after its chairman, British industrialist Andrew Rae Duncan, had a mandate to recommend changes to the way in which the industry operated in the province. Its immediate effect was to end the strike and bring the miners back to the pits. The Commission conducted an inquiry into the nature and status of coal mining in the province that included an investigation of corporate structures, and looked at all aspects of the terms of work between miners and the corporation. On the table was the question of wages and remuneration, but discussion was entered into by both miners and managers about changes in the way work was conducted underground as a result of new technologies. Testimony before the commission, which filled close to 3 000 pages, is one of most important discussions on changes to mining brought about by technology.[243]

When BESCO was wrapped up as a corporate entity in 1928, it left a legacy of industrial stagnation, embittered industrial relations, deteriorating living conditions, underemployment, unemployment and "a sense of defeat and demoralization"[244] to its corporate successors in the coal fields of Cape Breton. The sacrifices of the early 1920s failed to prevent substantial wage cuts. Throughout the remainder of the decade, the position of the miner deteriorated as corporate managers undertook a major rationalization of the industry through mine closures and rigorous introduction of new machines. A further wage crisis ensued with the onset of the Great Depression of the 1930s, when coal markets and prices plummeted once again, causing yet another round of wage cuts. This in turn led to yet another Royal Commission headed by A.R. Duncan, intended to facilitate the company's determination to reduce wages by addressing its corporate health and justifying the pay cuts that were

240. The best discussion of the struggle in 1923 is David Frank, "The Trials of James B. McLachlan," CHA *Historical Papers*, (1982); David J. Bercuson, *Fools and Wise Men: The Rise and Fall of the One Big Union* (Toronto, 1978). Other Pictou miners also left the UMWA for the OBU at this time. See NAC, RG 27, Vol. 2272, file 25 (23), "Excerpts from Mr. Plant's report Re: Standing of O.B.U. in the Pictou Coal District."

241. *Maritime Labour Herald*, 6 December 1924.

242. *Labour Gazette*, March 1925, 267; July 1925, 661; August 1925, 771–72. A summary of the experience of this decade is David Frank, "The 1920s," in D.A. Muise and E.R. Forbes (eds.), *The Atlantic Provinces in Confederation* (Toronto, 1993).

243. Nova Scotia *Royal Commission on Coal Mining* (Duncan) (Halifax, 1926). The testimony is available at PANS (microfilm reels 3897–3899). The Chief Engineer of BESCO prepared a detailed study of its mechanization efforts, which was subsequently published.

244. Michael J. Earle, "The Coalminers and Their 'Red' Union: The Amalgamated Mine Workers of Nova Scotia, 1932–1936," *Labour/Le Travail*, 22 (Fall 1988), 101.

initiated. His brief report supported the company's position, based on an evaluation of the markets for coal at the time.[245]

In 1932 another version of the AMWNS was formed at Glace Bay, after a 12.5% wage decrease was accepted by UMWA leaders without consulting union members. By one estimate, miners' real earnings in 1932 after the cuts were just 58.6% of those of 1921. By 1935 the militant and radical AMWNS had nearly as many members as the UMWA. But when the Communist International called for a united front against the growing menace of fascism, the AMWNS, which was led by a number of communist sympathizers, was collapsed back into the UMWA.[246]

Since the 1930s the UMWA has continued to represent Nova Scotian miners. In 1941 it waged a four-month work slow down for improved wages and working conditions, despite the outrage generated in wartime Canada. During the 1950s, however, it stood by passively as mines were mechanized and levels of employment in the industry dropped.[247]

Western Canadian Unions

Conflict in the coal fields of western Canada was no less endemic than it was in Nova Scotia. Between 1900 and 1921 there were at least 125 strikes or lockouts in the industry. The ten largest disputes between 1903 and 1919 accounted for a loss of 10.6 million striker-days.[248] Efforts to organize unions on Vancouver Island in the 19th century had been largely unsuccessful. A local union at Nanaimo, the Miners' and Mine Labourers' Protective Association, had won recognition, but efforts to organize elsewhere on the Island had been violently checked. When the Nanaimo local affiliated in 1902 with the Western Federation of Miners (WFM), a militant American-based union, recognition was withdrawn. Efforts by the WFM to organize Dunsmuir's mines produced familiar results. After the most prominent advocates of unionization were dismissed, strikes ensued at both Extension and Union; both failed. Despite WFM interest in organizing Asian workers, they continued to operate the mines at Union while Caucasians struck. In the East Kootenays, a strike at the Crowsnest Pass mines in the spring of 1903, organized by the WFM, involving 1 500 mine workers also failed.[249]

After this debacle, the WFM was abandoned in favour of the UMWA, which formed its first locals in 1903 in southeastern British Columbia, and in early 1904 in Alberta. A UMWA local had also been formed at Nanaimo before the end of 1904. By 1906, the UMWA had organized at a number of mines along the CPR.[250] In 1907 and 1908 they successfully organized at a number of mines in Saskatchewan.[251]

The UMWA conducted its first major strike in Western Canada at Lethbridge in 1906 for equity with Crowsnest Pass miners in the area of pay rates and hours of work, as well as for a grievance procedure, and recognition as the miners' bargaining agent. When a handful of prominent unionists were discharged in March 1906, over 500 miners walked out. In May the first strikebreakers began work, but production levels fell considerably short of the usual output. Fears of a coal famine on the prairies, with the prospect of settlers literally freezing in their homesteads for lack of fuel, upset the company's plans to wait out the strikers. In November, a federal labour conciliator, William Lyon Mackenzie King, arrived in Lethbridge, and in December the miners returned to work with a significant pay increase, a grievance procedure and corporate recognition of their right to belong to a union. This strike was particularly noteworthy because it was the immediate cause of the *Industrial Disputes Investigation Act*, the first major industrial relations legislation passed by the federal government. Boosted by success at Lethbridge, the UMWA organized 11 new locals in the western coal fields in 1907.[252]

245. Nova Scotia *Royal Commission on Coal Mining* (Duncan) (Halifax, 1932).

246. Earle, "The Coalminers and Their 'Red' Union...," 101–18.

247. Political radicalism in the Nova Scotia coalfields is discussed in John Manley, "Preaching the Red Stuff: J.B. McLachlan, Communism, and the Cape Breton Miners, 1922–1935," *Labour/Le Travail*, 30 (Fall 1992), 65–114; David Frank and John Manley, "The Sad March to the Right: J.B. McLachlan's Resignation from the Communist Party of Canada, 1936," *Labour/Le Travail*, 30 (Fall 1992), 115–31; and Michael Earle, "'Down With Hitler and Silby Barrett': The Cape Breton Miner's Strike of 1941," in Earle (ed.), *Workers and the State....*

248. Allen Seager, "Socialists and Workers: The Western Canadian Coal Miners, 1900–1921," *Labour/Le Travail*, 16 (Fall 1985), 25.

249. *Report of the Royal Commission on Industrial Disputes in British Columbia*, Canada, *Sessional Papers*, XXXVII, No. 13, 36a, 1903, 35; 40; 57; 62.

250. Allen Seager, "A History of the Mine Workers' Union of Canada, 1925–1936" (M.A. thesis, McGill University, 1977), 17; Emil Bjarnason, "Collective Bargaining in the Coal Mining Industry of Canada, 1825–1938" (M.A. thesis, Queen's University, 1965), 40–41.

251. Glen Makahonuk, "Trade Unions in the Saskatchewan Coal Industry, 1907–1945," *Saskatchewan History*, XXXI, No. 2 (Spring 1978), 51–68. There were strikes at Saskatchewan coal mines in 1908, 1915, 1931, 1932, 1938, 1939 and 1948–49. See Glen Makahonuk, "Labour Relations and the Saskatchewan Coal Miners' Strike of 1948–1949," *Saskatchewan History*, XXXIX, No. 1 (Winter 1986), 1–20. See also Glen Makahonuk, "Labour Relations in the Saskatchewan Coal Mines during the 1930s" (unpublished M.A. thesis, University of Saskatchewan, 1976).

252. William M. Baker, "The Miners and the Mediator: The 1906 Lethbridge Strike and Mackenzie King," *Labour/Le Travail*, 11 (Spring 1983), 89–117; and "The Miners and the Mounties: The Royal North West Mounted Police and the 1906 Lethbridge Strike," *Labour /Le Travail*, 27 (Spring 1991), 55–96. Mackenzie King's account of the strike is in *Labour Gazette*, 7 (Dec 1906), 649–62. See also Paul Craven *'An Impartial Umpire': Industrial Relations and the Canadian State 1900–1911* (Toronto, 1980), esp. Chapter 9.

Colliery companies had formed the Western Coal Operators' Association in 1906 in response to what they defined as the threat of the UMWA. Association members forced a strike in the Crowsnest Pass in 1907 by the UMWA. They managed to retain an open shop (i.e. their right to hire non-union workers), but only at the price of wage increases. In 1909, mine operators in the Pass had to concede both further wage increases and the closed shop, and they faced yet another round of lengthy strikes in 1911.[253]

In 1911 efforts to gain recognition from employers in UMWA District 28 at Cumberland and Ladysmith on Vancouver Island led to a two year strike, an expenditure of $1.5 million, and the UMWA's first serious stumbling block in western Canada. The strike there was a mirror of the one conducted a year earlier in Nova Scotia, with long-term splits across the workforce that took a generation to heal. It was not until much later that the UMWA finally gained recognition on Vancouver Island — in 1937 at Cumberland and at Nanaimo in 1938.

A period of disenchantment with the UMWA was not limited to Nova Scotia. Throughout North America, from the end of World War I to the late 1930s the UMWA was challenged repeatedly by miners disturbed by its lack of internal democracy. Its corrupt leadership and perhaps most alarming, its steady retreat in the face of employer offensives directed against it, were affronts to the men who had struggled so hard for recognition of their right to a fair return for their labour and knowledge.

In the mine fields of the western interior a period of post-war turmoil, in some ways analogous to Nova Scotia's, was marked by both widespread industrial strife and rank-and-file estrangement from traditional unions in favour of radical alternatives. Beginning in 1919, wholesale defections from the UMWA to the OBU occurred in western Canada, which grew rapidly in the post-war climate. Strikes in 1919 involved 8 484 workers and 512 479 working days. After a series of failed recognition strikes, by 1921 the OBU was virtually smashed in the coal fields, leaving a weakened UMWA to face a series of wage reductions and more than a decade of disorganization. Lengthy strikes occurred in 1922, when 11 177 workers struck for 959 412 working days against wage reductions. They failed to halt the slide and were followed by another series of wage reductions and stoppages in 1924.[254]

Unsatisfactory contracts produced breakaways from the UMWA and local contracts with employers, which generally involved further wage reductions. The UMWA was forced to accept wage cuts again in 1925, leading to a massive decline in membership, and serious internal discord. In 1925 the Mine Workers' Union of Canada (MWUC) was formed to fill the breach created by the collapse of the UMWA. The MWUC was a radical organization affiliated in 1931 with the Workers' Unity League, the Communist trade union umbrella organization. The MWUC enjoyed some success among disaffected UMWA locals, but from 1929 its miners began to drift back to UMWA. In the meantime the MWUC led a great number of strikes for improved wages and working conditions, the largest of these occurring in the Crowsnest Pass in 1932.[255] The MWUC was formally disbanded in 1936 and its membership returned to the UMWA. Like the AMWNS, the MWUC and other Communist trade unions were ordered to disband and form a "common front" with other unionists against the rise of Fascism.[256] The UMWA has represented western miners ever since, and its experience there has been much the same as that of District 26 in Nova Scotia — a defensive attempt to protect miners against the unfavourable consequences of the transformation of mining.

253. Sharon Babaian, *The Coal Mining Industry in the Crow's Nest Pass* (Edmonton, 1985), 54, 96.

254. NAC, RG 27, Vol. 3131, file 123.

255. Seager, "The Mine Workers' Union of Canada...," Appendix C, "Strikes 1925–35."

256. On Communist organization and unionization in the western interior during the 1930s, see Gilbert Levine, "Patrick Lenihan and the Alberta Miners," *Labour/Le Travail*, 16 (Fall 1985), 167–78.

Chapter 6

A Century of Underground Coal Mining

Individual mines and coal fields have their own histories. Though variations exist, the basic objective has been to remove as much of the available coal within a seam at the least cost and risk with the maximum profit. The application of technology to various functions above and below ground were interdependent. Though it often proceeded unevenly, the trend was to replace human and animal power with machines.

Exploration and Discovery

Early exploration involved little more than observation of surface out-crops. In colonial periods coal was observed at various places on the continent, but especially on the east and west coasts. Experienced coal miners could sometimes estimate dip and thickness of the seam and calculate likely yields on the basis of small amounts of information. The large investments required for deep coal mines could only be profitable where the quantity and quality of a seam could be verified — or at least accurately estimated. Since coal fields often have several seams over-lying one another, different types and thicknesses of coal had to be factored in to the planning of any mine. Deep drilling, with sophisticated diamond drills, proved central to success in the later 19th century. Exploration provided the information necessary to determine the possible benefits from extensive investment in the development of deep mines. In essence, drilling takes core samples to various depths, which provide accurate information about the adjacent strata. Much exploratory work was undertaken under the sponsorship of provincial or federal government agencies during the expansive phase of the industry following Confederation.

Driving (Sinking) Shafts

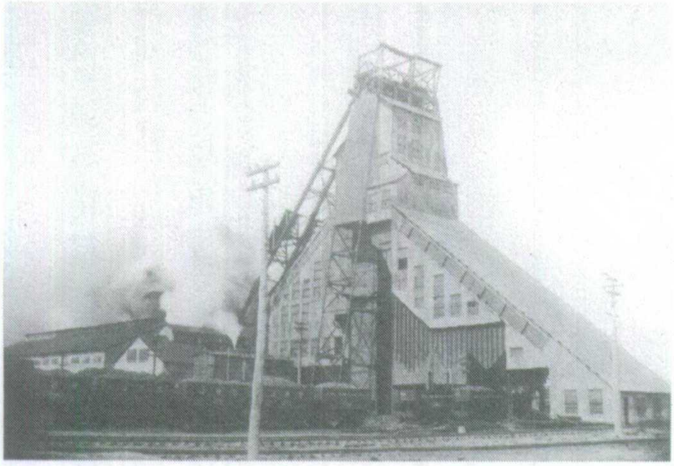
Initial development of a shaft or slope for an underground mine depends on the location, size and other properties of the seam of coal to be mined, as well as its relationship to adjoining seams, which often overlay one another in a coal field. Workers and materials had to be able to move efficiently into the mine and coal had to be able to be moved out of the mine if a mine's success was to be ensured. Most important was the driving of a slope or shaft to meet and parallel the seam of coal. Laying track and setting an effective road-bed were very precise operations, which had a significant bearing on the development of a mine. While technologies for driving a slope in the 19th century were primarily physical labour performed by miners equipped with hand tools, the 20th century witnessed the introduction of a variety of mechanical borers that sped both the development of the shaft and the removal of wastes.

Once a mine had been planned, its operating structure for extracting its coal had to be established. Laying haulage-ways and developing *airways* were the work of highly trained mining engineers and experienced miners, who were responsible for ensuring that a mine was well organized and therefore could be fully exploited. The planning of roadways and power delivery was central to the success of deep mines, and one of the main subjects of discussion within industry when it came to planning development. In all jurisdictions, departments of mines demanded effective planning and inspected workings on a regular basis to assure the government that mining was being conducted safely and efficiently. Too many mine accidents or too little control over the amount of coal being lifted was a costly problem.

Power and Light in the Mine

Power was essential to deep mines. Steam engines became the most important ingredient in hoisting, ventilating and pumping water out and air in. As well, all the materials and manpower had to be delivered to the most convenient spot for efficient operations. A fully developed mine might occupy as much as 30 or more square kilometres and employ more than 1 000 men. Virtually all of the mine had to be serviced with power of one sort or another; the type of power became increasingly more sophisticated as time went on. It was necessary to deliver air under pressure to mining machines or electricity to the operating parts of the mine.

In the early phases this technology was entirely British, brought virtually unchanged into the Nova Scotia and Vancouver Island fields by British-trained mining engineers who were so important to the initial development of the industry there, though there would be many local producers of the various engines that were necessary for operation of the mines. A similar pattern of development was followed in coal fields elsewhere in 19th-century Canada, although by the end of the century the American influence on coal mining technology was becoming pronounced.



Surface plant, Dominion Coal Company's Colliery No. 2, Glace Bay. *Life in the coal towns was dominated by the overwhelming presence of the surface plants. To support the activity of the men underground — more than 1000 in this mine alone — surface workings were in constant motion. Steam engines billowing smoke and steam and whistles signalling shift changes or accidents set the pace of life for the townspeople. Two mines, each operating on a different seam, were serviced by this surface plant, which typifies one of the great technological achievements of the late 19th-century coal industry. These structures, which housed the haulage equipment for shaft mines, dominated the landscape for miles around. Coal was lifted to the top of this building, sorted, cleaned and then dumped through chutes to railway boxcars waiting below. The owners also built machine shops, powerhouses and other ancillary buildings, which were spread over several hectares. The Sydney and Louisbourg Railroad, owned and operated by the Dominion Coal Company, transported the coal to tidewater for shipment to external markets or to Sydney for use in the giant steel works. (Courtesy of the National Photography Collection, Public Archives of Canada).*

The largest surface buildings, apart from head frames, were power plants, which housed some of the largest steam engines ever developed for Canadian industries. They delivered power to the massive drums responsible for hoisting materials into and out of the mines. Those buildings and head-frames can be seen in photographs of surface workings of mines; they gave a distinctive architectural feel to most mining communities. Delivering power for mining became necessary as mechanization underground demanded compressed air for hand-operated drills and coal cutters. Gradually, electric motors became the motive source and many mines established their own generating stations. Still more independent and safe power became a possibility with development of self-propelled (i.e. battery-operated) electric engines. But much of that development took place only after World War I.

Light was different than power. In a pre-mechanized era, miners carried their own lights; first open-flame candles or lamps and later closed-flame safety lanterns that were also capable of detecting gas. Electrification was an important component of the development of deep mines. With the introduction of more and more mechanized equipment into mines, there was a need for more adequate lighting. Electricity meant main working roads could be lit, a by-product of the introduction of power to mine operation. Following World War I, efficient portable, battery-powered, personal lamps that could be attached to miners' hats were introduced, revolutionizing individual work at the coal face and elsewhere in the mine.

The need for communication between the surface and the various parts of the mine became more acute as more and more technology was introduced into the mine. Early signalling devices were replaced by telephones as soon as they became available. In Cape Breton, where Alexander Graham Bell resided during the summer months, telephones were installed in the 1880s, earlier than in most mines in the world. Over time, their use became universal and they became very important to the safety and management of mine operations.

Ventilation

Whenever coal is cut, gases are released from the worked coal and pockets of explosive gas could be released from seams at any time. If allowed to accumulate, they could be ignited by any spark or disturbance. In primitive mines, the inability to ventilate workings adequately was the key limitation to the size and depth of the mine. As mines grew deeper, a furnace was fired at the base of a shaft; the hot air that moved to the surface through a main haulage shaft drew fresh air down separate airways, sweeping away the dangerous gases and providing sufficient oxygen for workers. This became both inefficient and dangerous as the workings got farther and farther from the main shaft. By mid-century, steam engines — later electric motors — drove giant fans that were capable of drawing hundreds of thousands of cubic metres of air from a mine. In the extended workings of a mature mine, the engineering of various air passages is centrally important to success. In particularly gaseous mines, miners' safety is a direct function of the efficiency of these systems.

Pumping Water

The design of the workings often had to account for the possibility that large amounts of water would be present; methods to channel it to where it could be moved to the surface had to be developed. In many mines, for every ton of coal removed, two tons of water had to be extracted. Some of this was surface water leeching into mine shafts or workings; some was the product of underground springs. In submarine mines there was always a discharge of sea water, though it was infrequent that any substantial amount of salt water penetrated into the deep workings of large mines, which were often left under-developed if there was any danger of too little ground cover between the coal seam and the weight of the ocean water. Pumps were generally operated from the surface, driven first by steam-engines and later by electricity. But, as mines became deeper and more complex, intermediate pumps had to be established at different levels to move enormous amounts of water.

Hoisting and Hauling

A system of moving men and materials into the mines and moving coal and waste out of the mines was essential to efficient mine operation. Elements in a hoisting system included: a) motive power in the form of engines; b) the gears and wheels for hoisting; c) ropes and cables for suspending containers; d) vehicles to move men, materials and coal; e) the road bed (mostly iron or steel rails) over which the containers moved; and f) the switching areas, where the men, materials and coal were moved from the operating faces to the main shaft or slope.

Haulage occurred away from the main hoisting shaft. Coal and waste materials were moved from the mining site to a point, usually at the bottom of a shaft or slope or at some handling area along the slope, from which it would be hoisted to the surface. In larger mines where operations took place at several different depths simultaneously, there were several levels where coal and materials were assembled — to be moved either in or out of the mine. This whole process was subject to intense technological development as it became important to avoid any inefficiencies in moving coal to the surface. Several people handled the coal on the way to the surface and all their functions had to be carefully coordinated to avoid bottlenecks in the system.

Mining Coal

The primary objective of a mine was to remove the largest amount of available coal in the most efficient manner, which in most cases meant the most economical manner. Coal had to be broken from the seam and prepared for transportation to the surface. In traditional bord and pillar mining, this normally required that it be loosened with some sort of explosive, which meant cutting or drilling it manually before inserting charges of black powder. The explosives had to be carefully set to ensure that a minimum of breakage occurred (to keep the more valuable larger pieces intact) in as safe a manner as possible.

The traditional method was to undercut the seam with a pick and then to over-shoot it using black gunpowder placed in drill-holes going a few feet into the seam at appropriate intervals up towards the roof of the seam. Once loosened, it had to be sorted for impurities and loaded into coal cars to be transported to the surface. Miners had to carry out these operations efficiently to maximize the amount of lump coal sent to the surface. It was the most labour intensive aspect of coal mining, and the miners were most eager to defend its integrity since it produced the highest earnings. After 1900, experiments attempted to introduce machines to this part of the process, most importantly the pneumatic drills and cutters that aided the breaking away of the coal. Problems associated with this process were at the heart of most labour negotiations throughout the century. With as many separate workplaces as there were teams of miners, cutting and boring had to be carefully synchronized to maintain maximum efficiency.

In the inter-war years, the main preoccupation was to develop effective mechanical loading machines that would perform the onerous task of transferring the loosened coal onto the coal cars for delivery to the surface. This was the part of the process that attracted the most attention and research during that period. Eventually the mining and loading of the coal was accomplished with mechanical miners, which largely replaced the miner at the coal face and developed the capacity to both mine and load the coal in one continuous process. This development was the preoccupation of the post-World War II period and is essentially the system in operation at underground mines today, where the coal is never touched by human hands, but delivered directly from the coal face to finely engineered conveyer belts that take it directly to the surface.

Since the coal exists in layers or seams, its removal can have a dramatic effect on surrounding surfaces. To avoid unplanned rock-falls or erosion of the surfaces being worked, miners had to shore up open spaces using timbering and propping, which accounted for much of the material taken into the mines. Depending on the techniques in use, any number of materials might be used to contain the surrounding strata while the actual mining was taking place. In Canadian mines, the most common material was wood, which as pit props or chocks was used to shore up the surrounding strata. Worked-out areas of mines were allowed to collapse after the mining was finished, although the mined-over areas could be used subsequently. Main shafts or slopes had to be more permanently secured, so various forms of shoring were used, including tin sheathing and steel beams. In modern mines, reinforced concrete was used for the walls and roofs of most main haulage ways.

Sorting, Cleaning and Grading Coal

In traditional bord and pillar mining, coal could be handled several times between the time it was cut from the coal face and the time it was delivered to the customer. Which of the various grades were produced depended on the intended use of the coal. If the coal was to be burned for energy production there was very little done besides trying to avoid breaking it into pieces too small for handling. In the earliest phases of development the amount of slack coal produced was always a problem; there was little demand for the by-product of what constituted inefficient mining or coal handling procedures. Later, as coal began being used for gas production or as coke for metallurgical purposes, a market for the slack coal developed. These new markets helped open the door to further mechanization, which, on the whole, tended to destroy lump coal.

On the surface, coal was screened into various sizes and impurities, such as stone and clay, were removed. This process involved passing the coal through different-sized screens, and over picking tables where impurities were manually removed. In the modern era, coal is washed and various flotation processes are used to prepare the material for market.

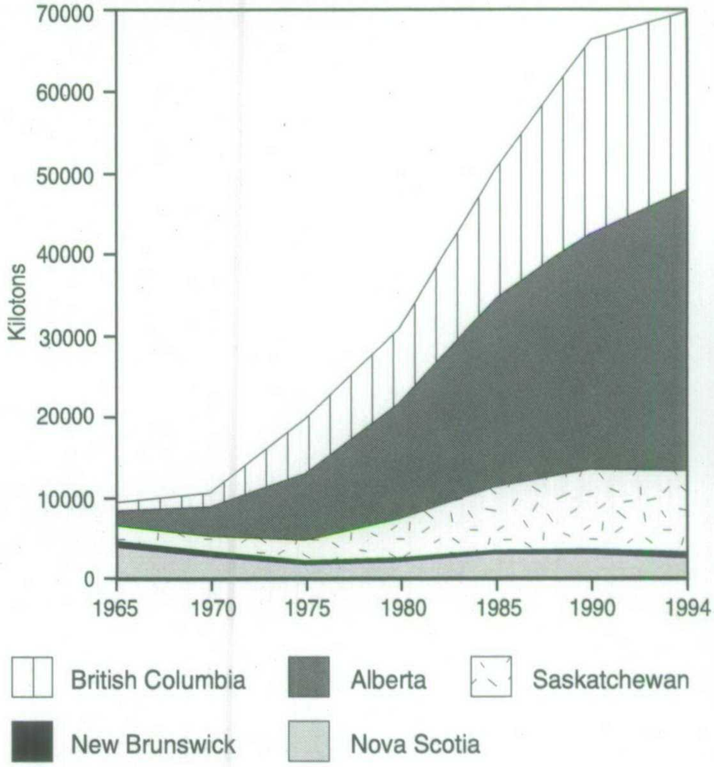
Epilogue

Contemporary Mining in Canada

The contemporary coal mining industry emerged during the 1960s. After decades of industrial stagnation, new markets for coal developed, largely as a consequence of Japanese demand for metallurgical coal.[257] Subsequently, the industry benefited from the major increases in the price of oil during the 1970s, which greatly increased coal's competitiveness as a source of thermal energy.[258] After a surge of new developments at the beginning of the decade, Canadian coal production increased by 86% during the 1980s.[259]

The use of coal is expected to rapidly expand in the upcoming decades. The extension of hydro-electric power generation is limited by the number of suitable dam sites. Nuclear power plants are very expensive and controversial. Reserves of oil and natural gas are declining and their exploration and production costs are increasing. These factors make coal relatively attractive.[260] Coal also remains relatively plentiful. World reserves of coal represent approximately a 220-year supply, as opposed to 65 for natural gas and 45 for oil.[261] In Canada, there are almost 6.5 billion tonnes of proven recoverable reserves of coal — a 100-year supply at current rates of consumption. In contrast, in 1991 there was only a 13-year supply of conventional crude oil, and a 27-year supply of natural gas.[262] World coal consumption is expected to surpass oil by the year 2000, and to double oil consumption by 2025.[263] Advances in coal gasification and/or liquification processes will also improve the prospects of coal.[264]

Coal Output (by province), 1961–1994



Source: Canada Yearbook.

Coal output (by province) 1961–94. *Stagnation was followed by explosive growth as northern Alberta and British Columbia reserves came into production. The economies available through large open-pit mining techniques allowed for competitive expansion, although most of the coal was exported directly to markets in the Far East.*

Markets

Today coal is generally mined in Canada for one of two uses, either thermal (power generation) or metallurgical. In the Maritimes and in Saskatchewan, most coal produced generates electricity in power plants. Further west, demand is more evenly balanced, with markets for metallurgical coal being slightly more

257. R.K. Singhal et al., *Western Canadian Surface Mining Technology* (Edmonton, 1987), i. China supplied much of Japan's coal until 1958, when a 'political incident' halted coal shipments and nearly shut down the Japanese steel industry. That same year Canada delivered its first coal shipment to Japan. The Coal Association of Canada, *Coal: Global Perspectives* (1) (Calgary, 1992) and The Coal Association of Canada, *Coal: Exports* (6) (Calgary, 1991).
258. Hugh Millward, "Mine Locations and the Sequence of Coal Exploitation in the Sydney Coalfield, 1720–1980," in Kenneth Donovan (ed.), *Cape Breton at 200: Historical Essays in Honour of the Island's Bicentennial 1785–1985* (Sydney, 1985), 185.
259. These developments are outlined in A.S. Romaniuk and H.G. Naidu, *Coal Mining in Canada: 1983* (Ottawa, 1984), 14. In total, over the late 1970s and early 1980s, almost $2 billion was invested in coal mines and infrastructure. See K. Morgan MacRae and Shaun Hatch, *Coal in Canada* (Calgary, 1991), 1.
260. Gerrit C. Van Kooten, "The Coal Industry in Canada" (M.A., University of Alberta, 1974), 44–45. Even by the 1960s, acceptable new hydro sites were becoming scarce. The Coal Association of Canada, *Coal: Power* (5) (Calgary, 1991).
261. *Canadian Mining Journal*, September/October 1991, S9.
262. MacRae and Hatch, *Coal in Canada...*, xv.
263. *Canadian Mining Journal*, September/October 1991, S9.
264. Van Kooten, *The Coal Industry...*, 61.

important.[265] The use of coal to generate electricity is relatively new in Canada. Its traditional uses, to the 1950s, had been industrial, for heating and to power locomotives and ships.[266] The thermal use of coal, restricted because the relatively high cost of transporting coal compared with that of natural gas, forced electric power plants that burned coal to locate near mines. Only by virtue of changes in electrical transmission technology — notably the invention of extra-high voltage power lines — were coal-fired plants able to expand their market.[267]

Today coal is the second most important source of electric power generation (behind hydro-electricity) and the use of coal to generate electricity accounts for over 85% of Canadian consumption. Thermal use of coal is particularly important in the coal-producing provinces of Alberta, Saskatchewan and Nova Scotia (where it accounts for over two thirds of electricity production), but it is also used to a considerable extent in Ontario (where it accounts for one quarter of electricity production).[268]

In contrast to its consumption patterns, Canada exports very little thermal coal. Metallurgical coal, a higher grade than thermal coal (bituminous as opposed to sub-bituminous or lignite), dominates Canada's export markets. Despite efforts to diversify sales, most coal exports continue to go to Japan (60% in 1991), as they have since the 1960s. Korea, which took 16% of Canadian coal exports in 1991, was a distant second.[269]

The Contemporary Industry

Western Canada, where very extensive coal deposits have only begun to be developed, dominates the contemporary coal industry.[270] By one estimate, over 90% of Canadian coal reserves are located in one province — Alberta.[271] Patterns of employment in coal mining from 1967 to 1986 reflect the continuing decline of the industry in the east and its rise in the west. In Canada as a whole, employment in coal mining increased over this period from 8 978 to 11 740, but employment dwindled in the old coal fields of the Maritimes, from 6 497 to 3 730 in Nova Scotia and from 731 to 250 in New Brunswick. In contrast, employment levels grew in each of the three western provinces: in Saskatchewan from 165 to 408; in Alberta from 1 132 to 2 102; and, most spectacularly, in British Columbia from 453 to 5 320.[272] In 1989, western Canada provided 95% of the national coal output, and 75% of employment.[273] The total number employed had dropped slightly to 11 239.[274]

The contemporary Canadian coal industry is also marked by increasing concentration and the clear emergence of economies of scale. During the 1930s, there were more than 400 coal producers in Canada, mostly small.[275] In 1955 there were 144 mines operating in Canada, most under the control of small owners.[276] In 1991, in contrast, 12 large producers operated 28 mines.[277]

Contemporary coal developments are mega-projects that entail massive expenditures on mine development, transportation infrastructure, residences and amenities. Since 1980, $5.6 billion has been spent to open new mines in southeastern and northeastern British Columbia and in the mountains and foothills of western Alberta. Improving railway infrastructure cost $1.7 billion and upgrading port facilities cost $450 million.[278] A good portion of this investment went to the Quintette/Bullmoose project in an isolated region of northeastern British Columbia. The Bullmoose mine was developed for $275 million; the much larger Quintette mine cost four to six times that sum. BC Rail built a 130-kilometre line from Anzac to the new town-site, and a 15-kilometre spur to the Quintette washplant. In all, it spent $550 million on rail lines and rolling stock. As part of the project, CN Rail upgraded its track from Prince George to Prince Rupert, a distance of nearly 1 000 kilometres. The new deep-water terminal at Prince Rupert, the Ridley Island facility, cost $280 million. To build the town of Tumbler Ridge to house mineworkers cost $220 million.[279]

Contemporary Mining Technology

Because of the mammoth investments in modern mines, great care has to be taken when selecting a potential mining site. In the past, trenches, tunnels

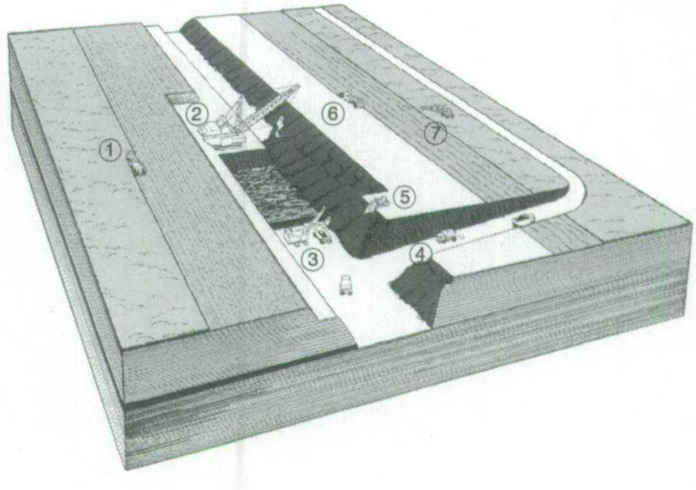
265. A.S. Romaniuk and H.G. Naidu, *Coal Mining in Canada: 1986...*, 18. Metallurgical coal is suitable for 'coking': that is, it is heated to temperatures up to 700° Celsius to remove moisture, gases, oils and coal tar. Approximately 70% of the original coal remains as coke — hard, porous, made mostly of carbon — and indispensable to iron and steel production.
266. MacRae and Hatch, *Coal in Canada...*, 5.
267. Van Kooten, *The Coal Industry...*, 43.
268. MacRae and Hatch, *Coal in Canada...*, xvi. During the 1980s, over half of DEVCO's coal output went to two thermal power stations. Millward, "Mine Locations...," 246.
269. *Ibid.*, 13. The four coking plants in Canada, all owned by Ontario steelmakers (two in Hamilton, one at Nanticoke on Lake Erie, one in Sault Ste. Marie), generally use imported American coal. The Coal Association of Canada, *Coal: More than a Fuel* (11) (Calgary, 1991).
270. Singhal, *Western Canadian Surface Mining...*, 5–7.
271. Romaniuk and Naidu, *Coal Mining...*, 20–21.
272. *Ibid.*, 36, Table 10, "Employees in Canadian coal mines, by province, 1967–1986." See also *Ibid.*, 34, Table 8, "Saleable Coal Production by Rank and by Province."
273. MacRae and Hatch, *Coal in Canada...*, 5.
274. *Ibid.*, xix.
275. The Coal Association of Canada, *Coal: Mining* (4) (Calgary, 1991).
276. Van Kooten, *The Coal Industry...*, 72.
277. The Coal Association of Canada, *Coal: Mining* (4) (Calgary, 1991).
278. The Coal Association of Canada, *Coal: Exports* (6) (Calgary, 1991).
279. *Canadian Mining Journal*, September/October 1991, S3–S7.

and drill holes had to be used — at great expense — to identify coal structures. Now, much greater use is made of surface mapping, new geometric techniques and computer mapping (modelling) combined with existing well and seismic data. Geometric Information Systems, where computer graphic modelling is used to link information drawn simultaneously from a number of databases, are beginning to be used.[280] Local geology — the thickness and number of seams, their dip, the thickness and nature of the overburden, the quality of the coal in the seams, the presence of folds, faults and other quirks, the lateral extent of the coal field, the presence of sub-surface water — has an impact not simply on whether a given mining development will proceed, but also on the selection of equipment and mining methods employed.[281]

Contemporary coal mines in Canada have been marked principally by the use of open-pit mining. Raw coal production in 1986 amounted to 3 590 000 tonnes underground and 67 825 000 tonnes on the surface.[282] The only major Canadian mines to operate underground are those in Cape Breton.[283] The last underground mine in British Columbia, the Michel Mine in the Crowsnest Pass, was shut down in February 1986. In Alberta, one mine in the Smoky River coal field still uses bord and pillar mining (and continuous miners and shuttle cars). It is the sole remaining underground coal mine in western Canada.[284]

Its clear cost advantages have made surface mining the method of choice in British Columbia and Alberta. Most Canadian coal reserves are currently accessible from the surface (5 914 mega-tonnes, as opposed to 664 mega-tonnes of reserves that require underground access).[285] Because open-pit mines are far more productive than those extending underground, surface mining will remain the option of choice. In terms of raw coal produced per person-year, the difference is considerable. In Alberta in 1986, open-pit mines averaged 13 680 tonnes per person-year. Underground, only 3 830 tonnes per person-year were produced.[286] In Nova Scotia, where mining was principally conducted underground, productivity was one-sixth the level in Alberta.[287]

In very general terms, surface mining involves the removal of the overburden by blasting and/or scraping; and then the mining of the coal by *dragline* or front-end



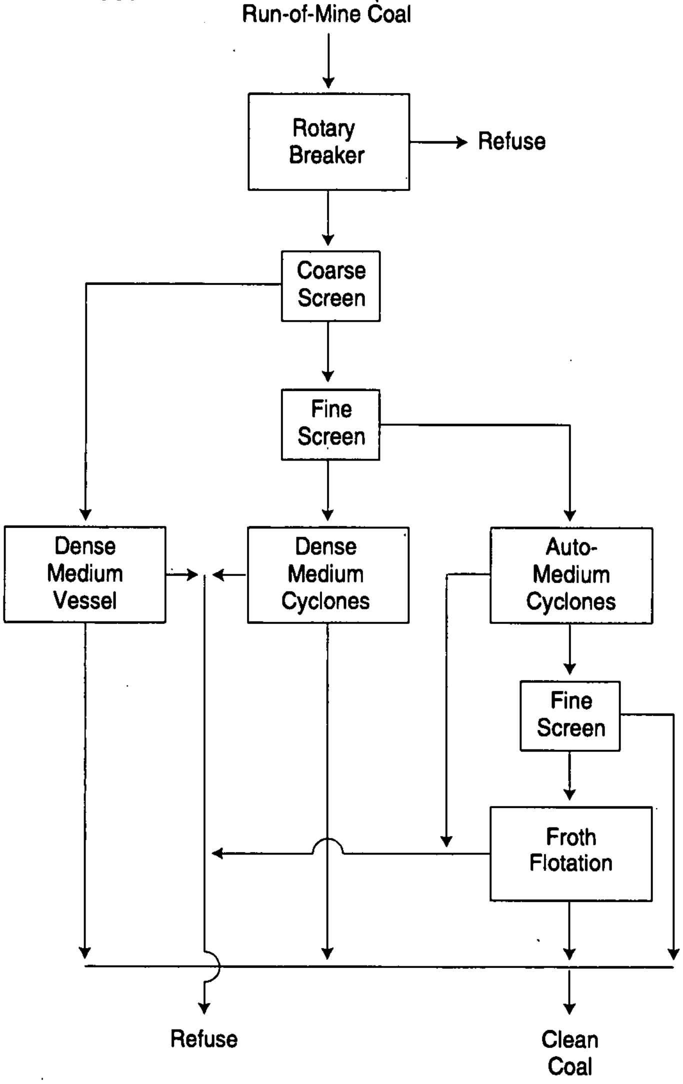
1 Soil is stripped ahead of mining and is salvaged for use in subsequent reclamation.
2 A dragline removes the overburden to expose the coal seam.
3 Coal is loaded into large off-road trucks for transport to the power plant.
4 Specialized tankers regularly spray haulage roads to control dust emissions.
5 "Spoil" piles left by the dragline are recontoured to produce suitable post-mining topography.
6 Soil which was salvaged before mining is replaced.
7 Revegetation is completed in increments roughly equal to the area disturbed by mining each year.

Strip mining. *Strip mining is common on the prairies where coal deposits are generally shallow, horizontal and several kilometres in width and breadth. The first step in the mining process involves the salvage of soils suitable for later reclamation. Typically, overburden is then removed by draglines to expose a section of the coal seam. (Reprinted from* Coal Mining 4, *Coal Association of Canada).*

loader. Freshly cut coal is carried by truck or conveyer to a preparation plant, where it may be stockpiled or fed directly into a receiving *hopper*. Coal is crushed to an appropriate size (or sizes), then taken by conveyer to raw coal silos for temporary storage, or immediately to a preparation plant. Coal is treated in a variety of ways after mining. These techniques change the coal's properties — most commonly, by removing moisture, ash and sulphur — so it meets market specifications or becomes more valuable.[288] The only means currently used commercially, physical coal cleaning, uses the differences in specific gravity of pure coal and impurities such as clays, rock and pyrites to separate it, generally by finely grinding it and suspending it in liquids.[289] At the Quintette Mine in British Columbia, for instance, coal is cleaned using heavy media baths and cyclones,

280. Alberta Energy, Research and Technology Branch, Office of Coal Research and Technology, *Some Studies of Alberta's Coal Geology* (Edmonton, 1991), 2–4.
281. Singhal, *Western Canadian Surface Mining...*, 4. For a discussion of the geology of the major coalfields in Canada see *Ibid.*, 4–7.
282. Romaniuk and Naidu, *Coal Mining in Canada: 1987...*, 35.
283. Because it extends far out under the ocean, open-pit mining at the Sydney coalfield is out of the question. *Ibid.*, 10.
284. *Ibid.*, 10, 26–33.
285. *Ibid.*, 23.
286. *Ibid.*, 37, Table 11.
287. *Ibid.*, 38, Table 12.
288. Federal-Provincial Task Force on Expanded Use in Ontario of Low-Sulphur Western Canadian Coal, *Western Canadian Low-Sulphur Coal: Its Expanded Use in Ontario. Technical Report* (Ottawa, June 1986), 103.
289. Federal-Provincial Task Force, *Western Canadian Low-Sulphur Coal...*, 104.

A Typical Western Canadian Coal Preparation Plant Flowsheet



A typical western Canadian coal preparation plant flowsheet. *(Source:* Modelling and Control of Coal Benefication Unit Operations, *Pitt, L.R. and B.C. Flintoff, Department of Mineral Engineering, University of Alberta, 1980; reprinted from* Coal Preparation Research in Alberta, *Alberta Energy Scientific and Engineering Services, 1989).*

water-only cyclones and froth flotation.[290] Modern markets are more and more demanding of product consistency in combustion characteristics, ash production and the formation of air pollutants.[291] After washing, coal is taken to a drier where excess moisture is removed. When dried, coal is stored in silos pending shipment.

290. *Canadian Mining Journal*, September/October 1991, S3–S7.
291. Alberta Energy, Research and Technology Branch, Office of Coal Research and Technology, *Recent Studies of Coal Mining, Cleaning and Upgrading* (Edmonton, 1992), 2.

Fifty percent of coal mined in Canada is used at or near its point of origin.[292] For the rest, the cost of transportation is of vital importance. Currently, coal is transported within Canada predominantly by rail (although lake steamers are used between Thunder Bay and points in southwestern Ontario). *Unit trains* can be as long as 1.6 kilometres, and can include up to 110 rail cars. These trains can be fully loaded with 11 000 tonnes of coal in under four hours.[293] After loading, coal is sprayed with a sealing compound, such as latex, to reduce dusting. Because railway freight rates can account for 30 to 50% of the total cost of coal, transportation remains a concern within the industry.[294] Since the 1960s, there have been massive expenditures on bulk transportation infrastructure — to upgrade and expand railway capacity and to construct bulk port terminals.[295] One alternative to rail transport is currently under consideration: the construction of a coal pipeline, whereby coal would be transported to market as a slurry. Such projects have been discussed since the 1950s, particularly in Alberta, and a variety of experiments have been conducted.[296]

Technical Challenges

Technical challenges extend over the range of operations in surface mining, beginning with the removal of thicker layers of overburden (and the introduction of more stringent soil reclamation requirements).[297] Continuous experiments have tried to lower the cost of overburden removal and handling.[298] To mine deeper overburdens, longer *boom* draglines are being used. At western Canadian mines the dragline booms measure up to 122 metres, the longest in the world. Today, pre-stripping by truck shovel is being considered to permit the greater use of draglines. Elsewhere in the world, bucket-wheel excavators (used at the Alberta oil-sands), *scrapers*, hydraulic or cable shovels have all been employed to remove overburden.[299]

292. MacRae and Hatch, *Coal in Canada...*, 25.
293. The Coal Association of Canada, *Coal: Exports* (6) (Calgary, 1991).
294. Alberta Energy, Research and Technology Branch, Office of Coal Research and Technology, *Studies of Coal Slurry Systems and Alternative Coal Transportation Methods* (Edmonton, 1991), 2; Mikhail and Romaniuk, *Coal Industry Views...*, 4.
295. MacRae and Hatch, *Coal in Canada...*, 25.
296. See Provincial Archives of Alberta, Acc. 77.237, Records of the Energy Resources Conservation Board, Box 209, file 3603, "Pipe Line for Coal, 1951–1963" and file 3604, "Long Distance Pipeline for Solids and Coal, 1962–1968."
297. Alberta Energy, Scientific and Engineering Services, Office of Coal Research and Development, *Advanced Coal Mining Techniques for Alberta* (Edmonton, 1989), 2.
298. These include blast casting with high strength explosives, used to both remove and fragment the overburden. Singhal, *Western Canadian Surface Mining...*, 19.
299. Singhal, *Western Canadian Surface Mining...*, 19.

There are perennial problems in mining coal: on the one hand, how to capture all the coal present; and on the other, how not to capture the impurities when mining the coal. Generally 80 to 90% of coal can be recovered from large seams dipping up to 30°. In the case of thinner seams, which are often broken and/or interspersed with other strata, levels of coal recovery are much lower and rates of dilution (by impurities) are much higher. There have been continual efforts to improve coal recovery (i.e. to mine more coal with fewer impurities).[300]

Other trends will likely include a focus on materials-handling — the site of greatest capital and operational costs. Over the last 20 years, larger and larger surface mining equipment has been applied, but it has likely reached a plateau in terms of size. Current equipment will continue to exist but computer applications will improve reliability, availability and serviceability.[301] Overall, mining techniques are not expected to change substantially over the next 25 years — but automation, remote control and new applications of computer-based techniques will continue to increase productivity.[302]

There is continuing concern over fine coal cleaning and treatment, particularly in western Canada. Western coal is 200 million years younger than eastern North American and European coal. This age difference contributes to the lower sulphur content of western coal, and the greater mineral content. It also contributes to its greater friability (tendency to crumble).[303] In Alberta, the production of fine coal can be double that of any other coal-producing area.[304] When coal is treated for market, losses to tailings (the coal that is literally thrown out with the wash water) can be as high as 30% of the recoverable coal. Means are being sought to both reduce the loss of coal during treatment, and to recover coal now sitting in colliery tailings ponds (the used wash water).[305]

300. *Ibid.*, 16.

301. *Ibid.*, 32.

302. Alberta Energy, *Advanced Coal Mining Techniques...*, 6.

303. Alberta Energy, Research and Technology Branch, Office of Coal Research and Technology, *Development of an Agglomeration Process to Beneficiate and Transport Alberta Coals* (Edmonton, 1988), 2.

304. Alberta Energy, Research and Technology Branch, Office of Coal Research and Technology, *Recent Studies of Coal Mining, Cleaning and Upgrading* (Edmonton, 1992), 4.

305. M.W. Mikhail and A.S. Romaniuk, *Coal Industry Views on Coal Preparation Research and Development Needs and Potential for Cooperative Work* (Devon, Alta., 1989). Some experiments were conducted to recover fine coal from the tailings pond at the Fording mine in British Columbia in 1980. It was recovered by dredge and then taken by pipeline to the plant for reprocessing. See *Canadian Mining Journal*, December 1980, 22–31 and Alberta Energy, Scientific and Engineering Services, Office of Coal Research and Technology, *Studies of Fine Coal Cleaning and Upgrading Processes for Alberta Coals* (Edmonton, 1989). See also Alberta Energy, Research and Technology Branch, Office of Coal Research and Technology, *Recent Studies of Coal Mining, Cleaning and Upgrading* (Edmonton, 1992), 4–6.

Environmental Concerns

The environmental concerns associated with the use of coal encompass a range of issues — and are expressed in a range of legislation. The relevant federal legislation, such as the *Fisheries Act*, or the *Canada Water Act*, carries sanctions for pollution, but the provinces are far more closely involved in regulating coal mining.[306] Mine approval regulations vary from province to province, but typically involve environmental impact assessments, public consultation and thorough reviews by regulatory agencies.[307] In Alberta, for instance, mine developments are subject to the provisions of the *Clean Air Act*, the *Clean Water Act*, the *Land Surface Conservation and Reclamation Act*, and the *Water Resources Act*, to name only the most important.[308]

Increasing use of coal will build pressure to develop clean coal technologies. Environmental considerations are evident at all stages of contemporary coal production. Even exploration, with its call for access roads and exploratory trenches, has an impact on the landscape.[309] The development of mines opens wilderness areas to other activities, intensifying the environmental impact. Surface mining can disturb great tracts of land, creating, most strikingly, an enormous hole in the ground and unsightly dumps for the removed overburden. The damage to vegetation is profound; the removal of habitat and alteration of surface topography adversely affect animal populations. Winter grazing can be affected. Mine waste-waters (spring run-off, fall rains) can contain noxious chemicals that can make their way into both surface- and groundwater. Fish are threatened by stream siltation (the seepage of coal dust into water). Stripping pollutes the air in the form of fugitive dust (although mine haulage roads are generally sprayed with water to reduce dust levels), as do emissions from diesel-powered equipment.[310]

Preparation plants currently produce coarse refuse (large rock fragments, wood and metallic particles) and fine refuse (now simply pumped to tailings ponds).

306. Acres Consulting Services Ltd. (Vancouver) for Department of Energy, Mines and Resources (Ottawa) *The Western Canadian Coking Coal Industry: A Case Study of the Employment Effects of Energy Resource Development* (Vancouver, October 1972), 139.

307. The Coal Mining Association of Canada, *Coal: Standards and Regulations* (7) (Calgary, 1991); The Coal Mining Association of Canada, *Coal: Land Reclamation* (14) (Calgary, 1991).

308. See Department of Energy and Natural Resources (Alberta), *A Coal Development Policy for Alberta* (Edmonton, 1976).

309. Acres Consulting Services Ltd. (Vancouver) for Department of Energy, Mines and Resources (Ottawa) *The Western Canadian Coking Coal Industry: A Case Study of the Employment Effects of Energy Resource Development* (Vancouver, October 1972), 138–39.

310. Federal-Provincial Task Force, *Western Canadian Low-Sulphur Coal...*, 165–66.

They also release fine particles and gas into the atmosphere. Liquid wastes, including both metallic and non-metallic elements, are also produced. Finally, the transportation of coal involves fugitive dust (although loaded coal cars are treated with chemical sealant, this is not the case with returning empty cars), diesel emissions or fires caused by sparks from wheel/rail contact.[311] Blowing dust is a particular problem in the Fraser Valley and in developed areas around port facilities.[312]

By far the most significant environmental problems arising from coal mining are associated with its combustion and the associated emissions. "Acid rain" and "the greenhouse effect" have entered the vocabulary of everyday life.[313] There are three possible responses to these concerns: less coal could be burned (or coal could be burned more efficiently); cleaner coal (low sulphur coal/treated coal) could be burned; or, finally, fewer emissions could be released when coal is burned (clean-coal technologies at power plants).[314] In practice, a combination of all three tactics is likely to be adopted.

Steps at the mine to produce a cleaner, more efficiently burning coal (by virtue of improved coal preparation techniques) are generally undertaken in conjunction with similar efforts at power plants. Currently, a number of utilities are experimenting with "first-in-Canada" commercial clean coal installations. The *fluidized bed combustion* plant of Nova Scotia Power at Point Aconi, which came on line in 1993, employs a process that substantially reduces emissions of sulphur dioxide and nitrogen oxides during combustion.[315] A related process, the LIFAC (limestone injection into furnace and activation of unreacted calcium) enhanced furnace sorbent injection technology being implemented by SaskPower at Poplar River and Shand, is an "end-of-pipe" control system directed against sulphur dioxide. Wet limestone sulphur dioxide *scrubbers* have been installed by New Brunswick Power at Belledune and by Ontario Hydro at Lambton.[316] There are also special means to reduce fly ash (airborne ash) at conventional power plants. Most ash is collected from the bottom of the burner but fly ash must be captured by electrostatic precipitators (which use a charge to attract ash) or a vacuum-cleaner-like system. These yield efficiencies of 99.5%. Captured ash can be used in the manufacture of cement, or used as backfill at the mine.[317]

Mine Safety

The issue of mine safety also remains current. It receives attention at every stage of mining — even during mine design, when efforts are made to predict the response of the earth's surface to the physical stresses produced by the excavation of large masses of earth. The task is all the more difficult at coal mines because coal seams (unlike the situation at hardrock mines) are often surrounded by weak rock formations. When coal seams are subject to mechanical stress, creep occurs, producing rockfall and, ultimately, roof collapse.[318]

Research is also currently being conducted on a means to prevent or predict open-pit highwall failure by monitoring and measuring strain. The loosening of bedrock can cause very serious accidents. Footwall anchoring is used at some open-pit mines. In the mountains, surface mining often involves nearly vertical seams. Mining exposes a sharply inclined footwall of rock under the coal. Because this footwall is very weak, the threat of falls of rock on miners working below is great. Various kinds of steel anchors have been tested as an alternative to the trouble and expense of removing the rockfall from the pit.[319]

Care is also taken in the selection of machinery for use at surface mines. High-grade steels more resistant to cold have been developed, as well as high-standard brakes for coal trucks.[320] The rate of mining accidents, fortunately, has diminished tremendously. In Alberta, between 1979 and 1989, coal production doubled. At the same time the accident rate fell by 80%. By the end of the 1980s the rate of accidents in coal mines was lower than that for department stores! To a large extent, of course, these statistics simply reflect the shift to surface mining, intrinsically safer than underground mining. The continuing dangers of the underground mines, even with careful design and major improvements in ventilation systems, was underlined sharply by the recent disaster at the Westray Mine in Pictou County, Nova Scotia.[321]

311. *Ibid.*, 168–70.
312. Acres Consulting Services Ltd., *The Western Canadian Coking Coal Industry...*, 139.
313. See The Coal Association of Canada, *Coal: Acid Deposition* (12) (Calgary, 1992); and *The Coal Association of Canada, Coal: Greenhouse Effect* (13) (Calgary, 1992).
314. The Coal Association of Canada, *Coal: Controlling Emissions* (9) (Calgary, 1992).
315. *Canadian Mining Journal*, October 1992, 33. It is planned to yield a 90% reduction in sulphur dioxide emissions and a 65 to 75% reduction in nitrogen oxide emissions. Alberta Energy, Scientific and Engineering Services, Office of Coal Research and Technology,. *Gasification of Alberta Coals* (Edmonton, 1989).
316. *Canadian Mining Journal*, September/October 1991, S9.
317. Alberta Energy, Scientific and Engineering Services, Office of Research and Technology, *Gasification of Alberta Coals* (Edmonton, 1989).
318. Ground-water flow can also be significant. Alberta Energy, Research and Technology Branch, Office of Coal Research and Technology, *Geotechnical Studies of Overburden and Coal at Alberta Coal Mines* (Edmonton, 1990).
319. *Ibid.*
320. The Coal Association of Canada, *Coal: Safety* (8) (Calgary, 1991).
321. Dean Jobb, *Calculated Risk: Greed, Politics and the Westray Tragedy* (Halifax, 1994).

General Observations on Contemporary Mining

Following the withdrawal of Dominion Coal from the operation of the coal mines of Nova Scotia, the remainder of the Nova Scotia coal industry was taken over in 1966 by the federal government, which closed down most of the existing mines. When DEVCO was formed, only four collieries remained open in Cape Breton. In 1971, two older mines were closed.[322] An important departure from the trend towards abandonment was DEVCO's decision to develop two highly mechanized mines on sections of reserved seams near New Waterford. These mines, opened in the 1970s, were models of modern technology. Their head-frames were large structures designed to handle massive amounts of coal and materials. Underground there was massive electrification that ran everything, from ventilation to the automatic shearers that threw coal directly onto the miles of conveyer belts used to transport coal to the surface. The technology was all imported from the U.S. or Europe and the workforce was entirely retrained to operate within the new structures that were put in place. Efforts continued to develop and apply leading-edge mining techniques and technologies. But in the face of highly competitive coal markets, the future of low productivity mines is particularly uncertain.[323]

At its outset in 1967–68 the western Canadian surface mining industry relied on imported equipment and skills. Since that time "the industry has made tremendous progress in establishing a technology base of its own."[324] As Canadian mines continue to face market pressures to reduce the cost of coal production, many of today's technical and environmental challenges will be addressed. The mining of coal will continue to call for technologies that meet world standards. Radically evolving techniques of producing coal have changed the industry profoundly, and will certainly continue to do so.

Currently the industry, more now than at any point in its past, is a research-based industry. Centres for coal research have been established.[325] New means of organizing research have been pioneered.[326] The investigation of coal on a molecular scale has been initiated.[327] The combustion characteristics of coal have been explored.[328]

An integral aspect of research has been not simply refining current techniques, but discovering alternative or expanded uses for coal. The study of the molecular properties of coal has led to the production of activated carbon (important in water purification) from coal.[329] Much research has been devoted to "co-processing," the production of liquid fuels from mixtures of coal and bitumen or heavy oils, and to the hydroprocessing of coal-based liquids, for use as refinery feedstock. Both are technically feasible, but more research is necessary to reduce costs and bring efficiency to commercial standards.[330] A process exists (patented by a German firm) whereby a coal-water fuel can be substituted for fuel oil in oil-fired power stations. This has been successfully tested in Alberta, and represents another potential market for Canadian coal.[331] Worldwide, coal has been used for a variety of purposes, from tars to chemicals, that have not been exploited in Canada.[332]

One notable consequence of the pressure to improve technical means will be the continuing erosion of the job of miner in favour of the job of machine-operator/technician, a trend evident since the adoption of the first mechanical coal cutters at the end of the 19th century. At surface mines today, more maintenance workers are employed than operators. Even those who are still called miners scarcely resemble their predecessors of even a few decades ago. While they may enjoy a much safer workplace, they have lost much of the control over their work enjoyed by earlier miners.[333]

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322. Hugh Millward, "The Development, Decline and Revival of Mining on the Sydney Coalfield," *Canadian Geographer*, 28 (1984), 180–85.
323. See A.S. Romaniuk and H.G. Naidu, *Coal Mining in Canada: 1986* (Ottawa, 1987), 27–28.
324. Singhal, *Western Canadian Surface Mining...*, 15.
325. Alberta Energy, Scientific and Engineering Services, Office of Coal Research and Technology, *Coal Research Centre, Devon* (Edmonton, 1988).
326. Alberta Energy, Scientific and Engineering Services, Office of Coal Research and Technology, *The Technical Committee Approach to Coal Research* (Edmonton, 1988).
327. Alberta Energy, Research and Technology Branch, Office of Coal Research and Technology, *Studies of Some Fundamental Properties of Coal and Potential Uses for Coal* (Edmonton, 1991).
328. Alberta Energy, Scientific and Engineering Services, Office of Coal Research and Technology, *Some Combustion Studies of Alberta Coals* (Edmonton, 1989).
329. *Ibid.*
330. Alberta Energy, Scientific and Engineering Services, Office of Coal Research and Technology, *Co-Processing Studies of Alberta Subbituminous Coals* (Edmonton, 1988); Alberta Energy, Research and Technology Branch, Office of Coal Research and Technology, *Methods for Producing and Upgrading Liquid Hydrocarbons from Alberta Coal* (Edmonton, 1992).
331. Alberta Energy, *Studies of Coal Slurry Systems...*, 5.
332. The Coal Association of Canada, *Coal: More than a Fuel* (11) (Calgary, 1991).
333. *Canadian Mining Journal*, (September, 1980), 28.

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A note on sources: *While considerable primary research was conducted for this book, the size and scope of Canada's involvement with coal mining necessitates dependence on secondary literature. A wide array of technological studies and reports, particularly in accounts of early and mid-20th century development, exists. Because of concerns about the impact of mechanization, information regarding new ways of doing things was communicated and debated within the industry on a regular basis. A number of trade journals, where industry professionals regularly assessed new technologies and commented on the suitability of various transfers and adaptations of mining technologies from other countries, became prominent. Secondary literature dealing with social and economic aspects of coal mining includes both local studies and broader interpretations. There has been little comparative analysis across regions of any aspect of the industry by scholars in any of the major disciplines.*

Because of the significance of coal mining and coal consumption to both national and regional development, federal and provincial governments were often concerned with the efficacy of various methods of mining coal. That preoccupation helped produce a large number of public inquiries. At the federal level, detailed annual reports by the Department of Mines and the Dominion Bureau of Statistics, as well as Royal Commissions have reviewed the nature and development of the industry from a wide variety of perspectives. Testimony before those commissions and the technical reports prepared for their consideration created a rich body of information on technologies associated with the industry. All five provinces involved in coal mining have departments of mines and minerals with responsibilities for tracking performance, including, from time to time, their own commissions of inquiry into various aspects of the industry. Their annual reports and detailed internal documents provide a unique window into the operation of their coal mines. In more recent years, various research agencies associated with the industry in Nova Scotia, British Columbia and Alberta have produced a wide array of useful summaries of technical developments, much of it commissioned from scholars and other researchers.

Private papers of corporations involved in the industry survive in limited quantities in local and regional archives and contain materials pertaining to all aspects of their operations. Though unable to undertake detailed research into these holdings, we have surveyed the Dominion Steel and Coal Company papers held at the Beaton Institute, University College of Cape Breton for facets pertaining to mechanization and development of new technologies. The scope of this study did not allow for detailed assessment of these sources.

Local heritage agencies in coal towns, whose pasts are often more storied than their presents, generally focus on the more expansive periods of their development for commemoration. An aspect of their concern for lived experience of miners has been accumulation of a vast array of oral history on the mining experience — a resource seldom used but one that forms an integral part of programs interpreting the technological history of the industry at that level. The artifacts of early coal mining are sometimes difficult to document. Within widely differing temporal and spatial circumstances, coal mining's essential objective has always been to take as much coal as possible from a given deposit. Successful mining operations leave empty holes, either on the earth's surface or as deep underground labyrinths of collapsed tunnels. Mine abandonment, a natural consequence of resource depletion, results in the permanent loss of many artifacts, as older mines are sealed over and, in some instances at least, allowed to fill up with water. In contemporary open-pit or strip mining, for instance, excavations created for the mining of coal are sometimes re-covered with top-soil in an attempt to remove all evidence of the massive earth moving activities that had taken place. Despite all this, a remarkable physical heritage of the industry has been preserved in a number of specialized museums, both in Canada and elsewhere. This brief work cannot trace the substance of their collections but acknowledges their significance.

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Glossary

Derived from E.N. Zern, Coal Miners' Pocketbook (Principles Rules, Formulas and Tables, etc.) *(New York, 1928); Albert H. Fay,* A Glossary of the Mining and Mineral Industry *(Washington, 1920).*

Adit — A nearly horizontal passage from the surface, by which a mine is entered and unwatered with just sufficient slope to ensure drainage.

Aerophore — The name given to an apparatus that will enable a man to enter places in mines filled with explosive or other deadly gases with safety.

Afterdamp — The gaseous mixture resulting from an explosion or firedamp; consists principally of carbonic acid gas with some nitrogen.

Agent — The manager of a mining property.

Agglomeration — A family of processes that can be used to concentrate valuable minerals (including coal) based on their adhesive properties.

Air box — Wooden tubes used to convey air for ventilating headings, sinkings or other local ventilations.

Air compartment — An air-tight portion of any shaft, winze, rise or level, used to improve ventilation.

Air door — A door to regulate currents of air through the workings of a mine.

Air furnace — A ventilation furnace.

Air pipe — A pipe made of canvas or metal or a wooden box used to convey air to the workmen, or for rock drills or air locomotives.

Air shaft — A shaft or pit used expressly for ventilation.

Air-crossing — An intersection of two air currents, one passing over the other.

Airway — Any passage through which air is carried.

Anthracite — Coal containing a small percentage of volatile matter.

Anticlinal axis — The ridge of a saddle in a mineral vein, or the line along the summit of a vein from which the vein dips in opposite directions.

Anticline — A flexure or fold in which the rocks on the opposite sides of the fold dip away from each other, like the two sides of the letter A. The inclination on one side may be greater than on the opposite side. An anticlinal is said to be overturned when the rocks on both sides dip in the same direction.

Apron conveyor — A conveyor contrived so as to provide a moving platform on which coal can be carried and, if necessary, cleaned by picking.

Arching — Brickwork or stonework forming the roof of any underground roadway.

Ascensional ventilation — The arrangement of the ventilating currents in such a manner that the air continuously rises until reaching the bottom of the upcast shaft. Particularly applicable to steep seams.

Automatic mine doors — Doors on a haulage road that are automatically opened by an approaching trip passing over a level, and that close automatically after the trip has passed through, thus making the services of a door- or trapper-boy unnecessary.

Back — (1) A plane or cleavage in coal, etc., frequently having a smooth parting and some sooty coal included in it. (2) The inner end of a heading or gangway. (3) To throw back into the gob or waste the small slack, dirt, etc. (4) To roll large coals out of a waste for loading into cars.

Back shift — The late afternoon or evening shift.

Back-balance — (1) A self-acting incline in the mine, where a balance car and the carriage in which the mine car is placed are used. The loaded car upon the carriage will hoist the balance car, and the balance car will hoist the carriage and empty car. (2) A weight moving vertically or an incline that places tension upon a tension carriage.

Backbye work — Work done between the shaft and the working face, as opposed to face work, or work done at the face.

Backing — (1) The rough masonry of a wall faced with finer work. (2) Earth deposited behind a retaining wall, etc. (3) Timbers let into notches in the rock across the top of a level.

Balance — (1) The counterpoise or weights attached to the drum of a winding engine, to assist the engine in lifting the load out of a shaft bottom and help it to slacken speed when the cage reaches the surface. It often consists of a bunch of heavy chains suspended in a shallow shaft. The shaft, resting on the shaft bottom, is unwound off the balance drum attached to the main shaft of the engine. (2) An inclined passage running up at right angles from a main level into the coal seam, normally tracked, with boxes drawn up and lowered by balance gravity; generally a pair of passages, connected at the top, one of which is upcast and the other downcast for ventilation.

Balance box — A large box placed on one end of a balance bob and filled with old iron, rock, etc., to counterbalance the weight of the pump rods.

Balk — (1) A more or less thinning out of a seam of coal. (2) Irregular-shaped masses of stone intruding into a coal seam. (3) A bar of timber supporting the roof of a mine, or for carrying any heavy load.

Ballast — Broken stone, gravel, sand, etc., used to keep railroad ties steady.

Bank — (1) The top of the shaft, or out of the shaft. (2) The surface around the mouth of a shaft. (3) To manipulate coal, etc., on the bank. (4) The whole or one side or one end of a working place underground. (5) A large heap of mineral on the surface.

Bank to bank — A shift.

Bank-head — The upper end of an inclined plane, next to the engine or drum made nearly level.

Bank-head machinery — The hoisting, dumping and screening equipment at a coal-mining shaft.

Banksman — The man in attendance at the top of the shaft, superintending the work of banking. Also called lander.

Barrier pillar — (1) A solid block of coal, etc., left unworked between two collieries or mines for security against accidents arising from the influx of water. (2) Any large pillar entirely or relatively unbroken by roadways or airways that is left around a property to protect it from water and squeezes from adjacent property, or to protect the latter property in a similar manner. (3) In incorrect parlance, a similar pillar left to protect a roadway or airway or group of roadways or airways or panel of rooms from a squeeze.

Barrier system — The method of working a colliery by pillar and stall, where solid ribs or barriers of coal are left in between a set or series of working places.

Battery — (1) A structure built to keep coal from sliding down a chute or breast. (2) An embankment or platform on which miners work. (3) A set of stamps. (4) Two or more boilers with a common setting. (5) Equipment to convert chemical into electrical energy.

Bay — An open space for waste between two packs in a longwall working. See board.

Bearing in — The depth or distance under the undercut or holing.

Bearing-up pulley — A pulley wheel fixed in a frame and arranged to tighten or take up the slack rope in endless-rope haulage.

Bed rock — The solid rock underlying the soil, drift or alluvial deposits.

Beehive oven — The ordinary circular or rectangular arched oven in which coke is made without the recovery of any by-products other than, in some instances, the heat.

Bench — A horizontal section of a coal seam included between partings of coal or shale.

Bit — (1) A piece of steel placed in the cutting edge of a drill or the point of a pick. (2) The cutting tool of a mining machine.

Bituminous — Soft coal, 70% to 85% carbon.

Blackdamp — A gas consisting of carbon dioxide mixed with an excess of nitrogen. It is given off by the coal seam and formed during an explosion. Being heavier than air, it is always found in a layer along the floor of a mine. It extinguishes light and suffocates its victims.

Blackleg — A strike breaker.

Blacklist — A list of names of workers, especially those active in union organizations, against whom all avenues of employment are closed.

Blasting cap — A small metal cylinder containing fulminate of mercury or other highly explosive material with the electric lead wires to fire it off. When in use, the cap is set in high explosive and by its detonation explodes the larger charge.

Block coal — Coal that breaks in large rectangular lumps.

Block hole — Hole for a pop shot.

Blowdown fan — A force fan.

Blower — (1) A sudden outburst or emission of gas in a mine. (2) Any emission or outburst of gas from a coal seam, similar to that from an ordinary gas burner. (3) A type of centrifugal fan used mainly to force air into furnaces. (4) A ventilating fan that operates under pressure; a force fan.

Blown-out shot — A shot that is blown out the tamping, but has not broken the coal or rock.

Blue cap — The blue halo of ignited gas (firedamp and air) on top of the flame in a safety lamp.

Board — A wide heading usually 3 to 5 yards (2.7 to 4.5 metres) wide.

Bonnet — (1) The overhead cover of a cage. (2) A cover for the gauze of a safety lamp. (3) A cap piece for an upright timber. (4) The upper part of a valve containing the stuffing box.

Boom — A wooden support of the mine roof, like a building rafter, set horizontally.

Booster fan — A fan used to suck in the intake air on an airway and force it on into the mine, thus reducing the work laid on the main fan.

Bootleg — Illegal digging and/or selling of coal.

Bootlegger — A worker in bootleg holes or anyone who cleans the coal in a small impermanent breaker, and the trucker who conveys the coal to markets.

Bord (English) — A narrow breast or room excavated in coal, off balance; also called a room.

Bord and pillar — A system of working coal where the first stage of excavation is accomplished with the roof sustained by pillars of coal left between the breasts. The distinguishing feature is the winning of less than 50% of coal on the first working. Often called breast and pillar.

Bord room — The space excavated in driving a bord. The term is used in connection with the "ridding" of the fallen stone in old bords when driving roads across them in pillar working; thus, "ridding across the old bord room."

Bore hole — A hole made with a drill, auger or other tool, in coal, rock or other materials.

Boss driver — A person in charge of men or boys who drive horses or mules for hauling coal at mines.

Bottom — (1) The landing at the bottom of the shaft or slope. (2) The lowest point of mining operations. (3) The floor, bottom rock, or stratum underlying a coal bed. (4) In alluvial, the bed rock or reef.

Bottom lift — (1) The deepest columns of a pump. (2) The lowest or deepest lift or level of a mine.

Bottom pillars or **large pillars** — Large pillars left around the bottom of a shaft.

Bottomer or **bottomman** — The person who loads the cages at the pit-bottom and gives the signal to the bank; also onsetter or bottom cager.

Box — A vehicle in which coal is conveyed from the working places along the underground roadways and up the shaft.

Brakeman — The man in charge of a winding (hoisting) engine for a mine.

Brattice — A board or plank lining, or other partition, in any mine passage to confine the air and force it into the working places. Its object is to keep the intake air from finding its way by the shortest route into the return airway.

Brattice cloth — Ducking or canvas used for making a brattice.

Breaker — A machine that combines coal crushing and screening. Normally consists of a rotating drum in which coal is broken by impact against the walls of the drum. In anthracite mining, the structure in which the coal is broken, sized and cleaned for market. Known also as coal breaker.

Breast — (1) A stall, bord or room in which coal is mined. (2) The face or wall of a quarry.

Breast auger — An auger for drilling in soft coal. It is driven forward by a plate, termed a breast plate, which rests against a miners body.

Breast machine — A coal-cutting machine constructed so that a series of cutting bits attached to a circulating chain work their way for a certain distance under the coal seam; when the limit is reached the cutting mechanism is withdrawn and the machine shifted to one side where another cut is made.

Broken — A district of coal pillars in the process of being removed, as opposed to the first working of a seam by bord and wall, or working in the "whole." See whole working.

Brown coal — Lignite. A fuel classed between peat and bituminous coal.

Brush — (1) To mix air with the gas in a mine working by swinging a jacket, etc., to create a current. (2) To "brush" the roof is to take down some of the roof slate to increase the height or headroom.

Brusher — A workman, always an experienced miner, who keeps the roof, sides and pavement of a passage in good repair.

Bucket — (1) An iron or wooden receptacle for hoisting ore or for raising rock in shaft sinking. (2) The top valve or clack of a pump. (3) One of the conveying units on a bucket conveyor that lifts the coal from a boot or bin when passing over the lower sprocket and is dumped when passing over the upper sprocket. The bucket is often made of perforated metal so that the water entrapped with the coal will pass through the perforations and back to the boot.

Bucket conveyor — A conveyor with buckets at intervals used to lift coal from a lower to a higher level, either vertically or on a steep incline.

Bucket pump — A lifting pump, consisting of buckets fastened to an endless belt or chain.

Buddy — A partner. Each of two men who work in the same working place of a coal mine.

Building — A built-up block or pillar of stone or coal to support the roof.

Bulkhead — (1) A tight partition or stopping. (2) The end of a flume carrying water for hydraulicking.

Bull — An iron rod used in ramming clay to line a shot hole.

Bull engine — A single, direct-acting pumping engine, or the pump rods forming a continuation of the piston rod.

Bull pump — A single-acting pumping engine in which the steam cylinder is placed over the shaft or slope and the pump rods are attached directly to the piston rod. The steam enters below the piston and raises the pump rods so that the water is pumped on the down stroke by the weight of the rods.

Bull shaker — A shaking chute where large coal from the dump is cleaned by hand.

Bull wheel — (1) A wheel on which the rope carrying the boring rod is coiled when boring by steam machinery. (2) The principal wheel of any machine, usually a driving wheel.

Buller shot — A second shot put in close to, and to do the work not done by a blown-out shot; loose powder is used.

Bully — A miner's hammer.

Bunkers — (1) Steam coal consumed on board ship. (2) Receptacles placed near a boiler for holding a supply of fuel.

Burden — Earth overlying a bed of useful mineral. (2) The proportion of ore and flux to fuel the charge of a blast furnace.

Burrell indicator — An instrument used in a mine that takes a sample of air and measures its contraction after the methane in it has been burned. This contraction is read on a scale and shows the percentage of methane present.

Bursts — Bounces, bumps or goths, with or without a copious discharge of methanes, coal dust or carbon dioxide. More usually called "outbursts."

Butt — (1) Coal surface exposed at right angles to the face; the "ends" of the coal. (2) The butt of a slate quarry is where the overlying rock comes in contact with an inclined stratum of slate rock.

Butt entry — An entry driven at right angles to the butt joints and parallel to the cleat. Frequently a room entry with rooms at right angles to cleat.

Butty — A partner in a contract for driving or mining; a comrade or crony. Sometimes called a buddy.

By-product oven — A coke oven arranged to conserve and recover the various by-products of the coking process.

By-products — Products of coking other than coke. The more common by-products are gas, tar, benzol and ammonium sulphate.

Cage — A frame with one or more platforms, used to hoist in a vertical shaft.

Cager — The person who puts the cars on the cages at the bottom of the mine shaft, or at intermediate landings. Also called a bottomer.

Cannel coal — A bituminous coal averaging about 50% volatile matter.

Cap — (1) A piece of plank placed on top of a prop. See also collar. (2) The pale bluish elongation of the flame of a lamp caused by the presence of gas.

Capstan — A vertical axle used for heavy hoisting, and worked by horizontal arms or bars.

Captive mine — One operated mainly or wholly to supply some industrial undertaking or undertakings of railroad, usually owned by the undertaking or railroad.

Car — A wheeled vehicle used for the conveyance of coal along the gangways or haulage roads of a mine.

Carbide — A compound of carbon with an earthy element such as calcium that decomposes with the addition of water and forms acetylene and an oxide of the earthy element.

Carbide lamp — A lamp that is charged with carbide and water and generates acetylene.

Carbon — A combustible elementary substance that forms the largest component part of coal.

Cartridge — Paper or waterproof cylindrical case filled with explosive, forming the charge for blasting.

Cauldron bottoms — The fossil remains or the "casts" of the trunks of sigillaria that have remained vertical above or below the seam.

Cave or **cave in** — A caving-in of the roof strata of a mine, sometimes extending to the surface.

Chain road — A pillar left to protect the gangway and aircourse and lying between these two passages.

Chain-runner — A person in charge of, and who accompanies, cars, trips or trains in mechanical haulage, and whose signals direct the hoisting engineer operator to start and stop the trip.

Chance washer — A washer in which coal is floated in a quicksand made of sand and water to separate it from its impurities. The coal is floated off at the top and the impurities are trapped off the bottom.

Check — A metal token used to identify which cars were loaded by which miner.

Check off — A system of deducting contributions from a miner's pay envelope for union dues, medical care, house rent, etc.

Check-weighman — A man appointed and paid by the miners to check the weighing of the coal at the surface and assign it to the individual miners responsible for mining it.

Chock — (1) A square pillar for supporting the roof, constructed of prop timber laid up in alternate cross-layers, in log-cabin style. The centre is filled with waste. (2) A wooden or other block used to prevent the movement of a car or other body. (3) To secure with chocks.

Choke damp — A loosely used term for carbon monoxide in the mine.

Chute, **shute** or **shoot** — (1) A narrow, inclined passage or a flat plate with sides, used in a mine for the passing of coal or ore by gravity or with the aid of bucking down to the loading point. (2) An inclined plate with the sides on a tipple for the loading of coal or ore. (3) An inclined passageway or shoofly between two parallel roadways.

Coal cutter — A machine for holing or undercutting coal.

Coal dust — Very finely powdered coal.

Coal face — The working face of a stall or room, composed wholly of coal.

Coal field — A region or locality containing coal deposits of economic value.

Coal hewer — A person who digs coal; a collier; a miner.

Coal measures — Strata of coal with the attendant rocks.

Coal-cutting machine — A machine worked by compressed air or electricity for undercutting coal.

Coffer dam — An enclosure built in the water and then pumped dry so as to permit masonry or other work to be carried on inside of it.

Coke — The fixed carbon and ash of coal sintered together.

Collier — Strictly speaking, one who mines coal with a pick.

Colliery — The whole coal mining plant, including the mine and all of its adjuncts.

Commercial mine — A mine operated for the purpose of supplying coal to purchasers in general, not a captive mine.

Company house — A house owned by the coal company and rented to a mine worker.

Company man — A worker who is paid by the day and not by the work performed, a datal man.

Compound ventilation — The system of dividing or splitting the air, and of ventilating the workings of a coal mine by giving to each district or panel a separate quantity of fresh air, and conveying the return air to a main air course directly from each panel.

Conglomerate — The rock strata lying right beneath a coal measure.

Consideration miner — A miner who is paid a consideration rate not based on the regular scale. This rate is fixed because of abnormal conditions.

Continuous miner — A coal cutting machine used for round the clock mining.

Conveyor-loader — A conveyor that, at its extremity, has a digging head that moves with the conveyor and works its way under the coal, which, by the unequal shaking of the conveyor, is carried back to the car. Also called a shaking-conveyor loader. (2) One who loads a conveyor.

Core drill — A diamond or other hollow drill for securing cores.

Cornish pumps — A single-acting pump, in which the motion is transmitted through a walking beam, similar to a bull pump.

Counterchute — A chute down which coal is dumped to a lower level or gangway.

Coupling or **coupler** — (1) Links, or links and a clevis, or other device, such as automatic couplers or swivel couplings, to connect or "couple" the drawbars of adjacent cars. Where one end of the drawbar terminates in a hook and at the other end has a hole forged in it, links suffice, but where both ends of the drawbar have holes, then links and a clevis are used. (2) A boy who couples or connects the cars of coal in order to form a trip or train.

Coursing or **coursing the air** — Conducting the air through different portions of a mine by means of doors, stoppings and brattices.

Creep — The upheaval of the floor or sagging of the roof of mine workings due to the weighting action of the roof and a tender floor.

Crib — (1) A structure composed of horizontal timbers laid on one another, or a frame work built like a log cabin. See chock. (2) A miner's luncheon. (3) See curb.

Crossbar — A horizontal timber held against the roof to support it, usually over a roadway.

Crosscut — (1) A tunnel driven through or across the measures from one seam to another. (2) A small passageway driven at right angles to the main gangway to connect it with a parallel gangway or air-course.

Cross-heading or **cross-gateway** — (1) A road kept through goaf and cutting off the gateway at right angles or diagonally. (2) A passage driven for ventilation from the airway to the gangway, or from one breast through the pillar to the adjoining working.

Cross-measure tunnel — A roadway or airway driven across pitching measures on, or nearly on, a level to reach the bed of coal or other mineral or to drain off water.

Crowbar — A strong iron bar with a slightly curved or flattened end.

Crush — A settling downward of the strata overlying a portion of an excavated coal seam.

Curb — (1) A timber frame intended as a support or foundation for the lining of a shaft. (2) The heavy frame or sill at the top of a shaft.

Curbing — The wooden lining of a shaft.

Curtain — A sheet of canvas or other material used to control or deflect an air current.

Cushion shot or **cushioned shot** — A shothole that is not tamped from the explosive to the mouth but has untamped length between the explosive and the tamping in which the gases formed by the explosion can expand and press on the coal or other mineral to be shot. Sometimes a spacer is inserted and sometimes a cartridge of untamped, finely ground rock dust. Sometimes the space is left beside or above the cartridge or both above and around it. Any of these spaces forms a cushion.

Cut — A groove excavated in the coal face in preparation for using an explosive.

Cutter — (1) Any coal-cutting or rock-cutting machine. (2) The men operating them, or the men engaged in underholing by pick or drill. (3) Crevices in the roof near the crop through which water leaks, making the roof weak and unstable.

Cutter bar — That part of the cutting machine that works its way into the coal carrying the cutter chain with its cutter bits.

Damp — Mine gases and gaseous mixtures are called damps. See also afterdamp, blackdamp, firedamp.

Davy — A safety lamp invented by Sir Humphrey Davy.

Day shift — The relay of men working in the daytime.

Dead — (1) Unproductive. (2) Unventilated. The air of a mine is said to be dead or heavy when it contains carbonic-acid gas or when the ventilation is sluggish.

Dead work — Exploratory or prospecting work that is not directly productive, such as brushing roof, lifting bottom, cleaning up falls or blowing rock.

Deep (English) — (1) "To the deep," toward the lower portion of a mine; the lower workings. (2) A passage driven downward in the measure being worked. The main deep is the principal or hoisting slope.

Deputy (English) — A man who fixes and withdraws the timber supporting the roof of a mine, and attends to the safety of the roof and sides, builds stoppings, puts up bratticing, and looks after the safety of the hewers, etc. (2) An underground official who sees to the general safety of a certain number of stalls or of a district, but does not set the timber himself, although he has to see that it is sufficiently and properly done.

Dip — (1) To slope downwards. (2) The inclination of strata with a horizontal plane. (3) The lower workings of a mine.

Dog — (1) An iron bar, spiked at the ends, with which timbers are held together or steadied. (2) A short heavy iron bar, used as a drag behind a car or trip of cars when ascending a slope to prevent their running back down the slope in case of an accident.

Dog hole — A little opening from one place in a mine to another, smaller than a breakthrough. Also monkey hole.

Domestic coal — Coal for use around the colliery, in miners' houses or for local sale. (2) Sized coal for use in houses. Much the same as house coal. (3) Coal used in country of origin; not for foreign consumption.

Door — A moveable frame or barrier of boards or other material, usually turning on hinges or pivots, by means of which a passageway may be opened or closed. Doors are placed in air passages of mines to prevent the ventilating current from taking a short cut to the upcast shaft, and to direct the current to the working face.

Door tender — One whose duty it is to open and close a mine door before and after a passage of a train of mine cars; a trapper.

Downcast — The opening through which fresh air is drawn or forced into the mine; the intake.

Draeger crew — Miners specially trained in rescue work, usually with self contained breathing apparatus, who maintain a stand-by situation in case of mining disasters.

Dragline — An excavating machine that uses a bucket operated and suspended by lines or cables, one of which lowers the bucket from the boom, the other (from which the name of the machine is derived), allows the bucket to swing out from the machine or to be dragged toward the machine to remove overburden above a coal seam.

Draw — (1) To "draw" the pillars after the breasts are exhausted. (2) An effect of creep upon the pillars of a mine. (3) The tension in the roof due to bending stresses, especially stresses in the upper measures over the unextracted or partly extracted coal. (4) The action of the roof at the surface of the ground above the pillar when coal has been extracted over an adjacent area. (5) The distance between the break over the pillar and a line perpendicular to the extracted material as drawn from the edge of the pillar.

Drawbar — A long bar on the bottom of a mine car that transmits the pull of the locomotive or draft animal to the axles of the car in which it lies and, through the couplings and other drawbars, to the other cars on the trip.

Drift — (1) A horizontal passage underground. A drift follows the vein, as opposed to a crosscut, which intersects it, or a level or gallery, which may do either. (2) In coal mining, a gangway above water level, driven from the surface in the seam. (3) Unstratified diluvium.

Driver — A person who drives a horse or mule in the mine.

Drum — The cylinder or pulley on which the winding ropes are coiled or wound.

Dump — (1) A pile or heap of ore, coal, culm, slate or rock. (2) The tipple by which the cars are dumped. (3) To unload a car by tipping it up. (4) The pile of mullock as discharged from a mine.

Dumper — A wheeled car carrying, on a platform, a turntable on which is a track. Mostly used for disposal of refuse on a rock or slate dump. A mine car run on the upper, horizontally revolving, track can be dumped sidewise or endwise at pleasure.

Endless chain — A system of haulage or pumping by the moving of an endless chain.

Endless rope — A system of haulage the same as endless chain, except that a wire rope is used instead of a chain; either on surface or underground roadways.

Engine plane — An incline up which loaded cars are drawn by a rope operated by an engine located at the top or bottom of the incline. The empty cars descend by gravity, pulling the rope after them.

Engineer — A geologist or mining technician of professional status, a supervisor of the technical operations of one or more mines. (2) The operator of a stationary hoisting or haulage engine, for which a certificate of qualification is required; at some mines, or group of associated mines, an official in charge of a specialized branch of the mine operation, e.g., the mechanical engineer, the electrical engineer.

Entry — The main entrance and travelling passage of a mine.

Examiner — An official who patrols a mine section to examine the workings for accumulation of gas and other hazards.

Exploitation — The working of mine and similar undertakings; the undertakings; the examination instituted for that purpose.

Face — (1) The place at which the material is actually being worked, either in a breast or heading in longwall. (2) To blast or wedge down coal.

Fast — (1) A road driven in a seam with the solid coal in each side. "Fast at an end," or "fast at one," implies that one side is solid coal and the other goaf or some previous excavation. (2) Bed rock.

Fault — A fracture or disturbance of the strata breaking the continuity of the formation.

Fire — (1) A miner's term for firedamp. (2) To blast with gunpowder or other explosive. (3) A word shouted by miners to warn one another when a shot is to be fired.

Fire boss — An underground official who examines the mine for gas and inspects safety lamps taken into the mine.

Fire clay — A geological formation, when found is usually immediately beneath a coal bed. It is heat resistant and easily processable qualities make it invaluable for use as fire brick in furnaces.

Firedamp — (1) A mixture of light carburetted hydrogen (CH_4) and air in explosive proportions; often applied to CH_4 alone or to any explosive mixture of gases.

Fissure — A separation of rock or coal across the seam.

Floor — (1) The stratum of rock upon which a seam of coal immediately lies. (2) That part of a mine upon which you can walk or upon which the road bed is laid.

Fluidized bed combustion — A process that removes sulphur from coal during combustion. Crushed coal and limestone are suspended in the combustion chamber in the bottom of a boiler by an upward stream of hot air. The coal is burned in this fluid-like mixture. Instead of being released as emissions, sulphur from combustion gases combines with the limestone to form a solid compound recovered with the ash.

Furnace — A large coal fire at or near the bottom an upcast shaft, for producing a current of air for ventilating the mine.

Furnace shaft — The upcast shaft in furnace ventilation.

Gallery — A horizontal passage.

Gangway — The main haulage road or level.

Gas — Any firedamp mixture in a mine is called gas. See firedamp

Gas coal — Bituminous coal containing a large percentage of volatile matter.

Gate — An underground road connecting a stall or breast with a main road.

Gateway — (1) A road kept through goaf in longwall working. (2) A gangway having ventilating doors.

Gather — (1) To assemble cars from the working faces for the formation of trips, trains or cars. (2) To bring trips from the working places to a parting, or side-track, where larger trips are formed and handled by a rope or large, main-line locomotive.

Geotechnical engineering — The branch of engineering that specializes in assessing the stability and strength of soil and rock materials, as well as groundwater conditions. Geotechnical engineering principles are used to determine the appropriate design of mine features such as pit walls, tunnels and earthen embankments.

Gib — (1) A short prop of timber by which coal is supported while being holed or undercut. (2) A piece of metal often used in the same hole with a wedge-shaped key for holding pieces together.

Gin — A vertical drum and framework by which the minerals and dirt are raised from a shallow pit. See horse gin.

Goaf, goave or **gob** — That part of a mine from which the coal has been worked away, and the space more or less filled up with waste.

Gob road — A roadway in a mine carried through the goaf.

Going headway or **going bord** — A headway or bord laid with rails and used for conveying the coal tubs to and from the face.

Haulage — The act or labour of hauling or drawing. The drawing or conveying, in cars or otherwise, of the produce of the mine from the place where it is mined to the place where it is to be hoisted, treated, used or stored.

Haulier — A boy or man who goes with a pony or horse in the mine, or who attends the trips upon engine planes, etc. A driver.

Head-frame — A structure of wood or steel erected over a shaft and supporting the sheaves by which cages or skips are lowered or raised in the shaft.

Head-gear — The pulley frame erected over a shaft.

Heading — (1) A continuous passage for air or for use as a manway; a gangway or entry. (2) A connecting passage between two rooms, breasts, or other working places.

Headways — (1) A road, usually 9 feet (2.7 m) wide, in a direction parallel to the main-cleavage planes of the coal seams, the direction of which is called "headways course." (2) Cross-headings.

Heave — The shifting of rocks, seams, or lodes on the face of cross-course, etc.

Hewer — A collier that cuts coal; a digger.

Hoist — An engine for raising coal from a mine and for lowering and raising men and material.

Hoister — A machine with winding drum and rope used to hoist the product. It may be operated by horse-power or steam-power.

Hole — (1) To undercut a seam of coal by hand or machine. (2) A bore hole. (3) To make a communication from one part of a mine to another.

Hopper — A coal pocket; a funnel-shaped feeding trough.

Horse gin — A gearing for winding horsepower.

Housing — A cover usually of sheet metal that is placed over the wheel of a car. It is set so low that the upper part of the wheel has to be passed through the car bottom.

Idler — (1) Sheave or pulley loose on the shaft to guide or support rope. (2) A spur wheel which merely transmits power from one spur wheel to another. It may, and usually does, change the relative speed of the two spur wheels thus connected.

Inbye — A term relative to position, meaning nearer to the coal face; the opposite of outbye. Sometimes used on the surface to mean that an individual is in the mine.

Incline — Short for inclined plane. Any inclined heading or slope road or track having a general inclination or grade in one direction.

Indicator — (1) A mechanical contrivance attached to winding, hauling or other machinery, that shows the position of the cages in the shaft or the cars on an incline on their journey or run. (2) An apparatus for showing the presence of firedamp in mines, the temperature of goaves, the speed of a ventilator, pressure of steam, water, etc.

Intake — A level carrying air to the coal face. The intake for one coal face may be the return for another.

Jacket — (1) An extra surface covering, as a steam jacket. (2) A water jacket is a furnace having double iron walls, between which water circulates.

Jackhammer — A hammer type of rock drill worked without a tripod and provided with an automatic rotating device.

Jugglers or **jugulars** — Timbers set obliquely against the rib in a breast, to form a triangular passage to be used as a manway, airway or chute.

Kerf — The undercut made to assist the breaking of the coal.

Kettle or **kettle bottom** — The petrified stump or the root of a tree or other fossil in the roof of a mine.

Knocker — A lever that strikes a plate of iron at the mouth of a shaft, by means of which miners below can signal those on top.

Ladderway or **ladder road** — The particular shaft, or compartment of a shaft, used for ladders.

Lagging — (1) Small round timbers, slabs or planks, driven in behind the legs and over the collar, to prevent pieces of the sides or roof from falling through. (2) Long pieces of timber closely fitted together and fastened to the drum rings to form a surface onto which the rope can wind.

Lamp — The apparatus carried by all personnel underground to give light.

Lamp men — Cleaners, repairers and those having charge of the safety lamps at a colliery.

Lamp station (cabin) — Certain fixed stations in a mine at which safety lamps are allowed to be opened and relighted by men appointed for that purpose or beyond which no naked light is allowed.

Landing — (1) A level stage for loading or unloading a cage or skip. (2) The top or bottom of a slope, shaft or inclined plane.

Large — The largest lumps of coal sent to the surface, or all coal that is hand picked or does not pass over screens; the large coal that passes over screens.

Larry — (1) A car to which an endless rope is attached, fixed at the inside end of the road, forming part of the appliance for taking up slack rope. (2) A car with a hopper bottom and adjustable chutes for feeding coke ovens.

Leg piece — An upright log placed against the side of a drive to support the cap piece.

Level — A road or gangway running parallel, or nearly so, to the strike of the seam, establishing a base from which other workings begin. For example, from a level, balances are driven off at right angles upwards into the coal, and from balances, bords are driven off at right angles to the coal. The coal from the bord is moved via the balance to the level, thence on the level to the mine bottom, and thence to the surface. Notwithstanding the name, a colliery level does not mean a passage excavated on a horizontal plane. A level is generally excavated in one or more slight inclines.

Lift — (1) The vertical height travelled by a cage in a shaft. (2) The lift of a pump is the theoretical height from the level of the water in the sump to the point of discharge. (3) The distance between the first level and the surface, or between two levels. (4) The levels of a shaft or slope.

Lifting guards — Fencing placed around the mouth of a shaft, which is lifted out of the way by the ascending cage.

Lignite — A coal of woody character containing about 66% carbon and having a brown streak.

Line brattice — A stopping set in the direction or line of an entry or crosscut to carry the air up one side of this working allowing it to return by the other side; a means of ventilating a dead end.

Loader — The man who loads coal at the working face after the coal has been shot down. He keeps the working place in order under the direction of a miner. Also one of the words used to define a miner, as in a shoot and load miner.

Long-pillar work — A system of working coal seams in three separate operations: (a) large pillars are left; (b) a number of parallel headings are driven through the block; and (c) the ribs or narrow pillars are worked away in both directions.

Longwall — A system of working a seam of coal in which the whole seam is taken out and no pillars are left, except the shaft pillars, and sometimes the main-road pillars.

Longwall advancing — Mining the coal outward from the shaft pillar and maintaining roadways through the worked-out portion of the mine.

Longwall cutter — A machine that forces the cutter bar forward laterally along the face, and not at right angles to the face.

Longwall retreating — First driving haulage road and airways to the boundary of a tract of coal and then mining it in a single face without pillars back toward the shaft.

Lump coal — (1) All coal (anthracite only) larger than broken coal, or, when steamboat coal is made, lumps larger than this. (2) In soft coal, all coal passing over the screen.

Machine helper — A man employed to assist in the operation of a coal-cutting machine, and whose duty it is to look after the jack and assist in moving and adjusting the machine.

Machine-runner — A man employed to operate a coal cutting machine, whose responsibility it is to undercut the coal in different rooms for the shooters and loaders to complete the mining process.

Main road — The principal haulage road of a mine from which the several crossroads lead to the working face.

Main rope — In tail-rope haulage, the rope that draws the loaded cars out.

Main-line locomotive — A large locomotive that hauls a long trip of cars over the main roads of the mine from a parting where the cars are assembled in small trips by gathering locomotives or mules.

Manager — An official who has the control and supervision of a mine, both under and above ground.

Manhole — (1) A refuge hole constructed in the side of a gangway, tunnel or slope. (2) A hole in boilers through which a man can get into a boiler to examine and repair it.

Manway — A small passage used as a travelling way for the miner, and also often used as an airway or chute, or both.

Match — (1) A charge of gunpowder put into a paper several inches long used for igniting explosives. (2) The touch and end of a squib.

Maundril — A pick with two shanks and points, used for getting coal, etc.

McGinty — Three sheaves over which a rope is passed so that it takes a course somewhat like that of the letter M. The resulting friction causes the rope to slide with difficulty. It is used for lowering loaded cars from the face to the mouth of a room on a steep roadway.

Measures — Strata.

Mine — Any excavation made for the extraction of minerals.

Mine run — The entire unscreened output of a mine.

Miner — One who mines. Technically, a workman engaged in extracting coal at the coal face, but generally used to describe anyone who works underground.

Mining engineer — A person having knowledge and experience in the many departments of mining.

Mining retreating — A process of mining by which the vein is untouched until after all the gangways, etc., are driven; the mineral extraction begins at the boundary and progresses toward the shaft.

Mobile radial rotary — A modern coal cutting machine.

Monkey — The hammer or ram of a pile driver.

Monkey drift — A small drift driven in for prospecting purposes, or a crosscut driven to an airway above the gangway.

Mouth — The top of a shaft or slope, or the entrance to a drift or tunnel.

Moyle — An iron with a sharp steel point, for driving into clefts when levering off rock.

Muck — (1) Any material, partially refuse, removed from a mine, shaft or slope. (2) To remove refuse.

Mucker — One who mucks or removes; a shoveller.

Muckle — Soft clay overlying or underlying coal.

Naked light — A candle or any form of lamp that is not a safety lamp.

Narrow work — (1) All work for which a price per yard driven is paid, and which, therefore, must be measured. (2) Headings, chutes, crosscuts, gangways, etc.

Natural ventilation — Ventilation of a mine without either furnace or artificial means; the heat imparted to the air by the strata, men, animals and lights in the mine, causing it to flow in one direction or to ascend.

Nicking — (1) A vertical cutting or shearing up one side of a face of coal. (2) The chipping of the coal along an entry or room, which is usually the first indication of a squeeze.

Night shift — The set of men that work during the night.

Nipper — An errand boy, particularly one who carries steel, bits, etc., to be sharpened.

Odd work — Work other than that done by contract, such as repairing roads, constructing stoppings, dams, etc.

Onsetter — The man who places cars on or takes them off the mine cage. See bottomer, cager.

Open cutting — (1) An excavation made on the surface for the purpose of getting a face wherein a tunnel can be driven. (2) Any surface excavation.

Opening — Any excavation of a coal or ore bed, or to reach the same; a mine.

Operator — The individual or company actually working a colliery.

Outburst — A blower. A sudden emission of large quantities of occluded gas.

Outbye — A word relative to position, meaning farther from the coal face; opposite of "inbye"; loosely used at times by men underground to signify the surface.

Outcrop — The portion of a vein or bed, or any stratum appearing at the surface, or occurring immediately below the soil or diluvial drift.

Outlet — A passage furnishing an outlet for air, for the miners, for water or for the mineral mined.

Output — The product of a mine sent to market, or the total product of a mine.

Out-take — The passage by which the ventilating current is taken out of the mine; the upcast.

Overburden — Layers of earth and rock covering a coal seam. In surface mining operations, overburden is removed using large equipment and is either used to backfill areas previously mined or is hauled to external dumping areas.

Over-cast — A passage through which the ventilating current is conveyed over a gangway or airway.

Overman — One who has charge of the workings in a section of a mine while the men are in the mine. He takes his orders from the underground manager.

Over-wind — To hoist the cage into or over the top of the head-frame.

Pack — A rough wall or block of coal or stone built up to support the roof.

Pack wall — A wall of stone or rubbish built on either side of a mine road, to carry the roof and keep the sides up.

Pan or **shaker pan** — A steel plate onto which coal is first loaded for conveyance to the levels.

Panel workings — A system of working coal seams in which the colliery is divided into two large squares or panels, isolated or surrounded by solid ribs of coal. In each panel, a separate set of breasts and pillars is worked, and the ventilation is kept distinct, that is, every panel has its own circulation, the air does not pass into the adjoining one, but is carried directly to the main return airway.

Parallel-throw switch — Switch level which is thrown parallel to the track of which the switch forms a part. Originally switch levers were thrown at right angles to the track and the person who threw the switch could lose his balance and fall in front of the trip.

Parting — (1) Any thin interstratified bed of earthy material. (2) A side track or turnout in a haulage road.

Pass — (1) A convenient hole for throwing down ore to a lower level. (2) A passage left in old workings for workers to travel in from one level to another.

Pass-by — A siding in which cars pass one another underground; a turnout.

Pavement — The floor.

Peat — The decomposed partly carbonized organic matter of bogs, swamps, etc.

Pentice — A few pieces of timber, laid as a roof over worker's heads, to screen them when working in dangerous places, such as at the bottoms of shafts.

Pick — (1) A tool for cutting and holing coal. (2) To dress the sides or face of an excavation with a pick.

Picker — (1) A small tool used pull up the wick of a miner's lamp. (2) A person who picks the slate from the coal in a coal breaker or tipple.

Picking belt — A travelling belt made of sheet iron placed horizontally or at an angle, used for conveying coal to a bin or wagon, while boys pick out rock or other waste material.

Piece-can — A miner's lunch can, usually made from sheet metal, with a tea can made from the same material.

Piece-work — Labour compensated by the quantity of work preformed (as, for instance, tons loaded) and not by the day or hour.

Pig — A piece of lead or iron cast into a long rough mould.

Piling — Long pieces of timber driven into soft ground for the purpose of securing a solid base on which to build a superstructure. Sheet piling consists of planks or steel shapes driven into the ground to prevent the influx of water, quicksand and the like.

Pillar — (1) A solid block of coal, etc., varying in area from a few square yards to several acres. (2) Sometimes applied to a timber support.

Piped air — Air carried into the workplace by pipes or brattices.

Pit — (1) A shaft. (2) The underground portion of a colliery, including all workings. (3) A gravel pit.

Pit bank — The raised ground or platform where the coal is stored and screened at the surface.

Pit headman — The man who has charge at the top of the slope.

Pit prop — A piece of timber used as temporary support for the roof.

Pit rails — Mine rails for underground roads.

Pit top — The mouth of a slope or shaft.

Pit-bottom — The portion of a mine immediately around the bottom of a shaft or slope.

Pitch — (1) Rise of a seam. (2) Grade of an incline. (3) Inclination.

Pitman — A miner; also, one who looks after the pumps, etc.

Place — The portion of coal face allotted to a hewer is spoken of as his "working" place or simply "place."

Plan — (1) The system on which a colliery is worked such as longwall or bord and pillar. (2) A map or plan of the colliery showing outside improvements and underground workings. (3) (Mexican) The very lowest working in a mine. To work to gain depth.

Plane — A main road, either level or inclined, along which coal is conveyed by engine power or gravity.

Plank tubbing — Shaft lining of planks driven down vertically behind wooden cribs all around the shaft. Holes are bored through the slabs near the leakage point and plugs of clay forced into them until the leakage is stopped.

Pluck-me — The nickname for the company store — which evolved because of the tendency to overcharge.

Pneumatic table — A table like a concentrating table for cleaning coal. Instead of water, jets of air pass through the table, lifting the coal over corrugations. The slate, being heavy, is not lifted as much as the coal and passes down riffles being removed from another part of the table.

Pocket — (1) A thickening out of a seam of coal or other mineral over a small area. (2) A hopper-shaped receptacle from which coal or ore is loaded into cars or boats.

Pole tools — Drilling tools used in drilling in the old fashion, with rods. Now superseded by the rope-drilling method.

Pop shot — A shot in a shallow hole in which only a small amount of explosive is used. Such pop shots are used to snub the kerf of an undercut face so as to taper the undercut and thus to cause the coal when shot too heavily to roll over and leave the face. Also block hole.

Pot bottom — A large boulder in the roof slate, having the appearance of the rounded bottom of a pot, which easily becomes detached.

Pot hole — A circular hole in the rock caused by the action of stones whirled around by the water when the strata was covered by water. They are generally filled with sand and drift.

Powder — Explosive chemical in powder form used at the coal face to blast coal.

Power drill — A rock drill employing steam, air or electricity as a motor.

Pricker — (1) A thin brass rod for making a hole in the stemming when blasting, for the insertion of a fuse. (2) A piece of bent wire by which the size of the flame in a safety lamp is regulated without removing the top of the lamp.

Projection — A plan showing the proposed direction and location of entries, rooms, shafts, fans and water courses. Such projections frequently cover the entire property to be worked by any mine and all completed work, though the latter is not strictly projection.

Prop — A timber set upright or at right angles to the dip, to support the mine roof.

Propping — The timbering of a mine.

Prospect hole — Any shaft or drift hole put down for the purpose of prospecting the ground.

Prospect tunnel or **entry** — A tunnel or entry driven through barren or a fault to ascertain the character of strata beyond.

Prospector — One engaged in searching for minerals.

Protector lamp — A safety lamp whose flame cannot be exposed to the outside atmosphere, since the action of exposing the lamp extinguishes the light.

Prove — (1) To ascertain, by boring, driving, etc., the position and character of a coal seam, a fault, etc. (2) To examine a mine in search of firedamp, etc., known as "proving the pit."

Proving hole — (1) A bore hole driven for prospecting purposes. (2) A small heading driven in to find a bed or vein lost by a dislocation of the strata, or to prove the quality of the mineral in advance of the other workings.

Pump-man — A workman who maintains and supervises the operation of a pump.

Pump-way — The compartment of a shaft or slope down which pump rods and pipes extend; also called a pump slope and pump shaft.

Puncher, pneumelectric puncher or **punching machine** — An undercutting machine, driven by air, that causes a pick to reciprocate and strike the coal in a series of blows. The machine is guided by a man sitting on an inclined board with a foot on each side of the machine guiding the wheels on which the machine runs.

Pusher — A person regularly employed to push mine cars from one place to another. He usually assists the diggers to push cars up into steep rooms. See putter.

Putter — A man or boy who conveys coal from the working place to the roadway. Same as haulier and drawer.

Rafter timbering — That in which the timbers appear like roof rafters.

Rake — A trip of travelling boxes that carry the men into and out of the mines.

Rap — The signal given to the engineer to haul the men or coal to the surface.

Rapper — A level with a hammer attached at one end, that signals by striking a plate of metal, when the signalling wire to which it is attached is pulled.

Reel locomotive — A trolley locomotive with a wire rope reel for drawing cars out of rooms. The rope end is pulled by a runner into the face of the room, attached to a car and reeled out by the locomotive.

Refuge chamber — A chamber shut off from the rest of the mine, stored with food, and supplies, to be used by the survivors in case of a mining disaster.

Refuge hole — A place formed in the side of an underground passage in which a man can take refuge during the passing of a train, or when shots are fired.

Regulator — A door in a mine, the opening or shutting of which regulates the supply of ventilation to a district of the mine.

Rescue and recovery — The work of recovering live men or dead bodies after a mine disaster; also putting the mine in shape again.

Retarding conveyor — A conveyor that is actuated by the weight of the coal or other material fed to it, its motion is retarded by a mechanical or electrical brake.

Return — The air-course along which the vitiated air of a mine is returned or conducted back to the upcast shaft.

Return air — The air that has passed through the workings.

Rib — (1) The side of a pillar. (2) Pillar adjacent to a roadway or room.

Riddle — (1) An oblong frame holding iron bars parallel to each other, used for sifting material that is thrown against it. (2) A hand operated sieve.

Ride or **riding** — To be conveyed on a cage or mine car.

Rider — (1) A guide frame for steadying a sinking bucket. (2) Boys that ride on trips on mechanical haulage roads. (3) A thin seam of coal overlying a thicker one.

Ring — (1) A complete circle of tubbing plates placed round a circular shaft. (2) Troughs placed in shafts to catch the falling water, so arranged as to convey it to a certain point.

Ripping — Removing stone from its natural position above the seam.

Rise — The inclination of the strata, when looking up the pitch.

Rise workings — Underground workings carried on to the rise or high side of the shaft.

Road — (1) Any underground passageway or gallery. (2) The iron rails, etc., of underground roads.

Roadman — A person whose duty it is to keep the roads of a mine in order.

Rob — To cut away or reduce the size of pillars of coal.

Robbing — The taking of minerals from pillars.

Rock fault — A replacement of a coal seam by some other rock, usually sandstone.

Roller — A small steel, iron or wooden wheel or cylinder upon which the hauling rope is carried just above the floor.

Rollerman — A workman who lubricates and maintains the rollers and pulleys over and through which haulage cables pass.

Rolls — Cast-iron cylinders, either plain or fitted with steel teeth, used to break coal and other materials into various sizes.

Roof — The top of any subterranean passage.

Room — Synonymous with breast.

Rope — A cord wound on the winding drum of a hoist, and running down a slope or shaft, or along a haulage way, to apply motive power to a cage or trip; also used in balances. At one time, as the name implies, it was made from hemp. When the GMA began mining coal some early patterns on vertical hoists were made from square-link chain; hemp was in use for years and was gradually replaced by steel cable.

Rope driver — A person who looks after the rope and the equipment of the train of cars drawing coal from the mine, and supervises the movement of cars.

Rope haulage — Any haulage system in which the cars are attached to ropes.

Rope rider — An employee whose duty it is to see that cars are coupled properly, and to inspect ropes, chains, links and all coupling equipment. A trip rider.

Rope-and-button conveyor — A conveyor consisting of a rope with discs or "buttons" attached at intervals, the upper flight running in a trough. The coal or other material is dropped into the trough, and the conveyor is actuated by the weight of the coal in the trough when the trough is inclined, forming a retarding conveyor, or moves the coal along the trough where the gradient is insufficient or adverse. In the one case a brake is provided, and in the other the sprockets are actuated by a motor.

Round coal — Coal in large lumps, either hand-picked, or, with the small lamps removed after the coal has passed over screens.

Royalty — The price paid per ton to the owner of mineral land by the lessee.

Run coal — Soft, bituminous coal.

Runner — A man or boy who goes with a train of cars in mechanical haulage; a man or boy who runs the loaded cars by gravity from the face of a room or chamber to the haulage road, controlling the speed by means of a brake or sprags; a man or boy who pushes tubs to and from the bords.

Running lift — A sinking set of pumps constructed to lengthen or shorten at will, by means of a sliding or telescoping wind bore.

Safety cage — A cage fitted with an apparatus for arresting its motion in the shaft in case the rope breaks.

Safety catches — Appliances fitted to cages to make them safety cages.

Safety door — A strongly constructed door, hinged to the roof, and always kept open and hung near the main door, for use when the main door is damaged by an explosion or otherwise.

Safety lamp — (1) A miner's lamp in which the flame is protected in such a manner that an explosive mixture of air and firedamp can be detected by the mixture burning inside the gauze. (2) An electric cap or hand lamp which will not ignite gas even when broken.

Sample — A representative specimen of coal from a much larger amount — a carload, shipload or face of a room.

Sampler — (1) An instrument or apparatus for taking samples. (2) One whose duty it is to select the samples for an assay or analysis, or to prepare the mineral to be tested, by grinding and sampling.

Scab — A man who works at a mine contrary to union orders or during a strike.

Scale — (1) A small portion of the ventilating current in a mine passing through a certain size of aperture. (2) The rate of wages to be paid, which varies under certain contingencies. (3) A weighing apparatus. (4) Encrustation on the inside of a boiler.

Scallop — To hew coal without kirving or nicking or shot firing.

Scoop — A large shovel with a scoop-shaped blade.

Scraper — (1) A tool for cleaning the dust out of the bore hole. (2) A mechanical contrivance used at collieries to scrape the culm or slack floor of a mine by a hoist so as to gather up coal shot from the face or rib and bring it to a chute from which it drops to a car.

Scrapping bottom coal — Lifting coal that has been left by an undercutting machine.

Screen — (1) A sieve of wire cloth, grate-bars or perforated sheet-iron used to sort coal according to size. (2) A cloth brattice or curtain hung across a road in a mine to direct the ventilation.

Scrubber — Any of several forms of chemical/physical devices that remove sulphur compounds formed as a result of fossil-fuel combustion. These devices normally combine the sulphur in gaseous emissions with another chemical to form inert compounds that can then be removed for disposal

Sealing — Shutting off all air from a mine or part of a mine by stoppings.

Seam — Synonymous with a bed or vein, etc.

Second outlet or **second opening** — A passageway out of a mine, for use in case of damage to the main outlet.

Second working — The operation of getting or working out the pillars formed by the first working.

Section — (1) A vertical or horizontal exposure of strata. (2) A drawing or sketch representing the rock strata as cut by a vertical or a horizontal plane.

Self-acting plane — An inclined plane upon which the weight or force of gravity acting on the full cars is sufficient to overcome the resistance of the empties; in other words, the full car, running down, pulls the other car up.

Separation doors — The main doors at or near the shaft or slope bottom, which separate the intake from the return airways.

Separation valve — A massive cast-iron plate suspended from the roof of a return airway through which all the return air of a separate district flows, allowing the air to always flow past or underneath it. In the event of an explosion of gas, the force of the blast closes it against its frame or seating, and it prevents a communication with other districts. Once the blast is over, the weight of the valve allows it to return to its normal position.

Set — To fix in place a prop or sprag.

Set of timber — The timbers that compose any framing, whether used in a shaft, slope, level or gangway. Thus, the four pieces forming a single course in the curbing of a shaft, or the three or four pieces forming the legs and collar, and sometimes the sill of an entry framing are together called a set of timber, or timber set.

Shaft — A vertical or highly inclined pit or hole made through strata, through which the ventilation is passed either into or out of the mine. A shaft sunk from one seam to another is called a "blind shaft."

Shaft pillar — Solid material left unworked beneath buildings and around the shaft, to support them against subsidence.

Shaftman — A workman who patrols a mine shaft in a slowly moving cage, and maintains the shaft by working through the cage side, or on its top, or suspended from the cage bottom.

Shaking conveyer — A broad trough that is thrust rapidly inby (away from the dump) so as to slide under the coal and slowly outby (toward the dump) so as to carry the coal toward the dumping point.

Shaking screen or **shaker** — A flat screen, often inclined, which uses an oscillatory motion to size coal.

Shaking-conveyer loader — The broad tapering shovel-like end of a shaking conveyer that is thrust suddenly under the coal and slowly withdrawn so as to carry the coal that has been lifted toward the dumping point.

Shale — (1) Strictly speaking, all argillaceous strata that split up or peel off in thin laminae. (2) A laminated and stratified sedimentary deposit of clay, often impregnated with bituminous matter.

Shank — The body portion of any tool, up from its cutting edge or bit.

Shearer — A rotating cutting device used in underground mining to remove coal from the coal seam

Shearing — Cutting a vertical groove in a coal face or breast. The cutting of a "fast end" of coal.

Shearing machine — Mechanism for making a vertical kerf in the coal to facilitate shooting or make it unnecessary to use an explosive.

Sheave — A wheel with a grooved circumference over which a rope is passed either for the transmission of power or for winding or hauling.

Sheets — Coarse cloth curtains or screens for directing the ventilating current underground.

Shift — (1) The number of hours worked without change. (2) A gang or force of workmen employed at one time for any work, as in the day shift or the night shift.

Shiftman — A man engaged on a time-wage basis at various jobs. Also called a company or datal man.

Shoe — (1) A steel or iron guide fixed to the ends or sides of cages to fit or run on the conductors. (2) The lower capping of any post or pile, to protect its end while driving. (3) A wooden or sheet-iron frame or muff arranged at the bottom of a shaft while sinking through quicksand to prevent the inflow of sand while inserting the shaft lining. (4) A curved piece of metal or wood that fits over a part of the circumference of a wheel and is pressed thereon with pressure to create friction and retard or stop the revolution of a wheel. (5) A piece of angle iron on which, on a steep grade, the wheels on one side of a car are caused to mount. The angle iron slides along the rail and by its friction retards the movement of the car or trip to which the car is attached.

Shoofly — A short gang or inclined crosscut between two other gangways at an easy angle to both, to facilitate cars in passing from one gangway to the other. See chute.

Shoot — To break rock or coal using explosives.

Shooting — Blasting in a mine.

Shore up — To stay, prop up or support by braces.

Shortwall — The reverse of longwall, frequently used to mean the face of a room.

Shortwall cutter or **machine** — A machine that can cut its way into the face of the coal and then can be drawn across the face to cut the coal, like a longwall machine.

Shot — (1) A charge or blast. (2) The firing of a blast. (3) Injured by a blast.

Shot hole — The bore hole in which an explosive substance is placed for blasting.

Shot lighter or **shot firer** — A man specially appointed by the manager of the mine to fire off every shot in a certain district if, after he has examined the immediate neighbourhood of the shot, he finds it free of gas, and otherwise safe.

Shutter — (1) A movable sliding door, fitted within the outer casing of a guibal or other closed fan, for regulating the size of the opening from the fan, to suit the ventilation and secure economical working of the machine. (2) A slide covering the opening in a door or brattice, and forming a regulator for the proportionate division of the air current between two or more districts of a mine.

Side — (1) The more or less vertical face or wall of coal or goaf forming one side of an underground working place. (2) Rib. (3) A district.

Side chain — A chain hooked on to the sides of cars running on an incline or along a gangway, to keep the cars together in case the coupling breaks.

Siding — A short piece of track, parallel to the main track, to serve as a passing over.

Sill — The floor piece of a timber set, or that on which the track rests; the base of a framing structure. (2) The floor of a seam.

Single-entry system — A system of opening a mine by driving a single entry only, in place of a pair of entries. The air current returns along the face of the rooms, which must be kept open.

Single-rope haulage — A system of underground haulage in which a single rope is used; the empty trip runs by gravity, which is engine-plane haulage.

Sink — To excavate a shaft or slope; to bore or put down a bore-hole.

Sinker — A man who works at the bottom of a shaft or face of a slope during the course of sinking.

Sinker bar — In rope drilling, a heavy bar attached above the jars, to give force to the up stroke, so as to dislodge the bit in the hole.

Sinking — (1) The process of excavating a shaft or slope or boring a hole. (2) A passage driven on an incline down to coal workings in lower depths, comparable to an inside slope.

Sizing — To sort minerals into sizes.

Skip — A sled with runners used to transport coal underground.

Slack — (1) Fine coal that will pass through the smallest sized screen. The fine coal and dust resulting from the handling of coal, and the disintegration of soft coal. (2) The process by which lignite disintegrates when exposed to the air and weather.

Slant — (1) An underground roadway driven at an angle between the full rise or dip of the seam and the strike or level. (2) Any inclined road in a seam.

Slate — (1) A hardened clay having a peculiar cleavage. (2) About coal mines, slate is any shale accompanying the coal; also sometimes applied to bony coal.

Slate picker — (1) A man or boy who picks the slate or bone from coal. (2) A mechanical contrivance for separating slate and coal.

Sled — A drag used to convey coal along the face to the road head where it is loaded, or to the chute.

Sliding scale — A mode of regulating the wages of working men by taking, as a basis for calculation, the market price of coal; the wages rise and fall with the state of the trade.

Slip — (1) A fault. (2) A smooth joint or crack where the strata have moved upon each other.

Slope — A plane or inclined roadway, usually driven in the seam from the surface. A rock slope is a slope driven across the strata, to connect two seams; or a slope opening driven from the surface, to reach a seam below that does not outcrop at an accessible point.

Slopeman — A working man who patrols and keeps in repair the mine's main and back slopes.

Socket — (1) The innermost end of a shot hole, not blown away after firing. (2) A wrought-iron contrivance by means of which a wire rope is securely attached to a chain or block.

Sollar — (1) A wooden platform fixed in a shaft, for the ladders to rest on. (2) A division of the air compartment in a drift or slope. (3) A shovelling platform in a shallow shaft or vertical prospect hold to assist the removal of earth or rock by providing one or more intermediate places to and from which the material may be thrown.

Sounding — (1) Knocking on a roof to see whether it is sound or safe to work under. (2) Rapping on a pillar to communicate with the person on the other side, or to enable a miner to estimate its width.

Spacer — A piece of metal wire twisted at each end to form, at one end a guard to keep the explosive in the shothole in place, and at the other end another guard to hole the tamping in its place, thus providing an open space between explosive and tamping. When this is provided, the charge constitutes a cushion shot.

Spent shot — A blast hole that has been fired, but has not done its work.

Spiral — A spiral coal chute which mechanically separates the slate from the coal.

Split — (1) To divide an air current into two or more separate currents. (2) Any division or branch of the ventilating current. (3) The workings ventilated by that branch. (4) Any measure of a coal bed split by thick partings into two or more seams. (5) A bench separated by a considerable interval from the other benches of a coal bed.

Spoil — All the debris taken out of a coal mine.

Spout — A short underground passage connecting a main road with an air-course.

Sprag — (1) A short wooden prop set in a slanting position for keeping up the coal during the operation of holing. (2) A short round piece of hard-wood, pointed at both ends, that acts as a break when placed between the spokes of mine-car wheels. (3) The horizontal member of a square set of timber running longitudinally with the deposit.

Sprag road — A mine road having such a sharp grade that sprags are needed to control the speed of cars.

Spragger — One who travels with the trip of cars to attend to sprags and switches.

Squealer — A shot that breaks the coal only enough to allow the gases of detonation to escape with a whistling or squealing sound. Also called a whistler.

Squib — A straw, rush, paper or quill tube, filled with a priming of gunpowder, with a slow match on one end.

Stableman — A workman who cares for the horses and maintains the stables underground. On non-working days, the stableman is responsible for watering and feeding horses, and for cleaning the stables; on working days he ensures that the horses are watered and fed either by the drivers themselves or himself, depending on the work schedule and where the horse may be working that day.

Stage — A platform on which mine cars stand.

Stage pumping — Draining a mine using two or more pumps placed at different levels, each of which raises the water to the next pump above, or to the surface.

Staging — A temporary flooring, or scaffold or platform.

Stall — A narrow breast or chamber for working the coal.

Stall gate — A road along which the mineral worked in a stall is conveyed to the main road.

Starter — A man or boy who ascends a chute to the battery and starts the coal running.

Station — A flat or convenient resting place in a shaft or level.

Steam coal — A hard, free-burning, non-caking coal.

Stint — The amount of work to be done by a man in a specified time.

Stitch — To fasten a timber by toe nailing.

Stobb — A long steel wedge used to bring down coal after it has been holed.

Stomp — A short wooden plug fixed in the roof of a level to serve as a bench mark for surveys.

Stop — Any cleat or beam to check the descent of a cage car, pump rods, etc.

Stope — (1) To excavate mineral in a series of steps. (2) A place in a mine that is worked by stoping.

Stoping — A door or barrier used to baffle air to control its flow.

Storekeeper — A semi-clerical employee who supervises a colliery's storeroom of tools and equipment, and who issues tools or equipment, upon authorization.

Stow — To pack away rubbish into goaves or old workings.

Stowing — The debris of a vein thrown back of a miner and which supports the roof or hanging wall of the excavation.

Straight work — A system of getting coal by headings or narrow work.

Strike (of a seam or vein) — The intersection of an inclined seam or a vein with a horizontal plane. A level course in the seam. The direction of strike is always at right angles to the direction of the dip of the seam.

Strip — (1) To remove the overlying strata of a bed or vein. (2) Mining a deposit by first taking off the overlying material.

Stump — The pillar between the gangway and each room turned off the gang-way. Sometimes the entry pillars are called stumps.

Submarine mines — Workings that follow the mineral under the sea.

Surface deposits — Those that are exposed and can be mined from the surface.

Swab-stick — A short wooden rod, bruised into a kind of stumpy brush at one end, for cleaning out a drill hole.

Switch — (1) The movable tongue or rail by which a train is diverted from one track to another. (2) The junction of two tracks. (3) An apparatus for changing the course of or interrupting an electrical current.

Swivel coupling — A coupling where one link is made so that it can be rotated independently of other links. When such a coupling is used, one or more cars can be rotated on a revolving dump without uncoupling it or them from the rest of the trip.

Tail-rope haulage — A system of rope haulage by which the full cars, with the tail rope attached behind, are drawn by a main rope passing over a drum, and the empty hutches, with the main rope attached, are drawn back again by the tail rope passing over another drum.

Tally — A mark or number placed by the miner on every car of coal sent out of his place, usually a tin ticket. By counting these, a tally is made of all the cars of coal he sends out.

Tamp — To fill a bore hole, after inserting the charge, with some substance which is rammed into the hole. Vertical holes are often tamped with water, when blasting with dynamite.

Tap — (1) To cut or bore into old workings, for the purpose of liberating accumulations of gas or water. (2) To pierce or open any gas or water feeder. (3) To win coal from a new district.

Timber — (1) Props, bars, collars, legs, laggings, etc. (2) To set in place timber in a mine or shaft.

Timberman — A man who sets timber.

Tipper, tipple or **tippler** — An apparatus for emptying cars of coal or ore, by tipping or turning them upside down and then bringing them back to the original position with a minimum of manual labour.

Tipple — The dump trestle and tracks at the mouth of a shaft or slope, where the output of a mine is dumped, screened and loaded.

Token — A piece of leather or metal stamped with the hewer's or putter's number or distinctive mark, and fastened to the car he is filling or putting.

Ton — A measure of weight. Long ton = 2 240 lbs.; short ton = 2 000 lb; Metric tonne is 1 000 kilograms (2 204.6 lbs).

Trackman — A workman who keeps mine track in repair.

Train boy — A boy who rides on a trip, to attend to rope attachments, signal in case of derailment of cars, etc. Also a trip rider.

Trap — A door for cutting off a ventilating current, which is occasionally opened for haulage or passage; opened by a trapper, doors close by their own weight.

Trapper or **trapper boy** — A boy stationed at an underground door to open and close it when boxes pass and thus control the air current.

Travelling way — A passageway for men and horses in or into a mine.

Trimmer — One who arranges coal in the hold of a vessel (collier, ship) as the coal is discharged into it from shore.

Trip — A train of mine cars.

Trip rider — A labourer accompanying a train of mine cars.

Triple entry system — A system of opening a mine by driving three parallel entries for the main entries.

Trough fault — A wedge-shaped fault, or more correctly, a mass of rock, coal, etc., let down between two faults, not necessarily of equal throw.

Tub — A mine car used in a shaft for hoisting material.

Tubbing — Cast-iron, and sometimes timber, lining or walling of a circular shaft.

Turn — (1) The hours during which coal, etc., is being raised from the mine. (2) To open rooms, headings or chutes off from an entry or gangway. (3) The number of cars allowed each miner during a shift.

Undercut — To undermine, to hole or to mine. To cut below in the lower part of a coal bed by chipping away the coal with a pick or mining machine. It is usually done on the level of the floor of the mine, extending laterally the entire face and five or six feet into the material.

Underhand work — Picking or drilling downward.

Underholing or **undermining** — To mine out a portion of the bottom of a seam or the underclay, by pick or powder, thus leaving the bottom unsupported and ready to be blown down by shots, broken down by wedges, or mined with a pick or bar.

Unit train — A train, typically consisting of 100 to 110 cars, that is dedicated to the transport of a single commodity such as coal.

Upcast — The passages from and in a mine from which air leaves the mine.

Upthrow — A fault in which the displacement has been upward.

Ventilation — Circulation. The atmospheric air circulating in a mine.

Wagon breast — A breast in which the mine cars are taken up to the working face.

Wall — (1) The face of a longwall working or breast. (2) The rib of solid coal between two breasts. (3) A crosscut driven between bords.

Warning lamp — A safety lamp fitted with certain delicate apparatus for indicating very small proportions of firedamp in the atmosphere of a mine. As small a quantity as 3% can be determined by this means.

Washing apparatus or **washery** — (1) Machinery and appliances erected on the surface of a colliery, often in connection with coke ovens, for extracting, by washing with water, the impurities mixed with the coal dust or small slack. (2) Machinery for removing impurities from small sizes of anthracite coal.

Waste — (1) Very small coal or slack. (2) The portion of a mine occupied by the return airways. (3) Also used to denote the spaces between the pack walls in the gob of longwall working.

Water level — An underground passage or heading driven very nearly dead level or with sufficient grade only to drain off the water.

Wedging — The material, moss or wood used to render the shaft lining tight.

Wedging down — Breaking down the coal at the face with hammers and wedges instead of blasting.

Wheeler — A lad who drives horses, drawing skips to and from working places and the nearest collecting station.

Whim — A winding drum worked by a horse.

Whim shaft — A shaft through which coal, ore, water, etc., are raised from a mine by means of a whim.

White damp — Carbonic oxide (CO); a gas found in coal mines, generally where ventilation is poor. A product of slow combustion in a limited supply of air. It burns and will support combustion and is extremely poisonous.

Whole working — The first working of a seam that divides it into pillars.

Win — To sink a shaft or slope, or drive a drift to a workable seam of mineral in such a manner as to permit its being successfully worked.

Winch or **windlass** — A hoisting machine consisting of a horizontal drum operated by crank-arm and manual labour.

Winding — The operation of raising or hauling the product of a mine by means of engine and ropes.

Winding engines — Hoisting or haulage engines.

Winning — A sinking shaft, a new coal, ironstone, clay, shale or other mine of stratified material. A working place in a mine.

Workings — The colloquial term for an excavation of a mine as a whole, or that part of a mine in which mining operations are being done.

Yield — The proportion of a seam sent to market.

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