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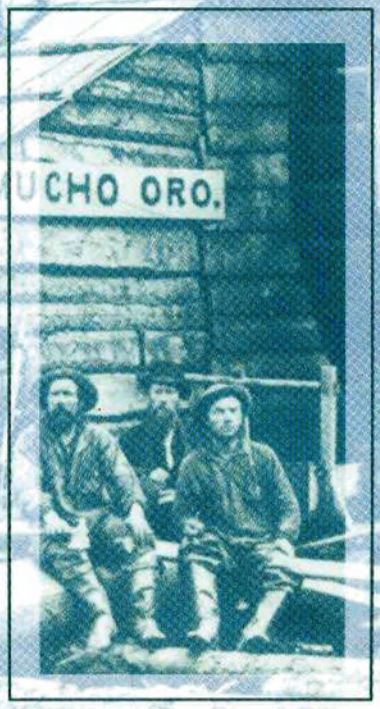

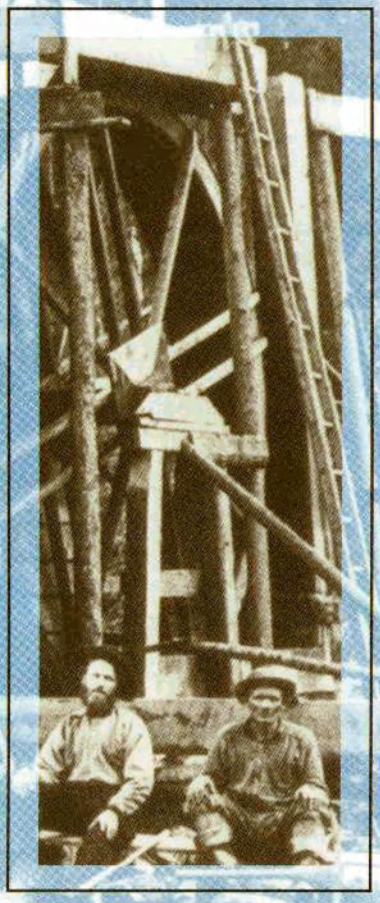

Jeremy Mouat

Canada

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Metal Mining in Canada, 1840–1950

Jeremy Mouat

National Museum of Science and Technology
Musée national des sciences et de la technologie
Ottawa, Canada
2000

Canadian Cataloguing in Publication Data

Mouat, Jeremy, 1950–
Metal Mining in Canada, 1840–1950

(Transformation series = Collection transformation,
ISSN 1188-2964 ; 9)
Includes bibliographical references and index.
Includes foreword, abstract and acknowledgements in French.
ISBN 0-660-17987-3

1. Mineral industries–Canada–History–19th century.
2. Mineral industries–Canada–History–20th century.
I. Title. II. Series: Transformation series (Ottawa, Ont.) ; 9.

HD9506.C32M68 2000 338.2'0971 C00-900109-3

Contents/Table des matières

Abstract

This historical assessment of the Canadian base and precious metals mining industry covers the years 1840 to 1950 and emphasizes the changes in technology that occurred throughout that time. The chapters identify three broad time periods, as follows:

1) 1840–1880—a period of early mining
2) 1880–1918—a period of general expansion and growth
3) 1918–1950—a period of consolidation

The Introduction offers a rationale for this periodization, while subsequent chapters explore each period in greater detail. The second and third chapter examine the earliest period; the gold rushes—especially the gold rush to the region that was to become British Columbia—are the subject of Chapter Two, and the copper and silver mines of central Canada are the central focus of Chapter Three.

While pioneer activity in both western and central Canada was significant, the years 1880–1918, described in the fourth chapter, were those which saw the emergence of a mature mining industry. Thus this chapter is the most detailed, and charts not only the growth in mining and the greater technological sophistication which accompanied this growth, but also the establishment of mining engineering schools and other concomitants of modern industry. The outstanding feature of this period was the shift from the selective extraction of high-grade ore to bulk mining methods that relied on greater mechanization and economies of scale. This shift meant mining companies required far more initial capital, and tended to become not only larger but also more complex organizations. Instead of relying on one particularly rich mining property, companies tended to run a stable of properties as well as vertically integrating the operation of their own smelters, refineries, and so on.

The fifth chapter describes the industry during the third period, one marked by fluctuations caused by depression and war. In many ways, however, mining in this period continued to develop along the lines established during the first years of the twentieth century. The Conclusion offers a brief summary of mining's growth and provides a graphic depiction of that growth since the 1880s. The global interests of Canadian mining companies and recent developments at home—the start-up of North America's first diamond mine, the discovery of the Voisey's Bay nickel deposit—suggest the industry's continuing importance and highlight the complex role that technology has played in its growth.

Résumé

Ce compte rendu historique donne une description de l'industrie canadienne de l'extraction des métaux de base et des métaux précieux. Il porte sur les années 1840 à 1950 et met l'accent sur les changements techniques qui se sont produits dans cet intervalle. Les chapitres délimitent trois grandes périodes :

1) 1840-1880, période d'exploitation préliminaire
2) 1880-1918, période d'expansion et de croissance générales
3) 1918-1950, période de consolidation

Le premier chapitre présente une justification de cette classification en périodes, examinées en détail dans les chapitres subséquents. Les deuxième et troisième chapitres examinent la première période. Les ruées vers l'or, en particulier la ruée dans la région qui est devenue la Colombie-Britannique, forment le sujet du deuxième chapitre, alors que les mines de cuivre et d'argent du Centre du Canada sont le point d'intérêt essentiel du troisième. Si cette activité de colonisation dans l'Ouest et le Centre du Canada a été significative, les années 1880-1918, décrites dans le quatrième chapitre, sont celles qui ont vu l'industrie minière atteindre la maturité. Ce chapitre est donc le plus détaillé et rend compte non seulement de la croissance de l'exploitation minière et de la sophistication technique accrue qui l'a accompagnée, mais aussi de l'établissement d'écoles de génie minier et autres apanages de l'industrie moderne. L'élément le plus marquant de cette période est le passage de l'extraction sélective de minerai à haute teneur à des méthodes d'extraction toutes teneurs reposant sur une mécanisation accrue et des économies d'échelle. Ce changement a obligé les entreprises minières à engager un capital de départ beaucoup plus important et les a incitées à devenir des organisations non seulement plus grosses mais aussi plus complexes. Au lieu de se baser sur une seule propriété minière particulièrement riche, les entreprises ont eu tendance à exploiter un portefeuille de propriétés, de même qu'à rechercher l'intégration verticale par l'exploitation de leurs propres fonderies, raffineries, etc. Le cinquième chapitre décrit l'industrie au cours de la troisième période, marquée par les fluctuations associées à la crise économique et à la guerre. De bien des façons cependant, l'exploitation minière de cette période a continué à se développer selon les règles instaurées au cours des premières années du XX^{e} siècle. Le dernier chapitre offre un bref résumé de la croissance de l'industrie minière et une illustration claire de cette croissance depuis les années 1880.

Les intérêts des entreprises minières canadiennes sur le plan international, de même que les derniers développements au pays, soit la mise en exploitation de la première mine de diamant en Amérique du Nord et la découverte du dépôt de nickel de Voisey's Bay, suggèrent que l'industrie est toujours vigoureuse et mettent en lumière le rôle complexe qu'a joué la technologie dans sa croissance.

Foreword

Mineral resources are a big part of Canada and are one of the main factors in the economic and industrial evolution of this country. Nevertheless, to date, very few scientific publications have studied the historical aspects of this evolution. Jeremy Mouat's study *Metal Mining in Canada 1840-1950* does so, viewing the subject from a broad, socio-economic perspective and targeting problems related to technologies that over the past century have been used in the processing of important minerals such as gold, silver, copper, nickel, lead and zinc.

Some key issues the study examines include: the interdepdendence of capital and the type, the extent and the location of metalliferous deposits; the contribution to mining of various sources of energy—from steam to hydro-electricity; technical processes; and innovations brought on by Canadian mining engineers.

The author also demonstrates the primary role that the Candian mining industry has played on the international business scene over the 20th century. The major role of automated mining techniques, the increasing use of robotic and computerized technologies, as well as the repercussions of these activities on workers, are some issues raised in this context and would be worth further study for researchers interested in this field.

Sponsored by the research and publishing program at the National Museum of Science and Technology, Jeremy Mouat's study represents an invaluable complement to that work on the evolution of Canadian coal mines: *Coal Mining in Canada: An Historical and Comparative Overview*, published as part of the Tranformation series in 1996. It succeeds in showing us how important the mining industry has been to Canada's industrial heritage.

Louise Trottier
Curator,
Energy and Mining Resources

Avant-propos

Les ressources minérales occupent un espace privilégié dans le paysage canadien et demeurent l'un des ressorts majeurs de l'évolution économique et industrielle du pays. Néanmoins, peu de publications scientifiques ont abordé le contexte historique de cette évolution à ce jour. Envisagée globalement dans une perspective socio-économique, l'étude *Metal Mining in Canada 1840–1950* que propose l'historien Jeremy Mouat a justement pour but de cerner les problèmes se rapportant aux technologies qui ont marqué, pendant plus d'un siècle, l'exploitation et la transformation de minerais significatifs tels que l'or, l'argent, le cuivre, le nickel, le plomb et le zinc.

Parmi les questions soulevées, il convient de signaler en premier lieu l'interdépendance entre le capital, la nature, l'étendue et l'emplacement des gisements métallifères, l'apport des diverses sources d'énergie – de la vapeur à l'hydroélectricité –, les procédés techniques ainsi que les innovations apportées par les ingénieurs miniers canadiens.

En second lieu, l'auteur démontre pertinemment le rôle de premier plan que l'industrie minérale canadienne est parvenue à occuper sur la scène économique internationale au cours du XX^{e} siècle. L'importance accrue de la mécanisation des opérations minières, le recours accentué aux technologies de la robotique et de l'informatique, de même que les répercussions de ces activités chez les travailleurs font partie des problèmes offrant un champ d'investigation privilégié aux chercheurs intéressés à ce sujet.

S'inscrivant dans le programme de recherche et d'édition du Musée national des sciences et de la technologie, l'étude de Jeremy Mouat représente un complément inestimable à celle qui porte sur l'évolution des charbonnages canadiens, *Coal Mining in Canada : An Historical and Comparative Overview*, parue dans la collection Transformation en 1996. Elle réussit à nous convaincre de l'importance primordiale de l'industrie métallurgique dans le patrimoine industriel du Canada.

La conservatrice,
Énergie et ressources minières,
Louise Trottier

Acknowledgements

I would like to thank several people for their help in the preparation of this monograph. It was written with the assistance of Louise Trottier, Curator of Energy and Mining Resources at the National Museum of Science and Technology in Ottawa, with whom it was always a pleasure to work. I was particularly grateful for her patience, which over the course of this project attained saintly proportions. My thanks also to Roger Burt, Professor of Mining History at the University of Exeter, who read an earlier draft of the manuscript and offered encouragement. Similarly, two anonymous reviewers provided some good advice and sensible criticism. Here in Alberta, during the long process of research and writing, my friends in Athabasca University Library's inter-library loans department—Judy Stady and Sandy Partyka—obtained innumerable books and theses for me; I am grateful for their good humour as well as for their help. Logan Hovis, with whom I worked during my days as a graduate student, taught me much about mining technology. Such expertise as I have acquired owes a good deal to our friendship and collaboration, something that I haven't forgotten. My greatest debt, however, is to Lynda Ross, who was finishing her own manuscript as I was working on this one. Attachment theory and mining history may not be closely related but in our home they have adjacent offices.

Jeremy Mouat
Athabasca, Alberta

Remerciements

Je voudrais remercier quelques personnes de leur aide dans la préparation de cette monographie. Celle-ci a été rédigée grâce à l'aide de Louise Trottier, conservatrice responsable du secteur de l'énergie et des ressources minières au Musée national des sciences et de la technologie, à Ottawa, avec qui ce fut toujours un plaisir de travailler. Je lui suis particulièrement reconnaissant de sa patience, qui a atteint une grandeur angélique au fil de ce projet. Je remercie aussi Roger Burt, professeur d'histoire minière à l'Université d'Exeter, qui a lu une version préliminaire du manuscrit et m'a prodigué ses encouragements. Dans le même ordre d'idées, deux réviseurs anonymes m'ont nourri de bons conseils et de fines critiques. Ici, en Alberta, au cours du long processus de recherche et de rédaction, mes amies du département des prêts entre bibliothèques de l'Université d'Athabasca, Judy Stady et Sandy Partyka, m'ont procuré d'innombrables livres et thèses ; je leur suis reconnaissant de leur humour et de leur aide. Logan Hovis, avec qui j'ai travaillé au cours de mes études supérieures, m'a beaucoup appris sur le sujet de la technologie minière. L'expertise que j'ai acquise est due en grande partie à notre amitié et à notre collaboration, que je n'ai pas oubliées. Cependant, je suis le plus redevable à Lynda Ross, entre tous, qui terminait son propre manuscrit au moment où je travaillais sur celui-ci. Même si la théorie de l'attachement et l'histoire minière semblent assez éloignées, chez nous, elles sont voisines de bureau.

Jeremy Mouat
Athabasca, Alberta

1. Introduction

The increasing significance of minerals to modern civilization gives a study of the mining industry in the more recent nations of the New World a place of crucial importance.

–H.A. Innis[1]

Canadian historians have largely ignored Innis's emphasis on the importance of mining, although they have noted on occasion the absence of any sustained scholarly inquiry about one of the country's leading resource industries.[2] Even the dramatic growth in labour and working class history since the 1970s has produced remarkably little work on mining, a curious omission given the often dramatic role played by miners and their unions within the Canadian labour movement. The following pages, a study of the changing technology of the metal mining industry, scarcely fill this gap in the historiography, but may draw attention to some of the more significant issues in the history of mining in Canada.

The presence, extent, and nature of mineral deposits determine the viability of mining activity. While this may seem obvious, many factors affect the possibility of profitably exploiting a given ore body. Mineral prices often fluctuate dramatically, for example, and the complexity or variable nature of an ore deposit can make its economic treatment impossible, as can the remote location of even a relatively rich deposit. This helps to explain why technology has tended to define a company's ability to engage in mining: historically, new tools and processes have continued to turn lower grade and more complex ore deposits into potentially valuable economic assets. It follows that the definition of what constitutes a mine has changed dramatically over time. On the other hand, the location of mining activity has been more constant. Geological maps of Canada show that, in general terms, particular areas of northern Ontario, northern Quebec, northern Manitoba, British Columbia, the Yukon, and the Northwest Territories possess the bulk of Canada's base and precious metal wealth and thus these regions have been the site of much of the country's metal mining during the period covered by this book.

The phrase *metal mining* defines the topics examined in the following pages. It is worth noting that other mining activity, which in some cases was more widespread than the exploitation of base and precious metals, is not dealt with in this book. For example, Quebec's asbestos industry is not described, despite its considerable significance, nor are Saskatchewan's uranium and potash industries. Similarly, the iron industry of Canada—arguably the country's oldest industrial activity—is not depicted, since iron ore was quarried rather than mined. The history of metallurgical processes is distinct from the history of mining, despite its considerable impact on mining.[3]

As with the earlier monograph on coal mining commissioned by the National Museum of Science and Technology,[4] this study situates the history of mining technology within the broader social and political context. It also adopts a similar format in terms of periodization, delineating the phases of the industry's development and discussing the dominant features of each. Although the metal mining industry does share some features with coal mining, it also differed in some important respects, particularly in terms of technology.

In the closing years of the nineteenth century, the base and precious metals mining industry shifted from the selective extraction of modest amounts of high-grade ore to bulk mining methods facilitated by greater mechanization and economies of scale. This shift served to highlight the differences between coal and metal mining. Once mined, coal requires very little secondary treatment prior to its use, a situation that has not changed dramatically over the last two centuries. With the greater reliance on bulk mining, the ore produced by base and precious metal operations required elaborate treatment. The smelters and refineries of Sudbury and Trail stand as witnesses to just how complex the process of metal mining was to become.

Metal mining quickly became a predominantly North American industry. It was a new industry in many ways; unlike coal mining, the processes and technology that functioned adequately in such European mining regions as Cornwall or Germany did not transfer successfully to North America's mining frontier. Instead of the adoption and adaptation of traditional European methods, rapid innovation and technological change were the norm. By the early years of this century, Canadian and American mining engineers had become the industry's undisputed leaders, as the careers of such luminaries as Herbert Hoover, John Hays Hammond, and James Douglas suggest.

The respective place of coal and metals also changed dramatically. The emergence of hydroelectricity and the internal combustion engine challenged the prominence of steam and undermined coal's position as a key source of thermal energy. Base and precious metals, on the other hand, continued to play a critical role in the economies of the industrialized world. If anything,

they grew increasingly important, as events such as the First World War brought home.

This study adopts three chronological divisions that reflect profound changes within the mining industry as it developed from a pioneer activity to become a sophisticated business enterprise. The chronology is intended as a rough guide and not as an arbitrary or inflexible formula. Nonetheless, it seems useful to identify three broad time periods, as follows:

1) 1840–1880—a period of pioneer mining activity

2) 1880–1918—a period of general expansion and growth

3) 1918–1950—a period of consolidation

During the first period, hard-rock mining tended to be unsophisticated, based on readily identifiable ore deposits, and employing imported technology. Although steam engines were sometimes used—typically for ore treatment in an above-ground mine mill or for pumping—the work of mining was almost always carried out by hand. The typical underground workplace was poorly lit, poorly ventilated, and difficult to access. It was also dangerous. Nor was mining particularly successful: business failures and constant restructuring tended to be the rule.

The early mining period is best known for the gold rushes. The territory that was to become British Columbia experienced its first rush along the Fraser River in the spring of 1858, followed by a series of subsequent rushes to more remote areas of the region. Gold mining also took place in Canada East/Quebec, notably in the Chaudière district; Canada West/Ontario in Hastings County; and in Nova Scotia. Although these three regions experienced considerable excitement, none produced gold in a quantity to match the rich placer fields of the western cordillera.

Early gold mining in Canada owed much to the Californian gold rush and American mining methods generally. This is not surprising: almost all of those who participated in the Fraser River rush came by way of California. And gold mining in California was often at the leading edge of technological developments. This certainly was the argument of Sterry Hunt, of the Geological Survey, who in 1863 urged the adoption of California-style hydraulic mining in the Chaudière valley. On the other hand, failures were often blamed on the ineptitude and inexperience of local managers. For example, in April 1870 Henry Hind confessed to the Geological Society of London that Nova Scotia was "passing through that stage of blundering incompetency which has already visited Australia and California, and from which those countries have emerged with wonderful strength and aptitude."[5] Generally, then, the initial period of mining in Canada was marked by the adoption of technology from elsewhere and a rather uneven record of success.

During the second period—that is, the years from 1880 to 1918—Canada established its reputation as a leader in mining and mining-related technology. Mineral output rose sharply, not just with gold and silver, but also with the base metals, notably lead, zinc, copper, and nickel. Other developments in this period, such as the construction of transcontinental railways, did much to stimulate prospecting and mining.

The first transcontinental railway crossed the United States in 1869; as it did not run anywhere near the 49th parallel, it had little influence on Canadian mining. The completion of the Northern Pacific in 1883 was more important for the mining industry of southern British Columbia. The region's mineral wealth had long been recognized, but lack of transportation facilities had prevented the exploitation of any but the richest deposits.[6] With the Northern Pacific, all that changed. The line ran through Idaho and Spokane in eastern Washington before dipping south to reach the Pacific coast at Portland. Steamboats on the region's rivers and lakes complemented and extended the rail system, making many once-isolated valleys relatively accessible. Two years later, in 1885, the Canadian Pacific Railway reached tidewater on the Pacific coast, giving a boost to mining in western Canada. Its route through Northern Ontario meant that it also facilitated access to another region that had been little visited by European prospectors and miners. Since profitable working of most mineral deposits relied on access to a transportation network that could carry considerable freight for a modest price, the railway's arrival created many opportunities for Canada's mining industry.

By the turn of the century, managers and engineers had realized that windfall profits from rich ore deposits could not sustain the business of mining. Rather, the industry's survival in the long term depended upon working relatively low-grade deposits at a profit. The underground world became far more mechanized, often subject to the supervision and control of a mining engineer. As mining concentrated less on the recovery of rich ore, economies of scale became critical to success. The need to move large tonnages of low-grade ore led to a more efficient means of breaking and transporting ore to an aboveground mill. Increasingly, mining came to depend upon a central shaft, through which people, supplies, and ore passed. Electric locomotives facilitated the movement of broken rock, although they were simply one of a number of improvements to the haulage system. A notable Canadian contribution to underground mining came in 1904, with the development of the self-dumping Granby mine car.

The shift to mass ore extraction was made possible not just by changing methods of underground mining. It also depended on changes in ore treatment. Several key inventions in mineral processing enabled above-ground mills to handle low-grade ores, notably the flotation and cyanide processes. Both processes were covered by patents and extensive litigation accompanied their introduction. This highlights another feature of the period: the far greater importance of proprietary ownership of mining technology. In most cases, metallurgical advances relied on the extensive resources of research and development laboratories, which most large companies were maintaining by the close of this period. The inspired lone inventor was no longer the typical catalyst for the advances of mining's industrial age. Similarly, the period saw the emergence of large vertically integrated mining/smelting companies, such as the Granby Consolidated Mining, Smelting and Power Company, Ltd., and the Consolidated Mining and Smelting Company of Canada, Ltd. (Cominco) in British Columbia, and the International Nickel Company (Inco) in Ontario. These corporate re-alignments, like the restructuring of the workplace, shifted entrepreneurial risk away from single bonanza ore deposits toward a mining industry that depended upon a broad stable of mines, most of which would possess extensive low-grade ore deposits.

As mining grew in scale and scope, it also grew in economic importance. The outbreak of the First World War brought this into sharp focus. With the war came a new demand for base metals. The government of Canada, anxious to demonstrate its loyalty, offered to supply munitions to Britain as part of the Canadian war effort. The fact that the country had no refineries capable of producing either copper or zinc—the constituent metals of brass—meant that Canada's munitions factories had to import refined copper and zinc from the United States. Sudbury's nickel also had to be shipped south for treatment. For the first three years of the war, however, the United States was neutral. Reliance on a non-combatant country for essential war materials caused concern in government circles, leading to a commission "to inquire as to the possibility of refining copper and producing metallic zinc in Canada," and another on the production and supply of nickel.[7] Government subsidies subsequently went to large concerns such as Cominco, to enable the production of essential war materials within Canada.

By the close of this second period, Canada's modern mining industry had begun to take shape. Northern Ontario was fast emerging as the country's most important mining centre, with growth in both base metals production (notably at Sudbury) as well as the discovery and production from numerous new gold properties, such as those at Kirkland Lake.

Although the third period, from 1918 to 1950, was also one of growth, this growth tended to result from the refinement and extension of technology rather than dramatic changes in mining technology per se. A 1939 retrospective article on changes in Canadian mining methods offered the following analysis: "[the] progress of the past 60 years has been based upon methods and practices conceived for the most part prior to 1900 and developed and perfected during the succeeding years. Throughout the progress of these years runs the thread of increased mechanization and electrification and improvements in materials, design, and construction[,] without which modern [mining] methods would be impossible."[8] As this passage suggests, the major theme of these years was the growing scale and pace of mechanization. In 1919, for example, the U.S. Bureau of Mines decided to conduct a thorough study of underground labour-saving devices, a good indication of just how important these new devices had become.[9] The consequences of this were predictable: by the close of this period, investment and production in mining were increasing dramatically, with only a modest increase in employment opportunities.[10]

The application of proven methods to new and more remote regions produced some outstanding developments during this period. The development of Noranda during the 1920s is a good example of this process. The increasing use of airplanes made the more remote regions of Canada easier to reach and to prospect, and aerial mapping became a new tool available to mining companies. One result was that serious mining activity began in various parts of northern Canada, for the first time since the Klondike excitement. This period also saw low metal prices followed by the severe economic downturn known as the Great Depression. The industry's gradual slowdown was dramatically reversed with the outbreak of the Second World War, although gold mining tended to follow its own counter-cyclical trajectory.

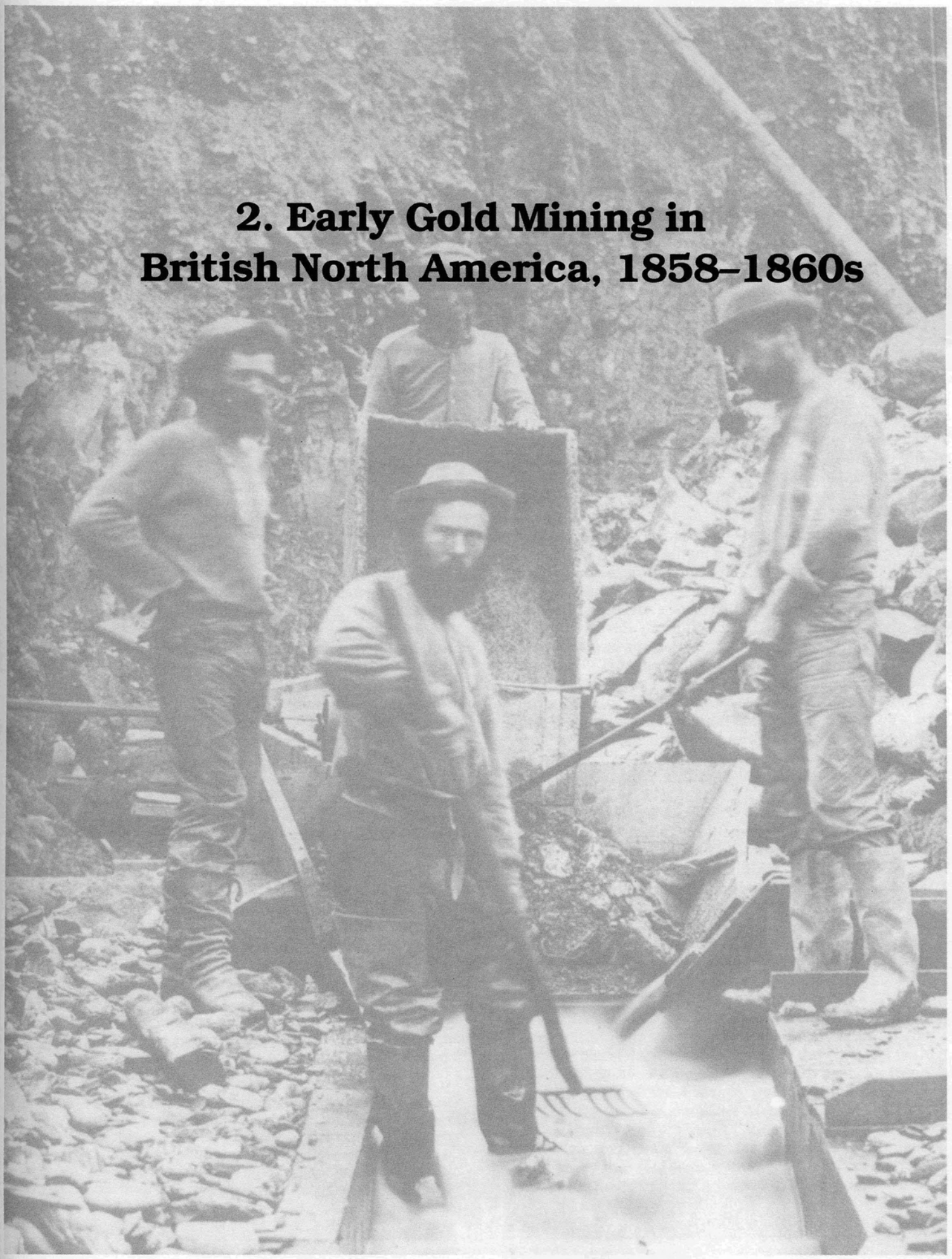
The following four chapters flesh out this brief summary, discussing the three periods in detail. The initial period is the subject of two chapters: the first looks at the gold rushes and the second examines early mining in the regions that were to become the provinces of Ontario and Quebec. The next chapter looks at the critical period from the early 1880s through to 1918, and the final chapter describes the years from 1918 to 1950. This is followed by a brief conclusion, which reiterates some of the more significant changes in the history of mining technology and suggests some of the lessons that we might draw from the preceding narrative. Appended to the text is a bibliographical essay and a rather lengthy bibliography, indicating the resources and literature available to those who wish to know more about the mining industry in Canada and the process of technological change. One caveat: while this bibliography attempts to provide readers with a

broad and representative sample of the available literature, it remains a selective rather than a comprehensive list of Canadian scholarship. Finally, a glossary is included, listing common mining terms, which hopefully will be of assistance to those readers unfamiliar with the industry's specialized vocabulary.

Notes

1. H. A. Innis, "Foreword," in E. S. Moore, *American Influence in Canadian Mining* (Toronto: University of Toronto Press, 1941), p. v.
2. For examples from the last three decades, see W. George Richardson, *A Survey of Canadian Mining History* (Montreal: Canadian Institute of Mining and Metallurgy, 1974), pp. 1-2; Alexander C. Dow, "The Canadian Base Metal Mining Industry (Non-ferrous) and Its Impact on Economic Development in Canada, 1918-55" (PhD thesis, University of Manitoba, 1980), pp. 5-23; and Thomas Henry Nicholson, "A Sordid Boon: The Business of State and the State of Labour at the Canadian Copper Company, 1890 to 1918" (MA thesis, Queen's University, 1991), pp. 6-9.
3. The bibliographical essay lists significant works in non-metal mining, as well as the history of metallurgy in Canada.
4. Delphin A. Muise and Robert G. McIntosh, *Coal Mining in Canada: A Historical and Comparative Overview* (Ottawa: National Museum of Science and Technology, 1996).
5. Henry Youle Hind, *Report on the Sherbrooke Gold District, together with a Paper on the Gneisses of Nova Scotia, and an Abstract of a Paper on Gold Mining in Nova Scotia* (Halifax: Charles Annand, 1870), p. 27. Cf. the similar comments of the newly-appointed Director of the Geological Survey, Alfred R. C. Selwyn, in *Notes and Observations on the Gold Fields of Quebec and Nova Scotia* (Halifax: Nova Scotia Printing Co., 1872), pp. 13-4. For Hunt's comments on hydraulic mining, see T. Sterry Hunt, *On the Gold Mines of Canada, and the Manner of Working Them*, reprinted from the *Canadian Naturalist*, February 1863.
6. See the discussion in Jeremy Mouat, *Roaring Days: Rossland's Mines and the History of British Columbia* (Vancouver: UBC Press, 1995), pp. 5-16.
7. The quotation is from David Carnegie, *The History of Munitions Supply in Canada 1914-1918* (London: Longmans, Green & Co., 1925), p. 60. Cf. *A Record of the Investigation, Report and Subsequent Action of the Commission.... To investigate the feasibility of Refining Copper and Producing Metallic Zinc on a Commercial Scale in the Dominion of Canada* (Ottawa: Imperial Munitions Board, 1916); Alfred Stansfield, "Some Effects of the War on the Metallurgical Industries of Canada," *Transactions of the Canadian Mining Institute* 19 (1916): 134-36; and *Report of the Royal Ontario Nickel Commission* (Toronto: King's Printer, 1917).
8. Chas. F. Jackson, "Metal Mining Practice Over Sixty Years," *Canadian Mining Journal* 60, no. 11 (November 1939): 691. Similarly, John Convey and L. E. Djingheuzian argued that "From 1834 to 1920, mineral processing in Canada, as elsewhere in the world, was in its formative stage. This, however, prepared the ground for developments that have resulted in a mining empire [in Canada] from the Atlantic to the Pacific." John Convey and L. E. Djingheuzian, "History of Developments in Mineral Processing in Canada from 1921 to the Present Time," *Transactions of the Canadian Institute of Mining and Metallurgy* 68 (1965): 146.
9. See the subsequent study by Charles E. Van Barneveld, *Mechanical Underground Loading in Metal Mines* (Rolla, Missouri: School of Mines and Metallurgy, University of Missouri, 1924).
10. See the comments in J. A. MacMillan, G. S. Gislason, and S. Lyon, *Human Resources in Canadian Mining: A Preliminary Analysis* (Kingston: Queen's University, 1977), p. xiv.

2. Early Gold Mining in British North America, 1858–1860s



2. Early Gold Mining in British North America, 1858–1860s

Canada's hard-rock mining industry—that is, the mining of minerals other than coal—has a long history. Well before the first European wrote optimistically of Canada's mineral wealth, Native groups were using these resources.[1] This is clear not just from the archaeological evidence but also from the number of early European accounts which acknowledge Native interest in metals. The observations of the German traveller, Johann Georg Kohl, who spent the summer of 1855 among the Ojibwa of Lake Superior, are typical:

> *Among the dead stuffs of nature, the dwellers on Lake Superior seem to feel the most superstitious reverence for copper, which is so often found on the surface-soil in a remarkable state of purity. They frequently carry small pieces of copper ore ... in their medicine bags; they are carefully wrapped up in paper, handed down from father to son, and wonderful power is ascribed to them.*[2]

It is tempting to describe European attachment to gold in precisely the same terms, but these early descriptions tacitly recognize Native familiarity with mineral deposits. In fact, numerous European "discoveries" of gold and other minerals were the result of Native people sharing their knowledge.[3] However, mining by Native people was relatively small-scale and did not extend underground. The Canadian mining industry that emerged in the nineteenth century was largely a consequence of European colonization.

The first European explorers to reach Canada were engaged in a search for minerals. In March 1534, for example, the French king's orders to Jacques Cartier, the first European to lead an expedition into the St. Lawrence valley, included the command "to discover certain islands and lands where it is said that a great quantity of gold, and other precious things, are to be found."[4] Although Native people told Cartier of a fabulous Kingdom of Saguenay, a country in the interior of the continent where gold was abundant, he failed to locate it.[5] Cartier imagined that he had discovered something equally valuable on his third and final voyage. He and his men wintered not far from present-day Quebec, at Cap Rouge, in 1541–42. While there, they located what they were sure were diamonds, silver and gold:

> *... there is a rising ground which is of a kind of slate stone, black and thick, wherein are veins of mineral matter, which show like gold and silver; and throughout all that stone there are great grains of the said Mine. And in some places we have found stones like diamonds, the most fair, polished and excellently cut that it is possible for a man to see. When the sun shines upon them, they glisten as it were sparkles of fire.*[6]

In the spring they hastily loaded this rich cargo on board and returned to France. Alas, their enthusiasm had blinded them. The gold was iron pyrites, or fool's gold; the diamonds were quartz crystals. The French took up the story, and for years afterwards any particularly useless item was greeted with the ironic exclamation, "Voilà un diamant de Canada!" Quebec ultimately did become a rich gold producer, but this was nearly four centuries after Cartier's visits.

Thirty-five years later, another early European explorer had a similar experience. Martin Frobisher left England in 1576, searching for a North-West Passage through to Asia. His trip through northern waters to Baffin Island failed to find a route, but he did bring back some black rock. Several English assayers examined the stone, one of whom reported that it was gold-bearing. The following year Frobisher—assisted by Queen Elizabeth—organized a second expedition to Baffin Island. Three ships, including among the crew a handful of miners and several metallurgists, set off from England to the spot where Frobisher had found the "ore." This time 200 tons were mined and brought back. With reports that the ore would return a good profit, a third expedition was arranged for 1578. The preparations were elaborate and included 15 ships as well as materials to build a fort and establish a colony of 100 people. Rough weather put an end to these plans, as the ship carrying the bulk of the supplies sank in a storm. Despite the setback, the expedition mined some 1,500 tons of ore, which was duly brought back to England. The truth had come out during Frobisher's absence, however: the ore was worthless and the chief backer was already in debtor's prison. The first company organized to mine gold in Canada was an embarrassing failure, leaving behind only a few scars on the Arctic landscape.[7] In England, Frobisher's ore was discarded, although even today a few pieces can be found in stone walls in the area where the ore was sent for treatment.

Cartier's and Frobisher's enthusiasm for gold, however misguided, indicates Europeans' passion for the acquisition of mineral wealth, which they brought with them to North America. We should bear in mind that the value of these metals was a cultural construct originating in a perception of their usefulness, the adequacy of supply, aesthetic choice, and other factors. Gold in particular fascinated Europeans.[8] Biblical references and Greek legend suggest its considerable appeal to the people of the Mediterranean basin, where

gold-based coinage has been in circulation for thousands of years.[9] The value placed on gold became enshrined in law: from the time of the Pharoahs in Egypt, rulers have claimed an exclusive right to mine gold.[10] This custom came to Canada as part of the cultural baggage of the Europeans.

The first documented gold discovery in Canada came in 1834, more than 200 years after the first Europeans colonized the St. Lawrence valley. Clothilde Gilbert spotted a nugget while crossing a tributary of the Chaudière River, 85 kilometres south of Quebec. She later said that "I never thought then such a pebble would make so much noise afterwards."[11] The Seigneur of Rigaud-Vaudreuil, where the discovery had been made, applied for and received exclusive mining rights. Efforts were soon underway to mine the area, but these were never commercially successful.

Large-scale gold mining came to what is now Canada only in the wake of the first of the world's spectacular gold rushes. These began with the discovery of California's rich placer gold deposits, not far from the site of Sacramento, in the first weeks of 1848. The United States had just acquired the Pacific region from Mexico, and California was a long way from the centres of population on the eastern seaboard. Travel and communications between the two areas were difficult and slow. As a result, the first gold rush took some time to get going. But once launched, the rush to become rich drew thousands to the edge of the Pacific Ocean.[12]

Many contemporaries came to regard the gold rushes as bizarre and inexplicable. With the passage of time it is possible to see them in a larger context and arrive at a clearer sense of their meaning. It was certainly no coincidence, for example, that the gold rushes were confined not only in time but also in space, occurring in roughly similar territories. By the mid-nineteenth century, Europeans had begun to move into the areas where gold rushes occurred—into the western region of the North American continent and to New Zealand and the Australian colonies. This process of colonization, a function of British and American expansion in the Pacific basin, meant that a growing number of Europeans lived in regions where large and hitherto unexploited gold deposits existed.

The growing European presence in the Pacific region was only one pre-condition of the gold rushes. Naturally enough, gold had to be found in sufficient quantity, but it also had to be gold of a particular type. The gold that was discovered in California and later in what is now British Columbia* was placer gold—that is, water-borne gold—and these deposits were both rich and easily worked.

Placer gold was relatively pure, easily recognized, and represented instant wealth. It could be readily sold and its value was known to all; contemporary descriptions of miners' fortunes invariably listed their daily returns as a dollar value. In addition, the process of separating gold from the sand, gravel, or clay in which it occurred was straightforward. This reflected gold's unusually high specific gravity, one-and-a-half times greater than lead. Since it was by far the heaviest ingredient among the material with which it was found, gold was the least prone to wash away. As a result, the technology of placer mining could be crude but still be reasonably effective. The traditional tools used by gold rush miners—pan, rocker, and sluice—were inexpensive, portable, and required little skill to use. Few barriers stood in the way of aspiring miners; fitness, strength, and determination were certainly necessary, but little else. An observer of the first Australian gold rush noted:

> *Nothing, indeed, can have a more levelling effect on society than the power of digging gold, for it can be done, for a time at least, without any capital but that of health and strength; and the man inured to toil, however ignorant, is on more than equal terms with the educated and refined in a pursuit involving so much personal hardship.*[13]

Contemporaries almost always commented on the egalitarian nature of the gold rushes; the participation of people from every walk of life and from many countries was recorded with a regularity that suggests just how unprecedented this was. Few if any economic opportunities had offered such an equal chance of success.

The gold rushes themselves offer proof that large numbers of people could travel across oceans and from one goldfield to another by the middle of the nineteenth century. This was a relatively recent development and largely a function of the quickening pace of trade that accompanied the industrial revolution.[14] In addition to fostering a transportation system that extended around the globe, industrialization encouraged a burgeoning communications network: like people, information could now travel faster and with greater ease. And the news of the gold discoveries and the subsequent rushes—widely reported in newspapers—reached an increasingly literate population.

* The mainland territory of British Columbia was originally named New Caledonia by British fur traders in the early nineteenth century. Although the area north of the 49th parallel was formally declared British by the Oregon Treaty of 1846, the only evidence of sovereignty was the presence of the Hudson's Bay Company and its servants. In 1849 Vancouver Island became a British colony under the control of the Hudson's Bay Company; in 1858 the mainland became the separate colony of British Columbia. Eight years later the two colonies joined, and then in 1871 the united colony became a province of Canada. Throughout the period, the British and Canadian governments made almost no treaties with Native people, unlike other regions of Canada.

Soon after news of the gold rushes appeared in magazines and newspapers, more extensive publications followed in a steady stream, such as self-help manuals, travel guides, and first-hand accounts of the goldfields. They were eagerly bought by a host of aspiring miners.[15] Thus people who lived far from the Pacific basin grew confident that they could travel to the point where gold had been found and also believed that they would be able to mine the precious metal successfully upon their arrival.

Other changes also facilitated travel, particularly for people in Europe. In many countries, greater freedom of movement was now possible. Upheavals such as the American and French revolutions, the lengthy Napoleonic wars and the ongoing effects of industrialization, swept away the last vestiges of the feudal order throughout much of western Europe. Nor had state bureaucracies yet formed to control the flow of migrants. The political turmoil in Europe during and after 1848 also encouraged people to seek adventure and economic advantage overseas.[16]

Gold fever did not take long to reach areas of what is now Canada. It first broke out along the north Pacific coast in 1849, when news came of the gold discoveries in California. Roderick Finlayson, a Hudson's Bay official then in charge of Fort Victoria on Vancouver Island, recalled:

> *In the Spring of 1849 a vessel appeared in the harbor, the crew of which wore red flannel shirts, and when they landed we took them to be pirates. I ordered the men to the guns, manned the bastions and made ready for defence. I then interviewed the men, from the gate, who told me they were peaceable traders, come from San Francisco, with gold, to trade for goods, as this was the only station on the northern coast where they could get the goods they wanted. Having satisfied myself that they were what they represented themselves to be, I let them in, and they then told me that gold had been discovered in California in large quantities the previous Fall, and that they had gold nuggets which they would gladly exchange for goods.... After this our operations here got considerably disarranged, by numbers of our men leaving for the California diggings.*[17]

As Finlayson indicates, the company soon found it hard to keep workers from joining the gold rush. The next year, when a ship arrived at Fort Rupert on the northern tip of Vancouver Island to pick up a cargo from the Hudson's Bay Company coal mine there, the miners left with the coal. "The presence of the *England*," grumbled James Douglas, head of the Hudson's Bay Company's operations in the region, "and the tales of the wealth to be acquired in Calefornia [sic] circulated by her highly paid crew, is the chief cause of all the dissatisfaction that prevails among the Company servants.... Their [sic] is little doubt about the intention of the Miners their ardent wish is to get to Calefornia."[18]

To add to the company's anxiety, gold was found within the region itself, on the Queen Charlotte Islands.[19] The Haida, the islands' Native people, had learned of the value that Europeans placed on gold—likely through trading expeditions to California—and brought some to a Hudson's Bay Company fort in the summer of 1850.[20] This was not placer gold like that found elsewhere but hard-rock gold, recovered from a rich quartz vein. Over the next two years, Hudson's Bay officials and groups of American miners arrived to work the vein. None of these forays were successful, largely because of Haida opposition to mining. In addition, although the quartz deposit was rich in gold, it was not extensive and interest in the area soon faded.

The flurry of excitement over the presence of gold in the Queen Charlotte Islands raised some troubling issues for the Hudson's Bay Company and the British government. The first was simply their ability to maintain authority and sovereignty in the face of a sudden influx of miners. There was also the uncertain political status of the area. Events in the Queen Charlottes led the British government to extend the authority of the governor of Vancouver Island to include those islands as well.[21] The British government also wanted gold mining to be regulated in a manner consistent with British law and precedent. "The property, both in land and mines, in Queen Charlotte's Island being unquestionably the Crown's," explained the Colonial Secretary to Douglas in 1852, "the Crown can delegate to you the power of granting land and issuing licenses for procuring gold."[22] The Colonial Secretary then indicated the best way to deal with the situation, based on the regulations adopted in the Australian colonies following the discovery of gold in 1851:

> *I ... send you copies of two papers which have been lately presented by command of Her Majesty to Parliament, relating to the recent discovery of gold in Australia, from which you will derive very valuable information as to the course of procedure adopted by the respective Governors in that country for granting licenses to persons to prosecute the search for gold. You will ... frame such regulations as you may deem practicable and advisable for granting licenses for collecting gold upon the principle of those which you will find, from the correspondence, have been granted to the Australian Colonies.*[23]

Despite the fact that no significant mining had taken place in the Queen Charlottes, the discovery of gold there resulted in the extension of formal British sovereignty and the establishment of mining regulations based on the Australian model. But the most significant consequence was that other Native people learned of the value that Europeans placed on gold. Following the example of the Haida, they started to bring gold to Hudson's Bay Company mainland forts for trading purposes.[24] The Company gradually accumulated the precious metal while maintaining a discreet silence to the world.

Farther south, the miners of California had begun to prospect well beyond northern California's motherlode region. By 1855 some had travelled nearly to the 49th parallel, participating in a minor rush near Fort Colville during that year.[25] As this northward movement continued during the spring of 1856, Douglas advised the Colonial Secretary that gold discoveries had been made "within the British territory."[26]

Douglas was anxious to maintain control over events on the mainland. Although he was governor only of Vancouver Island, Douglas's second job was Chief Factor and Head of the Western Department for the Hudson's Bay Company. Any disturbance on the mainland—an area over which the company possessed exclusive trading rights with Native peoples—would jeopardize its position. A gold rush would almost certainly bring chaos; events in the Queen Charlottes, for example, demonstrated that conflicts were likely between white and Native miners. South of the border, a war with Native Americans raged in Washington Territory during 1855 and 1856, something that Douglas was anxious to prevent on British territory. He was also well aware of the problems that the California gold rush had caused the company, and no doubt expected that these difficulties would be far greater if the rush was closer to home. In addition to the possibilities of wars with Native peoples and mass desertions by company employees, he was also concerned that an influx of American miners would lead to events similar to those that culminated in the loss of the Oregon territory in 1846. By late December 1857, he determined on a course of action, issuing a proclamation "declaring the rights of the Crown in respect to gold found in its natural place of deposit, within the limits of Fraser's River and Thompson's River districts ... and forbidding all persons to dig or disturb the soil in search of gold, until authorized on that behalf by Her Majesty's Government."[27]

Ironically, the rush of "adventurers from the American side" that Douglas dreaded was caused inadvertently by the Hudson's Bay Company itself, several months after his proclamation. The gold that had slowly increased in the Company forts through trade with the Native population—some 800 ounces—was shipped to the San Francisco mint in February 1858.[28] This was all the encouragement needed to start the stampede from California northward; the first shipload of miners, over 400 in number, arrived in Victoria in late April.[29]

The Fraser River gold rush of 1858 brought much publicity to British Columbia. In many ways the gold rush was an inevitable consequence of the earlier rush to California, 10 years before. After all, by 1858, California's richest deposits were mostly depleted. Journalist John Hittell wrote in 1869:

> *The miners were spoiling for an excitement. Many of the rich placers were exhausted.... The country was full of men who could no longer earn the wages to which they had become accustomed.... They were ready to go anywhere if there was a reasonable hope of rich diggings, rather than submit to live without the high pay and excitement which they had enjoyed for years in the Sacramento placers.... These men welcomed the rumors that a new California had been found in the basin of the Fraser with joy and enthusiasm.*[30]

Between April and August 1858, some 25,000 to 30,000 people rushed to the Fraser River, the vast majority of whom came by ship from San Francisco.[31]

The people who flooded into the region brought with them the knowledge, skills and technology of gold mining as it was practised in California. The standard tools of the early placer miner were soon in use along the banks of the Fraser River.[32] Perhaps the best indication of the diffusion of mining technology was illustrated—quite literally—in Matthew Macfie's book, *Vancouver Island and British Columbia: Their History, Resources, and Prospects*, published in London in the mid-1860s. The frontispiece as well as the drawings that accompanied Macfie's chapter, "The Process of Mining," were copied without acknowledgement from an article in the American periodical, *Harper's New Monthly Magazine*, entitled "How We Get Gold in California, By a Miner of the Year '49."[33] A contemporary of Macfie's, Richard Mayne, who also wrote a book in the early 1860s for a British audience, noted that the gold pan "is hardly ever used except for prospecting....

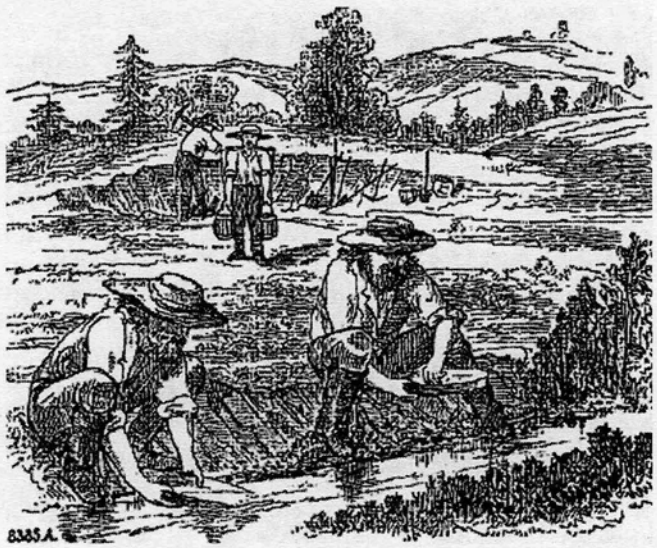


Figure 1. *THE PAN Notwithstanding its ubiquitous use as the symbol of the rush era, the gold pan was rarely used for mining on an extensive scale. It remained an excellent prospecting tool, however, as well as an accurate way of estimating the relative richness of a particular deposit.*[34]
(from Egleston, *Metallurgy*)

Figure 2. *USING A ROCKER* (Royal British Columbia Museum)

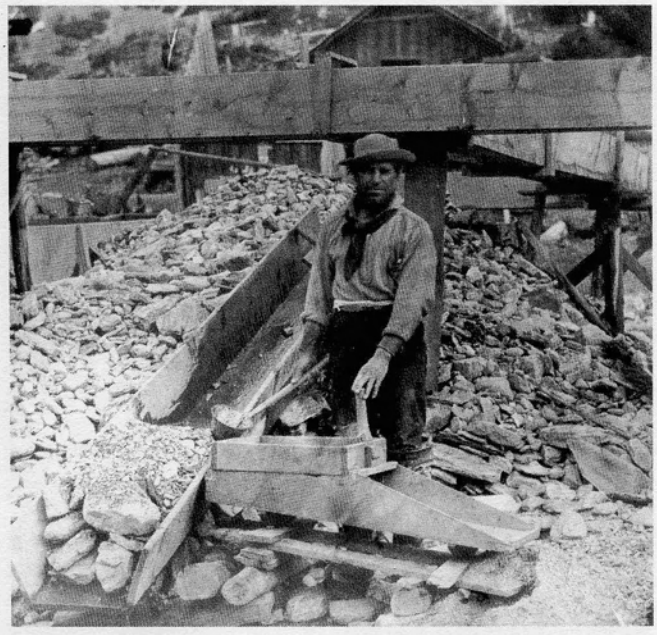


Figure 3. *BILL PHINNEY WITH HAND ROCKER AT THE CALEDONIA CLAIM The rocker's great advantage over the gold pan was simple: it permitted a person to 'wash' approximately four times as much amount of gravel in a day. By September 1858, some 800 rockers were reported at work along the Fraser River, between Hope and Yale. The use of the rocker was not confined to river claims, as can be seen in the 1868 photograph of Bill Phinney, taken at the Caledonia Claim on Williams Creek in the Cariboo.*[35] (B.C. Archives)

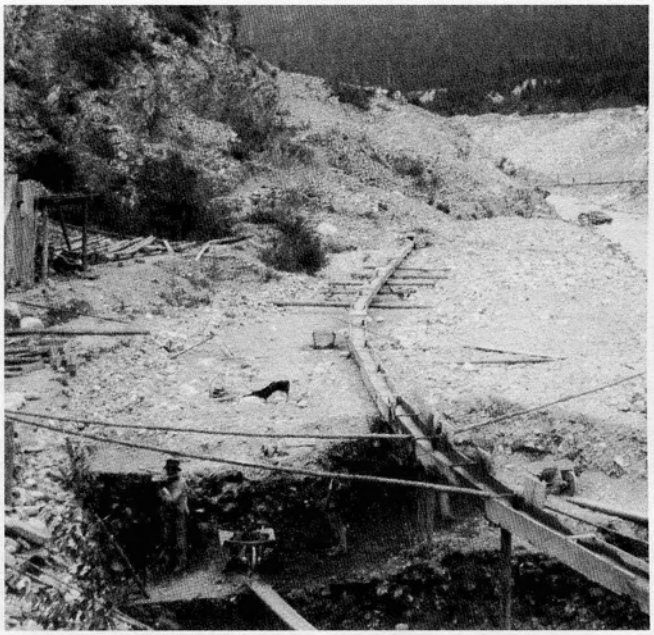


Figure 4. *PROSPECTORS SLUICING ON WILDHORSE CREEK Sluicing was a more sophisticated form of placer mining, and involved diverting water into a wooden flume—or sometimes simply into a ditch (ground sluicing). This water was brought to the claim and used to separate gravel from gold. As an early historian of British Columbia noted, "Sluicing yielded about twice the return obtained with rockers, but as this method involved considerable preliminary and often costly labor, the wooden pail, pan, and rocker retained the favor of the majority." The illustration is from the Cariboo, ca. 1862.*[36] (B.C. Archives)

The 'rocker' or 'cradle' may be described as the most primitive appliance used in gold-washing." When Mayne visited the Fraser River in late 1859, he observed that "the rocker was the general machine—the use of sluices not having then begun."[37]

Despite Douglas's anxiety about maintaining law and order in the event of a gold rush to mainland British Columbia, the Fraser River rush was more or less an orderly affair.[38] Considerable tension arose between European and Native miners, culminating in a series of confrontations, assaults and murders. At the height of the tensions between the two groups—in late summer, 1858—Douglas travelled to the mining district to act as a mediator, defusing the situation before the skirmishing between Native and European turned into war.[39] Overall, however, the rush was not particularly lucrative for the participants: the Fraser River was not destined to become another American River in California, where many a fortune had been won from the gravel. The harsh conditions and meagre returns of the Fraser left many miners with no desire to remain on the river bars and soon the exodus began. The event, noted a California historian four decades later, "was the longest and most disastrous of all the mining excitements... a big mistake."[40]

Bonanza discoveries typical of other nineteenth-century gold excitements came only two years after the first stampede and the departure of many a disgruntled miner. This second gold rush was to the Cariboo district, some 200 miles north of the Fraser River diggings. Preoccupied by the Civil War and perhaps overly cautious after the disappointments on the Fraser, few Americans took part. Substantial numbers arrived from the British North American colonies, however, and in the early 1860s British Columbia boomed once more.[41]

Mining in the Cariboo tended to be a more complex process than the placer activity typical of the Fraser River rush. Miners, wrote one nineteenth-century author, had to learn "a new lesson.... Hitherto the surface had been skimmed with the aid of rocker and sluice, and a few insignificant hydraulic enterprises had been undertaken on the benches; but in Cariboo, the mystery and art of deep placer-mining in its true technical sense were to be practically studied and unravelled by means of shafts and drifts, pumps, and hoisting machinery."[42] The surviving letters of John Evans, a mining engineer who worked along Lightning Creek from 1863, offer a good description of this new and more elaborate form of mining. His operations were sufficiently extensive to require "a small steam engine to master [pumping] the water," and he employed "4 men doing nothing else than sawing as we shall want many thousand feet of boards for making water wheels, sluices & lining shafts and a house for winter."[43] These comments hint at the need to pursue gold-bearing gravel underground, hence the need for pumps, to de-water the underground workplace, as well as timber to line the drifts or tunnels.

Not everyone could master the new skills that were needed to pursue this new form of placer mining, nor could everyone survive the often lengthy period of non-productive work before hitting pay dirt. Mining was gradually becoming an expensive and elaborate business, as Evans' letters suggest:

> *Aug. 8 [1863] After cutting two very large and deep ditches to draw the water off, we have today commenced the shaft, but do not intend to go down very deep until the water wheel is ready. We are at work with the smithy since the middle of the week. We had to burn charcoal as coal would cost over 2/- per lb.... The Sawyers are getting timber sawn for the water wheel & sluices—some men are cutting down trees both for that purpose & the pumps....*
>
> *One more of the comp[an]ies here, (numbering 10 individual miners) were beaten out by the water this week & having no means to replace their pump which broke they had to abandon it. I am very sorry for them as they were plucky fellows and I thought they would master the water but the above circumstance put a stop to their Labour for the season. Another one close to them—at the head of whom is a New Brunswick Magistrate, will have to follow suit; they have no skill and part of them have expended their all in endeavouring*

Figure 5. *NE'ER DO WELL CLAIM, GROUSE CREEK, IN THE CARIBOO The Ne'er Do Well Claim in Grouse Creek, taken in the late 1860s, suggests the scale and complexity of mining operations in the Cariboo. The flume in the background brought water to the claim.* (Frederick Dally)

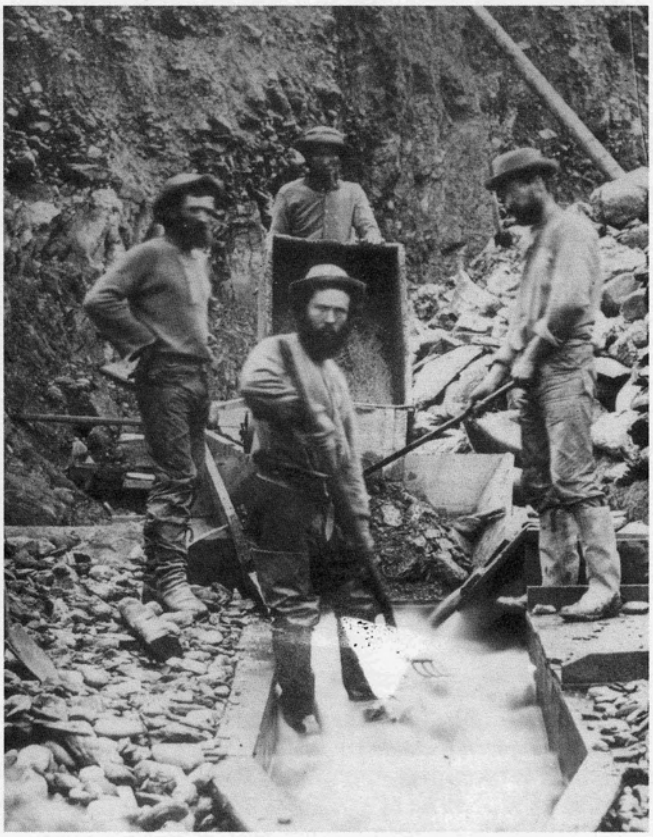


Figure 6. *MINERS ON THE NE'ER DO WELL CLAIM This illustrates the same group engaged in washing the claim's gold-bearing gravel.* (Frederick Dally)

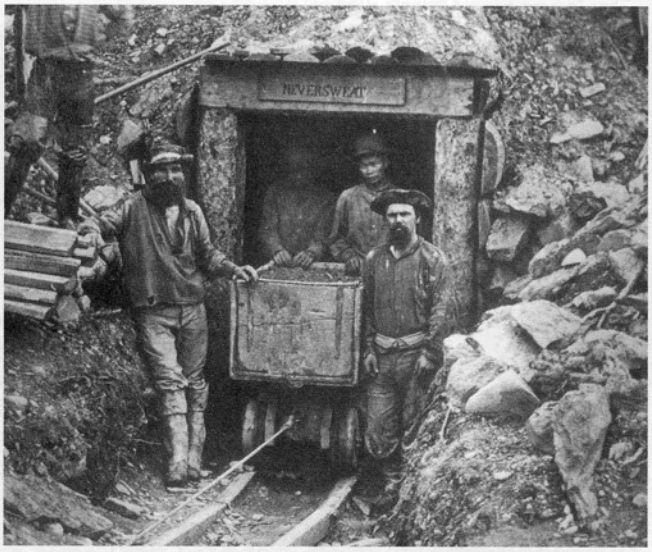


Figure 7. *MINERS AT THE NEVERSWEAT ADIT IN THE CARIBOO The group at the mouth of the unlikely-named Neversweat tunnel still rely on relatively simple tools, but the rough wooden rails and the laden skip gesture to the more complex underground mining that is not far in the future.* (Frederick Dally)

Figure 8. *WORKERS OF THE MUCHO ORO GOLDMINING COMPANY The 15 men of the Mucho Oro Goldmining Company are using waterpower to aid them in their operations.* (Frederick Dally)

by inefficient machinery to get down to the Bedrock. I am selecting the most skilful of our miners to take charge of the shaft....[44]

A similar letter by another Welsh miner suggests the premium placed on skill:

We started our journey towards Cariboo mines on 10 March [1863] by way of Fort Yale and three of us reached Williams Creek on 3 April. On 4 April we started working for 10 dollars a day and worked for a fortnight. After this I went to sink a pit at 12 dollars a day. I worked here seven weeks and as I was successful I had offers from many places after this at 14 dollars a day. Three Companies had tried to sink pits in Conklin's Gulch and could not get down because of the quicksands and water in that place. They valued their claims at 2,000 dollars and one of their chief men came to our tent to ask if I would take an ounce a day, that is 16 dollars a day. I said the place was wet and dangerous but I went down the pit to see. The pit was fifty three feet deep with planks from top to bottom to keep the sides in place and very weak. I told them that the pit was nearly falling down and by Saturday night the pit collapsed. On Sunday I agreed with the Company to sink a new pit for them. I sank the pit safely in three months, ninety six feet, but after we reached the bottom the Company lost heart....[45]

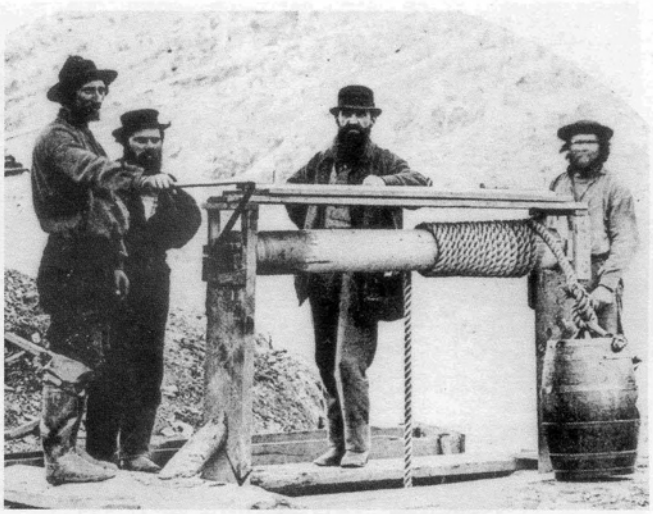


Figure 9. *WINDLASS AT THE BARKER CLAIM, WILLIAM'S CREEK* (R. Maynard)

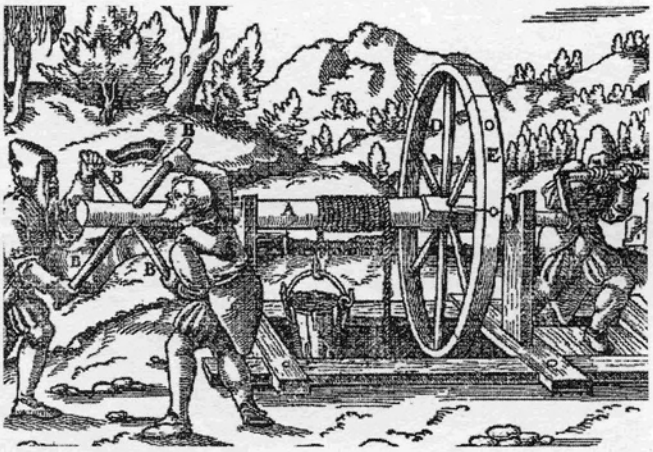


Figure 10. *MINERS WORKING A CAPSTAN Although the Cariboo's shafts and waterwheels reflected a reasonably sophisticated grasp of engineering, nothing in the region would have been unfamiliar to a well-read sixteenth-century mining engineer in Europe. Compare the bucket and capstan in Figure 9 with those in the woodcut from Agricola's* De Re Metallica, *first published in 1556.* (Agricola)

Figure 11. *WASHING WITH THE LONG TOM* ("How We Get Gold," *Harper's*)

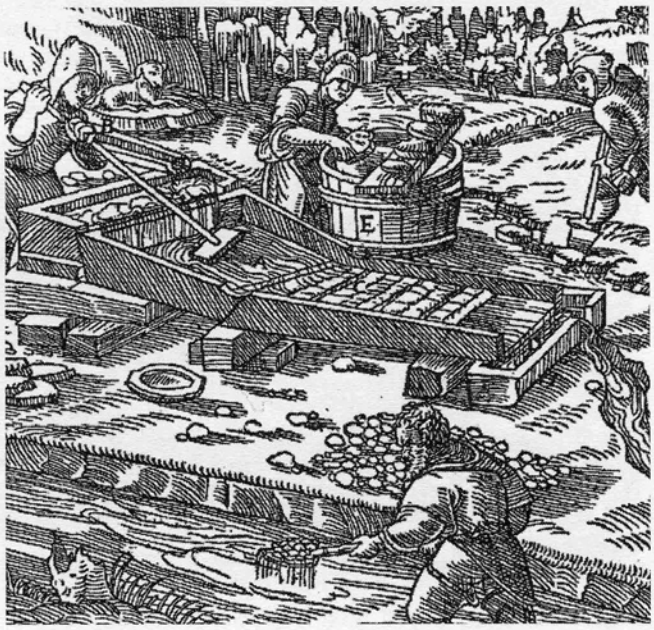


Figure 12. *WOODCUT OF SLUICING OPERATIONS As the two engravings on this page suggest, the placer mining techniques of California, which were much in evidence in British Columbia as well, were common in sixteenth-century Europe. "Washing with the Long Tom, Near Murphy's" first appeared in* Harper's New Monthly Magazine *in April 1860; Figure 12 is from Agricola's* De Re Metallica, *three hundred years earlier.* (Agricola)

Period photographs hint at the labour and determination needed to carry on.

British Columbia's gold rushes were not the first to stir the imagination and ambition of Canadians. The earlier rushes to California and Australia attracted enormous publicity in the area that is now eastern Canada. Contemporary newspapers in Nova Scotia and New Brunswick make it clear that many people contemplated leaving the Maritimes for the Australian colonies, for example, and a fair number did embark for the south Pacific. In the spring of 1852, advertisements of ships about to disembark for Australia were common, and the papers regularly carried letters, articles and editorials about the exodus.[46] At the same time, orders for new vessels provided a considerable boost to the region's ship-building industry.[47]

Within a few years, both the Province of Canada and the colony of Nova Scotia experienced their own gold rushes—Nova Scotia in 1861–62, and in 1866–67 in Hastings County, Canada West.[48] As with British Columbia, miners looked to those with experience on earlier gold fields—particularly California and Australia—for advice and guidance in adopting the most appropriate technology. Although the goldfields in central Canada and Nova Scotia did not prove as rich as those in British Columbia, they did provide plenty of excitement, as the following extract suggests:

> *The most extensive mines in the gold fields of Nova Scotia, are those of Goldenville, near Sherbrooke, on the St Mary's river, twelve miles inland from the Atlantic coast.... They were discovered on the 16th of September, 1861. When the tidings were announced that gold had been found in the hills on the opposite side of the river from Sherbrooke village, not only were the quiet and sober-minded villagers excited with joyous wonder, but the novel intelligence having circulated with almost electric velocity among the inhabitants of the country, hundreds of those also hurried to the hills, almost frantic with the golden fever. The morning succeeding the discovery, no fewer than five hundred persons of both sexes were assembled in the vicinity in which the gold had been found; each one having a hammer or pickaxe, eagerly "prospecting" among the rocks. Old gray-headed men and women who had seldom crossed the threshold of their doors for years, were seen hobbling upon crutches up the heights, or hammering with right good earnest upon the rocks. Gold was indeed the all-absorbing subject of every mind, and the only topic of conversation. Everything else seemed for the time being to remain unheeded and forgotten. So general and so ardent indeed was the lust for this mineral, that the country for miles around was swarming with the zealous votaries of this golden god.*[49]

Unlike the isolated and relatively unsuccessful mines that were typical of Ontario's pioneer mining industry in the 1840s and '50s, the miners along the banks of the Fraser River were the vanguard of an industry that would continue to the present day. The techniques and experience that they brought with them helped to establish mining, and established it along a north-south axis, an orientation that persisted for many years.[50] Although the gold rushes to the Fraser River and the Cariboo were not part of the first mining activity in what is now Canada, they heralded the new industry that was to dominate British Columbia's economic history through the late nineteenth and early twentieth centuries.

Notes

1. For a good indication of the Native trading patterns in the pre-contact period, see "Prehistoric Trade," Plate 14, in *Historical Atlas of Canada Volume 1, From the Beginning to 1800*, R. Cole Harris ed. (Toronto: University of Toronto Press, 1987). As the plate suggests, Native peoples traded a variety of minerals; cf. Sandra Zacharias, "Historic Use of Metals by Native People on the Northwest Coast and in Alaska," *Datum* 6, no. 3 (Spring 1981): 25-27.
2. Johann Georg Kohl, *Kitchi-Gami: Life Among the Lake Superior Ojibway* (St. Paul: Minnesota Historical Society Press, 1985), p. 60. Originally published 1860. For the archaeological record, see Robert E. Popham and J. N. Emerson, "Manifestations of the Old Copper Industry in Ontario," *Pennsylvania Archaeologist* 24, no. 1 (May 1954): 3-19; William P. McHugh, " 'New Archaeology' and the Old Copper Culture," *The Wisconsin Archaeologist* 54 (1973): 70-83; John T. Penman, "The Old Copper Culture: An Analysis of Old Copper Artifacts," *The Wisconsin Archeologist* 58, no. 1 (1977): 3-23; John R. Halsey, *Miskwabik – Red Metal: The Roles Played by Michigan's Copper In Prehistoric North America* (Eagle Harbor, Michigan: Keweenaw County Historical Society, 1992), originally published in *Michigan History Magazine*, September/October 1983; and David J. Krause, *The Making of a Mining District: Keenenaw Native Copper, 1500-1870* (Detroit: Wayne State University Press, 1992). Professor Susan Martin of Michigan Technological University is currently writing a monograph on Native mining in the area around Lake Superior.
3. The part played by Native people in mineral discoveries is discussed in the bibliographical essay of this volume.
4. Quoted in Marcel Trudel, "Jacques Cartier," *Dictionary of Canadian Biography, Volume I, 1000 to 1700*, (Toronto: University of Toronto Press, 1966), p. 165.
5. See Joseph Edward King, "The Glorious Kingdom of Saguenay," *Canadian Historical Review* 31, no. 4 (December 1950): 390-400. Similarly, Native people in Northern Canada freely told various Hudson's Bay Company traders of distant copper deposits during the eighteenth century: see the comments in E. E. Rich, *The Fur Trade and the Northwest to 1857* (Toronto: McClelland and Stewart, 1976), pp. 98-100 & 146-47. Originally published 1967.
6. H. P. Biggar, *The Voyages of Jacques Cartier*, Publications of the Public Archives of Canada, no. 11, (Ottawa: King's Printer, 1924), p. 255. Altered from the original, which is in archaic English.
7. The definitive account of Frobisher's mining adventures is D. D. Hogarth, P. W. Boreham and J. G. Mitchell, *Martin Frobisher's Northwest Venture, 1576-1581: Mines, Minerals & Metallurgy* (Hull, Quebec: Canadian Museum of Civilization, 1994). See also William W. Fitzhugh and Jacqueline S. Olin, eds., *Archeology of the Frobisher Voyages* (Washington: Smithsonian Institution Press, 1993); Stephen Alsford, ed., *The Meta Incognita Project: Contributions to Field Studies* (Hull, Quebec: Canadian Museum of Civilization, 1993); Alan Cooke, "Sir Martin Frobisher," *Dictionary of Canadian Biography, Volume I, 1000 to 1700* (Toronto: University of Toronto Press, 1966), pp. 316-19; and W. A. Kenyon, *Tokens of Possession: The Northern Voyages of Martin Frobisher* (Toronto: Royal Ontario Museum, 1975). For a discussion of the corporate significance of Frobisher's venture, see Carole Shammas, "The 'Invisible Merchant' and Property Rights: The Misadventures of an Elizabethan Joint Stock Company," *Business History*, 17 (1975): 95-108.
8. For some discussion of gold's history in Europe, see the opening chapters of Pierre Vilar, *A History of Gold and Money 1450-1920*, trans. Judith White (London: NLB, 1976), originally published in Spanish, 1969; and Brain Kettell, *Gold* (London: Graham & Trotman, 1982).
9. There are numerous references to gold in Genesis and Exodus; perhaps the most well-known classical allusions are to Midas and Jason and the Argonauts. During the gold rush period, contemporaries often called participants "argonauts" and most gold fields had either a mine or a community known as Ophir (the source of King Solomon's wealth in the Bible).
10. For the evolution of mining law and the doctrine of "Mines Royal," see T. A. Rickard, *Man and Metals: A History of Mining in Relation to the Development of Civilization*, vol. 2 (New York and London: Whittlesey House, 1932), pp. 571-618; also, "Property in Mines Royal," in Robert Foster MacSwinney, *The Law of Mines, Quarries, and Minerals* (London: W. Maxwell & Son, 1884), pp. 40-41, and the chapter, "The Law of the Mines," in Rodman W. Paul, *California Gold: The Beginning of Mining in the Far West*, 2nd ed. (Lincoln: University of Nebraska Press, 1965), pp. 210-39.
11. Quoted in W. Chapman, *Gold Mines of Beauce* (Lévis: Mercier & Co., 1881), p. 10. The date of this discovery is disputed: one source, A. H. A. Robinson, gives "1823 or 1824," *Gold in Canada: 1935* (Ottawa: King's Printer, 1935), p. 23; and Chapman himself claims it came in 1846. But for persuasive evidence that it was in 1834, see J. Obalski, *Gold in the Province of Quebec Canada* (Quebec: Department of Colonization and Mines, 1898), p. 8; Dr. W. J. Anderson, *The Valley of the Chaudière, Its Scenery and Goldfields* (Quebec: The Morning Chronicle, 1872), p. 5; and *Gold in Canada: The Chaudière Valley and Its Mineral Wealth* (Quebec: The Morning Chronicle, 1880), pp. 35-36.
12. The best histories of the California gold rush are Paul's *California Gold*; J. S. Holliday, *The World Rushed In: The California Gold Rush Experience* (New York: Simon and Schuster, 1981); and Malcolm J. Rohrbough, *Days of Gold: The California Gold Rush and the American Nation* (Berkeley: University of California Press, 1997).
13. Godfrey Charles Mundy, *Our Antipodes; or, Residence and Rambles in the Australasian Colonies, with a Glimpse of the Gold Field*, vol. 3, 3rd ed. (London: Richard Bentley, 1855), p. 564.
14. For a brief introduction, see L. Girard, "Transport," in H. J. Habakkuk and M. Postan, eds., *The Cambridge Economic History of Europe*, vol. 6, part 1 (Cambridge: Cambridge University Press, 1966), pp. 212-73, especially the sub-section, "Railways and Packet Boats, 1830-69," pp. 228-49; more generally, see the illuminating discussions of gold rushes in Eric Hobsbawm, *The Age of Capital, 1848-1875* (New York: Scribner, 1975), pp. 78-82, and David Goodman, *Gold Seeking: Victoria and California in the 1850s* (Stanford: Stanford University Press, 1994), pp. 24-37. James P. Delgado's *To California By Sea: A Maritime History of the California Gold Rush* (Columbia, S.C.: University of South Carolina Press, 1990), on the other hand, largely ignores the broader context although it does contain a wealth of information on individual ships and people.
15. Examples of British publications on the Fraser River gold discoveries include "The New Gold-Diggings," *Chamber's Journal of Popular Literature* 10, 3rd ser. (18 September 1858): 182-85, and (25 September 1858): 197-98; Beta Mikron, "British Columbia and Vancouver's Island," *Fraser's Magazine for Town and Country* 58 (October 1858): 493-504; William Carew Hazlitt, *British Columbia, and Vancouver Island; Comprising a Historical Sketch of the British Settlements in the North-West Coast of America; And a Survey of the Physical Character, Capabilities, Climate,*

Topography, Natural History, Geology and Ethnology of that Region; Compiled from Official and other Authentic Sources (London: G. Routledge & Co., 1858); Kinahan Cornwallis, *The New El Dorado; or, British Columbia* (London: Thomas Cautley Newby, 1858); Robert M. Ballantyne, *Handbook to the New Gold Fields: a full account of the richness and extent of the Fraser and Thompson River gold mines, with a geographical and physical account of the country and its inhabitants, routes, etc., etc.* (Edinburgh: Alex. Strahan; London: Hamilton, Adams, and Co., 1858); and John Domer, *New British Gold Fields: A Guide to British Columbia and Vancouver Island: with a coloured map, showing the gold and coal fields, constructed from authentic sources* (London: W. H. Angel, 1858).

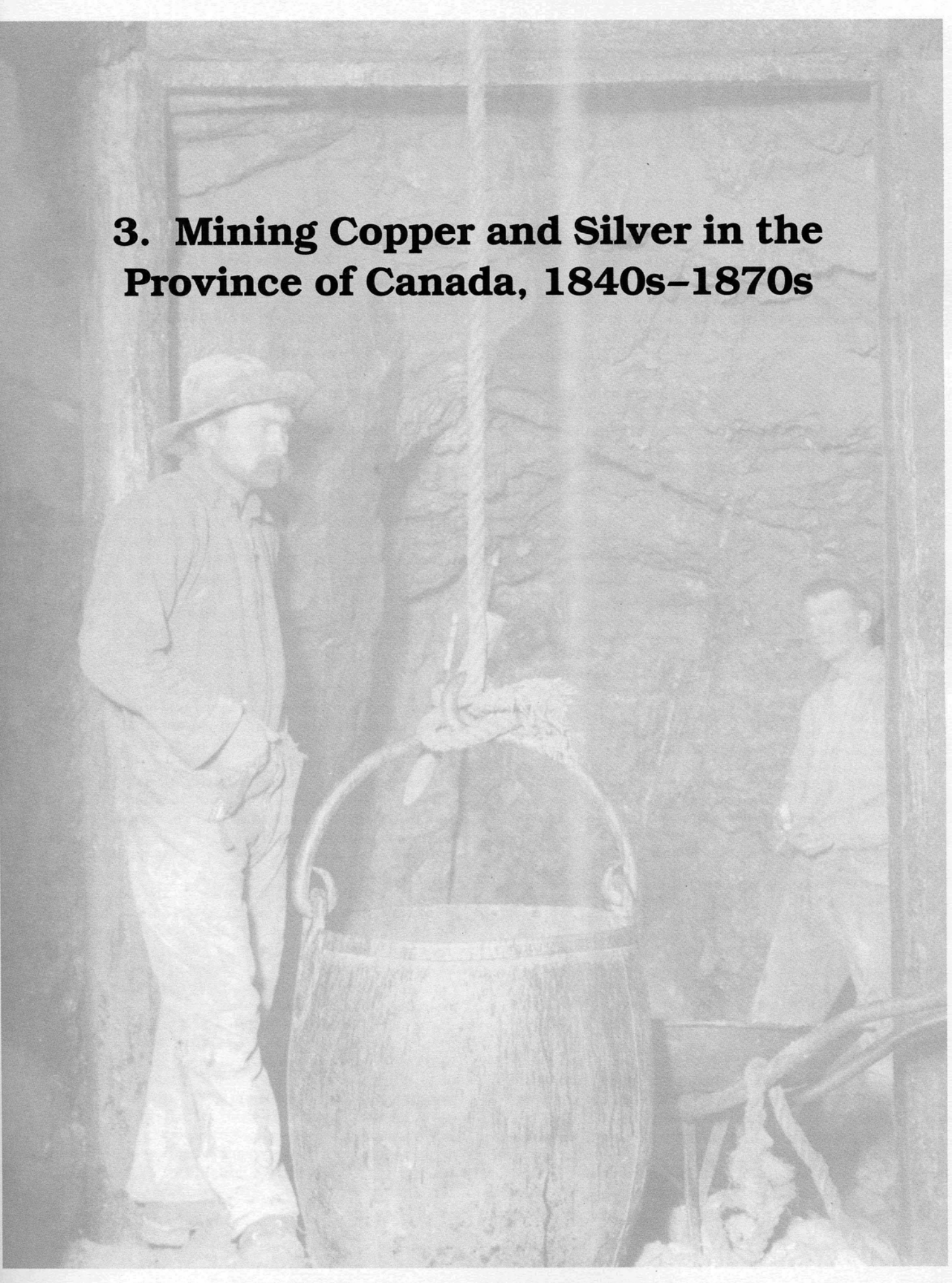
16. See, for example, Ralph J. Roske, "The World Impact of the California Gold Rush, 1849-1857," *Arizona and the West* 5 (Autumn 1963), esp. pp. 217 & 223; also, Seweryn Korzelinski, *Memories of Gold-Digging in Australia*, trans. and ed. Stanley Robe (St. Lucia: University of Queensland Press, 1979), pp. xi-xii. A Polish refugee in London, Korzelinski and a group of friends decided to quit Europe for the Australia diggings.
17. Roderick Finlayson, *Biography [sic] of Roderick Finlayson* (Victoria: n.p., 1891), pp. 21-22. Note also Helmcken's comments, in *The Reminiscences of Doctor John Sebastian Helmcken*, ed. Dorothy Blakey Smith (Vancouver: University of British Columbia Press, 1975), pp. 293-4.
18. Douglas to Barclay, 3 July 1850, reprinted in *Fort Victoria Letters 1846-1851*, ed. Hartwell Bowsfield (Winnipeg: Hudson's Bay Record Society, 1979), pp. 102-3. The year before, Douglas had explained the impact of the California gold rush to a friend who lived east of the mountains: "The Company's servants are distracted at the idea of losing so rich a prize and have deserted to the number of 30 from this establishment [Fort Vancouver on the Columbia River], the others so far steady, but we cannot depend upon them one hour." James Douglas to Donald Ross, 8 March 1849, in file 39, Microfilm A-831, Donald Ross Collection, B.C. Archives, Victoria.
19. For detail on the Queen Charlotte gold discovery and subsequent events, see Margaret Ormsby's Introduction to *Fort Victoria Letters 1846-1851*, pp. xci-xciv; Drew W. Crooks, "Shipwreck and Captivity: The Georgiana Expedition to the Queen Charlotte Islands," *Columbia* 8, no. 2 (Summer 1994): 17-23; Bessie Doak Haynes, "Gold on Queen Charlotte's Island," *The Beaver* (Winter 1966): 4-11; and Patricia Elizabeth Vaughan, "Cooperation and Resistance: Indian-European Relations on the Mining Frontier in British Columbia" (MA thesis, University of British Columbia, 1978), pp. 29-42. Much official documentary evidence may be found in two parliamentary papers: Great Britain, *Copies or Extracts of Correspondence Relative to the Discovery of Gold at Queen Charlotte's Island*, Ordered by the House of Commons to be printed 19 July 1853 (London: Eyre and Spottiswoode, 1853); and Great Britain, *Copies or Extracts of Correspondence Relative to the Discovery of Gold at Queen Charlotte's Island*, Ordered by the House of Commons to be printed 9 August 1853 (London: Eyre and Spottiswoode, 1853).
20. Vaughan, "Cooperation and Resistance," p. 29. She points out that "There is evidence to suggest that the Haida were looking for new trade items."
21. See Sir John Pakington to James Douglas, 27 September 1852, reprinted in Great Britain, *Copies or Extracts of Correspondence* (19 July 1853), pp. 12-14; also, Barry M. Gough, "'Turbulent Frontiers' and British Expansion: Governor James Douglas, The Royal Navy and the British Columbia Gold Rushes," *Pacific Historical Review* 41 (1972): 16-17.
22. Pakington to Douglas, 27 September 1852, *Copies or Extracts of Correspondence*, p. 13. (Douglas had become governor of Vancouver Island in 1851, combining that appointment with his other position as Chief Factor of the Hudson's Bay Company in the West.) For a history of British law in relation to the "Mines Royal," see Rickard, *Man and Metals*, vol. 2, pp. 571-618.
23. Pakington to Douglas, 27 September 1852, *Copies or Extracts of Correspondence*, p.13. More than six months later, Douglas sent a copy of the regulations that he subsequently framed to London, pointing out in a covering letter "the conditions being nearly similar to those proscribed by the Governor-general of New South Wales on the discovery of gold in that colony." James Douglas to the Duke of Newcastle, 11 April 1853, reprinted in Great Britain, *Copies or Extracts of Correspondence Relative to the Discovery of Gold at Queen Charlotte's Island*, Ordered by the House of Commons to be printed 9 August 1853 (London: Eyre and Spottiswoode, 1853) p. 3.
24. F. W. Howay, *British Columbia: From the Earliest Times to the Present*, vol. 2 (Vancouver, Winnipeg, Montreal, Chicago: S. J. Clarke Publishing Company, 1914), pp. 8-10, and Vaughan, *Cooperation and Resistance*, pp. 43-44.
25. William J. Trimble, *The Mining Advance into the Inland Empire: A Comparative Study of the Beginnings of the Mining Industry in Idaho and Montana, Eastern Washington and Oregon, and the Southern Interior of British Columbia; and of Institutions and Laws Based Upon that Industry* (New York: Johnson Reprint Corporation, 1972), pp. 15-23; originally published by the University of Wisconsin, 1914.
26. Douglas to Labouchere, 16 April 1856, in *Copies or Extracts of Correspondence Relative to the Discovery of Gold in the Fraser's River District, in British North America*, Presented to both Houses of Parliament by Command of Her Majesty, July 2, 1858 (London: Eyre and Spottiswoode, 1858), p. 5.
27. Douglas to Labouchere, 29 December 1857, *Correspondence...*, p. 8. Douglas candidly admitted to Labouchere that he had exceeded his authority in issuing the proclamation.
28. Howay, *British Columbia*, p. 14. See also the reminiscences of James Moore in "The Discovery of Hill's Bar in 1858," *British Columbia Historical Quarterly* 3, no. 3 (July 1939), esp. p. 217; "First Gold Excitement," in R. E. Gosnell, *The Year Book of British Columbia and Manual of Provincial Information* (Victoria, B.C.: s.n., 1897), p. 88 (another account based on Moore's recollections); and Walter N. Sage, *Sir James Douglas and British Columbia* (Toronto: University of Toronto Press, 1930), p. 203.
29. See Douglas to Labouchere, 8 May 1858, *Correspondence...*, pp. 12-14; also *The Reminiscences of Doctor John Sebastian Helmcken*, pp. 154-5.
30. John S. Hittell, "The Mining Excitements of California," *Overland Monthly* 2 (May 1869): 415.

31. As a recent study points out, estimates vary from a low of 10,000 to a high of 100,000; see Daniel P. Marshall, "Rickard Revisited: Native 'Participation' in the Gold Discoveries of British Columbia," *Native Studies Review* 2, no. 1 (1997): 91-108.
32. For an overview of this process of diffusion, see Rodman Wilson Paul, "'Old Californians' in British Gold Fields," *Huntington Library Quarterly* 17 (1954): 161-72; also, Jill Wade, "Pre-1885 Cariboo Mining Methods" (unpublished paper prepared for the B.C. Heritage Conservation Branch, Victoria, 1981).
33. Compare "Chapter X – Process of Mining," in Macfie's *Vancouver Island and British Columbia: Their History, Resources, and Prospects* (London: Longman, Green, Longman, Roberts, & Green, 1865), pp. 266-79, with "How We Get Gold in California, By a Miner of the Year '49," *Harper's New Monthly Magazine* 20 (April 1860): 598-616. "Prospectors at Work" in Macfie (p. 267) appears in the *Harper's* article as "'Panning,' on the Mokelumne," p. 600; Macfie's "Working with the Rocker" (p. 269) was originally "Cradle Rocking, on the Stanislaus," *Harper's*, p. 601; Macfie's "Hydraulic Mining," (p. 271) was originally "Hydraulic Mining, at French Corral," *Harper's*, p. 614; Macfie's "Ground Sluicing," (p. 275) was originally "Ground Sluicing, at Gold Hill," *Harper's*, p. 611; and Macfie's "Helvetia Quartz Mill, Grass Valley," (p. 277) appeared under the same title in the article, on p. 608. The frontispiece for Macfie's book, "River Operations on the North Pacific," also appeared in the article, as "River Operations at Murderer's Bar," p. 603. Although Macfie did cite the *Harper's* article in a footnote (p. 279), he made no reference to the fact that it was the source of his illustrations. Similarly, Macfie lifted unacknowledged the "Miners' Ten Commandments" (pp. 418-22) from a California broadside. For a discussion of the "Miners' Ten Commandments," see Rodman Paul's Introduction to *The Miners' Own Book* (San Francisco: The Book Club of California, 1949), p. v. Bernice Gilmore in *Artists Overland: A Visual Record of British Columbia, 1793-1886* (Burnaby: Burnaby Art Gallery, 1980), pp. 39-40, notes that Richard C. Mayne's *Four Years in British Columbia and Vancouver Island: An Account of their Forests, Rivers, Coasts, Gold Fields, and Resources for Colonisation* (London: J. Murray, 1862) also used other people's drawings without acknowledgement.
34. For comments on panning and the gold pan in B.C., see Mayne, *Four Years in British Columbia* pp. 428-9, and Matthew Macfie, *Vancouver Island and British Columbia: Their History, Resources, and Prospects* (London: Longman, Green, Longman, Roberts, & Green, 1865), pp. 267-68. More generally, see "How We Get Gold in California, By a Miner of the Year '49," *Harper's New Monthly Magazine* 20 (April 1860): 601. A full half a century after the first gold rush, Albert Williams could still claim that "there is nothing to compare with the old, original, California 20-inch gold pan, stamped out of one piece of sheet iron, with an angle of, say, 30 and no crease in the bend. With this tool, and a five-minute instruction, but with considerable experience, one can rapidly reach a rough estimate of the value per ton in gravel...." Albert Williams, Jr., "Exploring and Exploiting a Gold Country," (CIHM microfiche series, no. 16466), pp. 70-75.
35. My estimate of the relative efficiency of the rocker over the gold pan is taken from Rossiter W. Raymond, *Mines and Mining of the Rocky Mountains, the Inland Basin, and the Pacific slope: Comprising Treatises on Mining Law, Mineral Deposits, Machinery, and Metallurgical Processes* (New York: J. B. Ford & Co., 1871), p. 479. For the report of 800 rockers at work on the Fraser, see Bancroft, *History of British Columbia*, 1792-1887, p. 442, note 8.
36. Bancroft, *History of British Columbia*, p. 443. See also the description of "Sluice Mining" in Thomas Egleston, *The Metallurgy of Silver, Gold, and Mercury in the United States*, vol. 2 (New York: John Wiley & Sons, 1890), pp. 20-30.
37. Mayne, *Four Years in British Columbia and Vancouver Island*, p. 429. However, another account contradicts this, claiming that sluices were much in evidence on the Fraser River by 1858-59: see Hubert Howe Bancroft, *History of British Columbia, 1792-1887* (San Francisco: The History Company, 1887), p. 443.
38. The best account of the rush is Morley Arthur Underwood, "Governor Douglas and the Miners, 1858-1859" (BA Essay, University of British Columbia, 1974).
39. For an opposing view which argues explicitly that there was a "Fraser River War," see Marshall, "Rickard Revisited." My approach is largely drawn from Vaughan's "Cooperation and Resistance" esp. pp. 43-55. See also Sage, *Sir James Douglas and British Columbia*, pp. 225-28.
40. Theodore H. Hittell, *History of California*, vol. 3 (San Francisco: N. J. Stone & Co., 1898), pp. 153-155; see also the comments of Jean-Nicolas Perlot, *Gold Seeker: Adventures of a Belgian Argonaut during the Gold Rush Years* (New Haven: Yale University Press, 1985), pp. 359-62, and Herman Francis Reinhart, *The Golden Frontier: The Recollections of Herman Francis Reinhart 1851-1869*, ed. Doyce B. Nunis, Jr. (Austin: University of Texas Press, 1962), p. 133. The claim that the richness of the Fraser River gold deposits had been grossly exaggerated provoked several indignant responses. See for example Alfred Waddington, *The Fraser Mines Vindicated, or, The History of Four Months* (Victoria: P. de Garro, 1858), and R. C. Lundin Brown, *British Columbia, An Essay* (New Westminster, B.C.: Royal Engineer Press, 1863). Note also the comments of James Bell, in a letter dated 27 February 1859, reprinted in "Gold-Rush Days in Victoria, 1858-1859," *British Columbia Historical Quarterly* 12, no. 3 (July 1948): 244, and Bancroft, *History of British Columbia*, pp. 466-67. It's worth noting that there were those who similarly described the California rush as a "miserable delusion, a magnificent humbug": see Jocelyn Maynard Ghent, "The Golden Dream and the Press: Illinois and the California Gold Rush of '49," *Journal of the West* 17, no. 2 (April 1978): 25.
41. The best published studies of the B.C. gold rushes are Trimble's *The Mining Advance into the Inland Empire*; Gordon R. Elliott, *Barkerville, Quesnel & the Cariboo Gold Rush*, 2nd ed. (Vancouver: Douglas and McIntyre, 1978); and Netta Sterne, *Fraser Gold 1858! The Founding of British Columbia* (Pullman, Washington: Washington State University Press, 1998). Sylvia Van Kirk's "A Vital Presence: Women in the Cariboo Gold Rush, 1862-1875," in Gillian Creese and Veronica Strong-Boag, eds., *British Columbia Reconsidered: Essays on Women* (Vancouver: Press Gang,

1992), pp. 21-37, is a useful corrective, emphasising the role of women. A number of contemporary accounts of the Cariboo gold rush have been re-issued; see for example, *For Friends At Home: A Scottish Emigrant's Letters from Canada, California and the Cariboo 1844-1864*, ed. Richard Arthur Preston (Montreal: McGill-Queen's University Press, 1974), esp. pp. 259-313; W. Champness, *To Cariboo and Back in 1862* (Fairfield, Washington: Ye Galleon Press, 1972); Thomas McMicking, *Overland From Canada to British Columbia*, ed. Joanne Leduc (Vancouver: University of British Columbia Press, 1981); Margaret McNaughton, *Overland to Cariboo: An Eventful Journey of Canadian Pioneers to the Gold-Fields of British Columbia in 1862* (Toronto: William Briggs, 1896); and the various titles listed in note 15, above. Richard Thomas Wright's popularly-written *Overlanders* (Saskatoon: Western Producer Prairie Books, 1985), describes the experiences of those who undertook the trek from Canada West to British Columbia. Apart from Sterne's recent book—a well-researched chronicle—little scholarly work has been published on the Fraser River gold rush since the early studies by Bancroft, Howay, and Sage, although Dan Marshall is currently completing a dissertation at the University of British Columbia on the topic. There are two excellent unpublished pieces, Underwood's "Governor Douglas and the Miners, 1858-1859" and Vaughan's "Cooperation and Resistance: Indian-European Relations on the Mining Frontier in British Columbia, 1835-1858" (see esp. pp. 43-58).

42. Bancroft, *History of British Columbia*, p. 476.
43. *Letter Book of John Evans*, p. 17 (the letter was written some time in the summer of 1863). The letterbook is held in the Special Collections division of the Main Library of the University of British Columbia. On Evans' career in the Cariboo, see Robie L. Reid, "Captain Evans of Cariboo," *British Columbia Historical Quarterly* 2, no. 4 (October 1938): 233-46.
44. *Letter Book of John Evans*, p. 19 (letter of 8 August 1863).
45. E. W. Davies, 12 November 1863, in a letter to his family, quoted in Alan Conway, "Welsh Gold-Miners in British Columbia During the 1860s," *British Columbia Historical Quarterly* 21, nos. 1-4 (January 1957- October 1958): 69 (original in the National Library of Wales, MS. 337E, Aberdare Collection I.).
46. See for example "Australian Gold Mine!" *The Morning News* (St. John, NB), 28 May 1852, p. 1; cf. "Emigration—'Chebucto' for Australia," *The Nova Scotian*, 5 July 1852, p. 209; "Departure of the Ship Chebucto," *The Nova Scotian*, 5 July 1852, p. 210; "Interesting from Australia," *The Nova Scotian*, 27 September 1852, p. 316. For a good account of the impact of the Australian gold rush in the Maritimes, see Gwendolyn Davies, "Sailing for the Goldfields: The Ballarat-Maritime Provinces Connection," in Gwendolyn Davies, ed., *Studies in Maritime Literary History* (Fredericton, N.B.: Acadiensis, 1991), pp. 130-40; cf. Graeme Wynne, "Life on the Goldfields: Fifteen Letters," *Journal of the Royal Australian Historical Society* 64, pt. 4 (March 1979): 258-68.
47. See David R. MacGregor, *Fast Sailing Ships: Their Design and Construction, 1775-1875*, 2nd ed. (London: Conway Maritime Press, Ltd., 1988), pp. 139, 157-59; also Esther Clark Wright, *Saint John Ships and their Builders* (Wolfville, NS: E. C. Wright, 1976), esp. pp. 17-25.
48. For accounts of Nova Scotia's brief gold rush, see Donald Macleod, "Miners, Mining Men and Mining Reform: Changing the Technology of Nova Scotian Gold Mines and Collieries, 1858 to 1910" (PhD thesis, University of Toronto, 1981), pp. 9-27, and G. R. Evans, "Early Gold Mining in Nova Scotia," Nova Scotia Historical Society, *Collections* 25 (1942): 17-47. The best account of the excitement in Canada West five years later is Gerry Boyce's *Ontario's First Gold Rush: Eldorado* (Toronto: Natural Heritage/Nature History Inc., 1992). For early gold mining in Quebec, see Marc Vallières, *Des mines et des hommes: histoire de l'industrie minérale québécoise* (Quebec: Les Publications du Québec, 1989), pp. 87-89, but see also the works cited in note 11, above.
49. Andrew Learmont Spedon, *Rambles among the Blue-Noses: or, Reminiscences of a Tour through New Brunswick and Nova Scotia, during the summer of 1862* (Montreal: John Lovell, 1863), pp. 164-65; cf. "The Nova Scotian Goldfields," *The Illustrated London News* 39 (5 October 1861): 347. For comparisons of gold production in B.C., Canada West, and Nova Scotia during this period, see the statistics in B. F. Townsley, *Mine-Finders: The History and Romance of Canadian Mineral Discoveries* (Toronto: Saturday Night Press, 1935), p. 242, and Eugène Coste, *Report on the Mining & Mineral Statistics of Canada for the Year 1887* (Montreal: Dawson Brothers, 1888), pp. 25 S, 27 S.
50. On this topic see E. S. Moore, *American Influence in Canadian Mining* (Toronto: University of Toronto Press, 1941); Trimble, *The Mining Advance into the Inland Empire*; and Isabel M. L. Bescoby, "Some Social Aspects of the American Mining Advance into Cariboo and Kootenay" (MA thesis, University of British Columbia, 1935).

3. Mining Copper and Silver in the Province of Canada, 1840s–1870s



3. Mining Copper and Silver in the Province of Canada, 1840s–1870s

Mining in the region that is now the provinces of Ontario and Quebec has deep roots. As the last chapter suggested, Native peoples were familiar with surface mineral deposits long before Europeans came to North America. In this region, they were particularly well-acquainted with the copper deposits of the Upper Lakes. This is clear from the earliest written references to the area's mineral wealth, which reached Europe in the mid-seventeenth century. As their missionary activities drew them further into the continent, the Jesuits reported the presence of copper in Lake Superior. For example, Father Claude Allouez published in the *Relation* of 1666-67 an account of his travels west of the Sault, where he saw pieces of copper in the hands of Native peoples.[1]

Such accounts served to pique the interest of French officialdom: both Intendant Talon and his superior, Colbert, were anxious to develop these mineral resources into commercial activity. French explorers and Jesuits continued to report the presence of copper in the region bordering Lake Superior, but authorities in Quebec appear to have been too preoccupied to organize any formal mining activity.[2]

The first systematic effort to work the copper deposits of the Upper Lakes came in the following century. In 1768 the fur trader Alexander Henry met an English entrepreneur at Michilimackinac, the trading post on the south shore of the straits that separated Lake Michigan from Lake Huron. This person had heard rumours of the mineral wealth of the Upper Lakes and was very interested to hear Henry's opinions about the region. "To this gentleman," Henry recorded in his memoirs, "I communicated my mineralogical observations and specimens, collected both on my voyages and at my wintering-ground; and I was thus introduced into a partnership, which was soon afterward formed, for working the mines of Lake Superior." Two years later, Henry's partner returned from England, where he had managed to raise enough money to finance a mining venture on Lake Superior. For three years, Henry and his partner, with a band of miners, attempted to work various outcrops on both the south and north shore of the lake. This was an idea whose time had not yet come: the region was too far from other European communities to function successfully as a mining enterprise. "The metal was probably within our reach," Henry wrote, "but, if we had found it, the expense of carrying it to Montreal must have exceeded its marketable value.... The copper-ores of Lake Superior can never be profitably sought for but for local consumption. The country must be cultivated and peopled, before they can deserve notice."[3] Another 70 years passed before Europeans again attempted to tap the mineral resources of the region.

Mining on the Great Lakes began in earnest in the 1840s. The stimulus came largely from the southern side of the Lakes, in much the same way that the gold rush to the Fraser River was an extension north of Californian mining. In the early 1840s, the reports of Houghton, Michigan's state geologist, fuelled a copper boom on the Keweenaw Peninsula. A lucrative mining industry soon coalesced around the rich deposits uncovered by Houghton and later prospectors.[4] Canadian business people were keen to discover similar mineral wealth on the northern shore of Lake Superior, and in an effort to locate it they formed numerous companies, notably in Montreal. Much enthusiasm and more than a little exaggeration accompanied their efforts. In the summer of 1846, a journalist from Sault Ste. Marie reported:

> *It is now ascertained, beyond a doubt, that the north shore of Lake Superior is as rich, if not richer, than the south, in copper and silver ores. The explorations that are now going on, are bringing to light some of the richest veins of these minerals, that have been found on the shores of this wonderful Lake....*
>
> *I have been shown some magnificent specimens both of native copper, and of the best of all ores, the gray sulphuret; and I am assured by those who have visited the mineral regions, and on whose statements I can rely, that there is "any quantity" of mineral there. I hear of four companies that have been on the ground this season, exploring and making their locations, and I am glad to learn that these companies are composed of men of wealth and influence, and engage in the business of mining, as a safe and profitable way for the investment of capital, and not like many of the American Companies, merely for purposes of speculation. These companies have contributed, for the first outlay of expenses, from ten to twenty thousand dollars, and they are all making preparations for going into the business in an extensive manner, though the most that can be be [sic] done this season will be to secure and examine locations, and open the doors to those long concealed mines of wealth.*[5]

Such enthusiasm for mining was driven not simply by the boom on the south shore of Lake Superior, but also by anxiety about the economic future of Montreal and the trading system based on the city. Britain's adoption of free trade threatened to render much of the colonial economy irrelevant. To perpetuate what Donald Creighton would later characterize as "The Commercial Empire of the St Lawrence," it seemed

essential to secure the Upper Lakes as the city's resource hinterland.[6] The creation of a new staple trade—particularly one that would make full use of the new and expensive canal system along the St. Lawrence River system—was a priority for the anxious business people of Montreal.

Their investments in mining were premature or at least a little misguided, as Charles Robb later recalled. Writing in 1863, he criticized this early mining enthusiasm for its effects on those who were still hoping to mine successfully in the region:

> *...when the excitement consequent upon the great discoveries of copper on the south shore of Lake Superior was at its height, similar mining schemes were instituted on the Canadian side, and companies were formed in Montreal, Quebec, and various other Canadian cities, who with praiseworthy zeal, though questionable discretion, sent armies of explorers and miners into the field, equipped in the most extravagant style, and who certainly obtained abundance of ore, but at a cost greatly above its value. The consequence of these rash and imprudent proceedings was that most of the companies speedily abandoned their operations, after the irretrievable loss of large sums of money; and with those who have continued in the business till the present time, the debts thus incurred have proved a severe drag upon their subsequent more cautious proceedings.*[7]

One such company slowed down by their debts was the Montreal Mining Company, which was the most important of the companies formed in the 1840s. Its directors and promoters included many of Montreal's notable entrepreneurs and its political friends included the most prominent figures of the day. The company acquired a number of promising mineral locations, and given its membership, its relatively substantial resources (it was capitalized at £200,000), and the abundant mineral wealth of the Upper Lakes, its future seemed assured.[8] Notwithstanding such advantages, the company's career was little short of disastrous and followed the trajectory outlined by Robb above.

The company also attracted criticism for the extent of its holdings and its lack of progress in developing them, leading some to accuse the company of blocking legitimate mining. "The best portion of our mineral lands are locked up," complained William Gibbard, the Commissioner of Crown Lands, in his *Report on the Mines of Lakes Huron and Superior* in 1862:

> *... no exploring party or explorer is safe in spending his capital or labor in the neighborhood of any of these existing claims.*
>
> *... the immense block of land, consisting of 16 Locations 5 miles x 2 miles, patented to the Montreal Mining Company, embracing the most likely looking mineral lands, and held by them unimproved since 1847, is a great injury to our side.*
>
> *As near as I can estimate they hold a lake frontage of 150 miles; they will neither work nor sell, and under the present system may hold the same for 15 years more unimproved, without incurring any extra expense.*[9]

As Gibbard forecast, the Montreal Mining Company did not sell some of its holdings until 20 years after it had acquired them.

Surveys and prospecting along the north shore of Lake Superior in the 1840s and 1850s confirmed that the region did possess substantial deposits of copper, but successful mining called for more than just the presence of minerals. The handicap of distance—from both markets and ore treatment facilities—as well as an uncertain and expensive transportation route meant that the problems that Henry had encountered in the 1770s had yet to be overcome. In addition, hiring and keeping a reliable labour force to work the mines was no easy task. Many Europeans found the region remote and uninviting, while the neighbouring mines on the Keweenaw Peninsula in Michigan often proved an irresistible magnet, causing many to desert the Canadian side. Thus, although a number of exploratory shafts were sunk along the north shore, none led to extensive and ongoing mining that lasted through the 1850s and 1860s.[10]

The most notable mining activity on the Upper Lakes occurred at Bruce Mines, on the northwest shore of Lake Huron. Native people showed the copper deposit there to a government official in the mid-1840s, and this person promptly filed a mineral location for the property.[11] Dissatisfied with its other properties, the Montreal Mining Company opted to purchase Bruce Mines for £40,000. In 1848 the company began the task of opening up the property to production mining.

The following account of its early years reveals the common pitfalls of the time:

> *...in the fall of 1848 the first engine house was erected and machinery installed. Unfortunately, the severity of the climate was not allowed for in the construction of the building, and in consequence, frost got in the stone work, and when the machinery was set in motion, it collapsed.*
>
> *...In 1849, the small settlement consisted of 77 miners, 65 laborers, 4 boys, 11 blacksmiths, carpenters and other artisans, 2 mining captains, 1 engineer, 2 clerks and 1 superintendent, giving a population, including the families of the workmen, of about 250 souls. Cholera caused several deaths and delayed the erection of the machinery, so that it was not until the summer of 1850 that any returns could be made.*
>
> *...the President of the company, the late Hon. James Ferrier, brought out from Wales a copper refiner and three furnace men. This first attempt, unfortunately, proved a failure and the smelting works were destroyed by fire.*
>
> *...The dressing operations seem to have been very crude. Crushing with Cornish rolls, break staff jigs, and concave buddles appear to have been used. Evidently the crushing was not carried far enough and it is*

highly probable that they lost three-fifths of the ore contents. At any rate, the results obtained were so different to the estimates, that in 1851 all the officers resigned or were dismissed.[12]

The phrase, "the severity of the climate was not allowed for," may bring a smile to any who have experienced northern Ontario's sometimes bone-chilling winter temperatures, but it reveals more than the fact that the first Europeans at Bruce Mines—like Cartier three centuries earlier—were unprepared for the rigours of the Canadian climate. The subsequent collapse of the engine house suggests what the rest of the extract underlines: the pitfalls and problems that could result from the introduction of technology ill-suited to local conditions.

Mining equipment that worked well in other parts of the world would not necessarily prove effective in Canada, a fact that many were slow to learn; a reliance on inappropriate imported technology was typical of the early mining period. And mining on the North American frontier was a pioneering venture carried out far from the comforts and advantages of centres of European settlement. Workers would demand more money to compensate for the less appealing lifestyle (and could readily move on and find other work if wages or working conditions failed to match their expectations). If equipment broke down or was damaged, or proved unsuited to the work, securing its replacement was often a daunting and time-consuming task. Even the simple act of relaying the need for new equipment to those who would have to purchase it could be a cumbersome and lengthy process. Transporting machinery to a distant mine site typically depended on the weather and the season. Such challenges often proved insurmountable: mining was not particularly successful during this period. Constant restructuring, as the above passage hints, or outright failure tended to be the rule rather than the exception. Thus the problems at Bruce Mines were typical, as was the outcome. By the early 1860s, the Montreal Mining Company had had enough and opted to sell Bruce Mines to an English group that worked the neighbouring property.[13]

Still in its pioneer phase, metal mining in Canada was based on a readily identifiable ore deposit and relied on familiar (imported) techniques to recover and treat the ore. Steam engines were sometimes used—typically for ore treatment or pumping—but the work of mining was carried out by hand, in an underground workplace that was often poorly lit, poorly ventilated, and dangerous. In a retrospective article on Canadian mining practice during this period, one of McGill University's mining engineers, W.G. McBride, made little effort to hide his professional disapproval: "In 1879, there was practically no special training for mining engineers.... Little was known of the nature and origin of ore bodies, and the popular belief was that success was a matter of luck.... The methods and appliances used were so crude and unscientific that manual skill was more important than technical knowledge."[14]

McBride's criticism is perhaps a little harsh. The Bruce Mines, like others to the west on Lake Superior, adopted the technology used in the copper mines of Michigan's Keweenaw Peninsula. And there, as an American mining engineer pointed out in 1949, "Cornish mining practice had been transplanted almost unchanged." He went on to provide a useful description of contemporary mid-nineteenth-century mining:

In 1871, drilling was done almost entirely by hand, although the first piston drills to be run by compressed air... had been used in the Mount Cenis tunnel in 1861.... Tramming was done in wooden cars, pushed by men or hauled by horses.... Hoisting was done largely in buckets....

In 1871 shafts usually were small and closely spaced. It was customary to sink them on the vein, and frequently they were crooked. That was because they performed two functions: exploration as well as exploitation. Drifting [the construction of underground horizontal passages] was slow, and so [vertical] shafts were sunk close to the ore.... The maximum economical distance between shafts was considered to be 600 feet, and the reason given was that it did not pay to tram ore by hand [along an underground passage to the shaft] more than 300 feet. That being incorrect, the real reason was probably the slowness with which drifting was done, and the necessity of getting a number of working places into production as soon as possible.... When the Cornish miners came to the United States, beginning in 1850, they brought with them a very effective technique of shaft sinking, but it was based on hand drilling and was slow....

Most systems of mining in use 75 years ago [i.e., in 1871] would be classed as advancing work, and required little development. As soon as the ore was reached a room was opened out and stoping [the actual work of mining, ore extraction] commenced. The system most often used was some form of open stope, usually breast stoping, back stoping or underhand stoping. In all three variations the ore was loaded out by hand as soon as possible after it was broken, pillars were left to support the back, and little timber was used.[15]

Cornish miners and techniques came to the north shore as well, reflecting the declining fortunes of mining in Cornwall as much as the attractions of a new life overseas.[16]

The most significant mining development in the Upper Lakes came in the 1870s, to the west of Bruce Mines, on the far side of Lake Superior. As its name suggests, the Silver Islet mine—near present-day Thunder Bay—was a silver property.[17] The Montreal Mining Company acquired the mine in the 1840s but had done almost nothing to develop it until the late 1860s. In 1868, the company sent Thomas MacFarlane

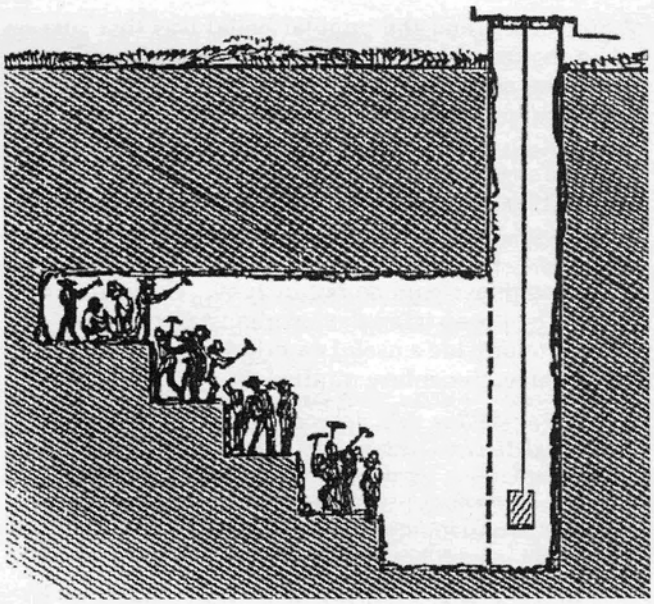


Figure 13. *DRIVING A BREAST The text accompanying this diagram from 1860 noted that the miners "commence to take off the ore from the side of the well [or shaft] at about 20 feet from the surface, and, after they have worked off about 10 feet, another gang is put in who commence about 5 or 6 feet below, and follow them. A third and fourth gang are put in, who follow each other, keeping always about the same distance apart and below each other. This is called "driving a breast," and the method of doing it is called "stoping."* (from "Artist-life," *Harper's*)

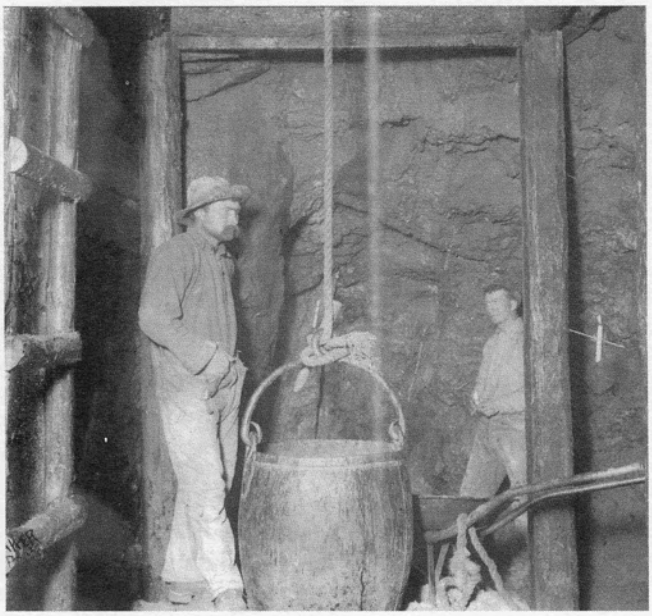


Figure 14. *SHAFT BOTTOM IN A B.C. GOLD MINE Figure 14 shows the bottom of the shaft in a B.C. gold mine. The ladder on the left was likely the only means of access down into the mine, with a windlass on the surface to hoist the ore to the grass. Candles held by several of the men, as well as one stuck into a timber, provided illumination.* (B.C. Archives)

to prospect the location. Even though MacFarlane reported discovering relatively rich silver ore, the company had apparently lost its appetite for mining and took advantage of MacFarlane's encouraging news to sell the property to an American-based company.[18] One of the pioneer mining entrepreneurs of the region recorded the seeming inability of Canadian companies to take advantage of the mineral wealth of Lake Superior:

> *On our side of the lake, people seem greatly disappointed when a mine does not pay a dividend the first year it is worked ... yet it is probable that the most of the future paying mines will have to be worked from two to five years before they will pay their first dividend.*
>
> *...our Lake Superior rocks enclose immense wealth, which only require energy and capital to extract; and it is to be hoped that our own people will not hold back and allow it all to pass into other hands, as I might say they have been doing up to the present.*[19]

As the passage hints, the wealth of Silver Islet ultimately flowed south, into the hands of canny Americans.

Silver Islet was not only Canada's most successful mine in the period before 1880, it was also the most technologically advanced. In part, this was a consequence of American ownership and the introduction of mining methods developed in the U.S. Figure 16,

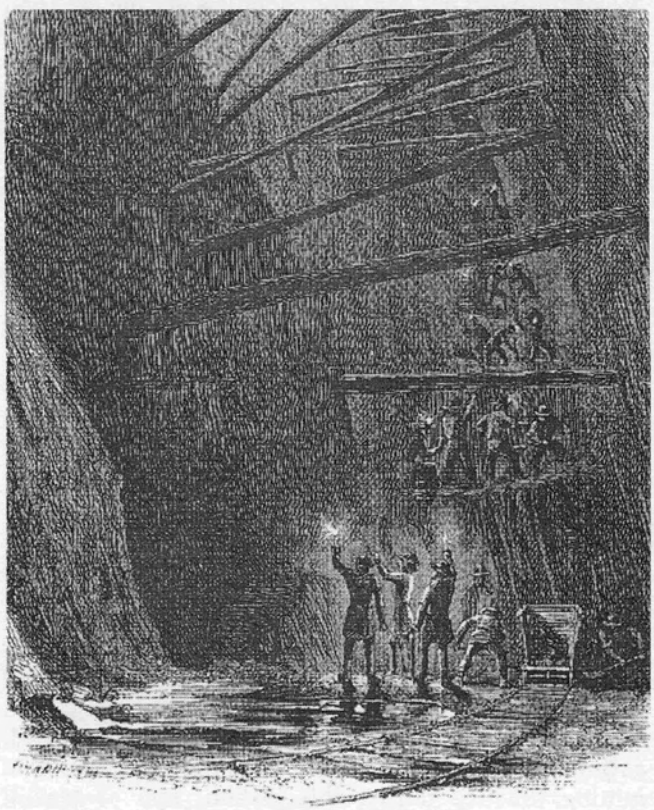


Figure 15. *INTERIOR OF THE MINE The rather eerie engraving is an artist's impression of a working mine in 1860.* (from "Artist-life," *Harper's*)

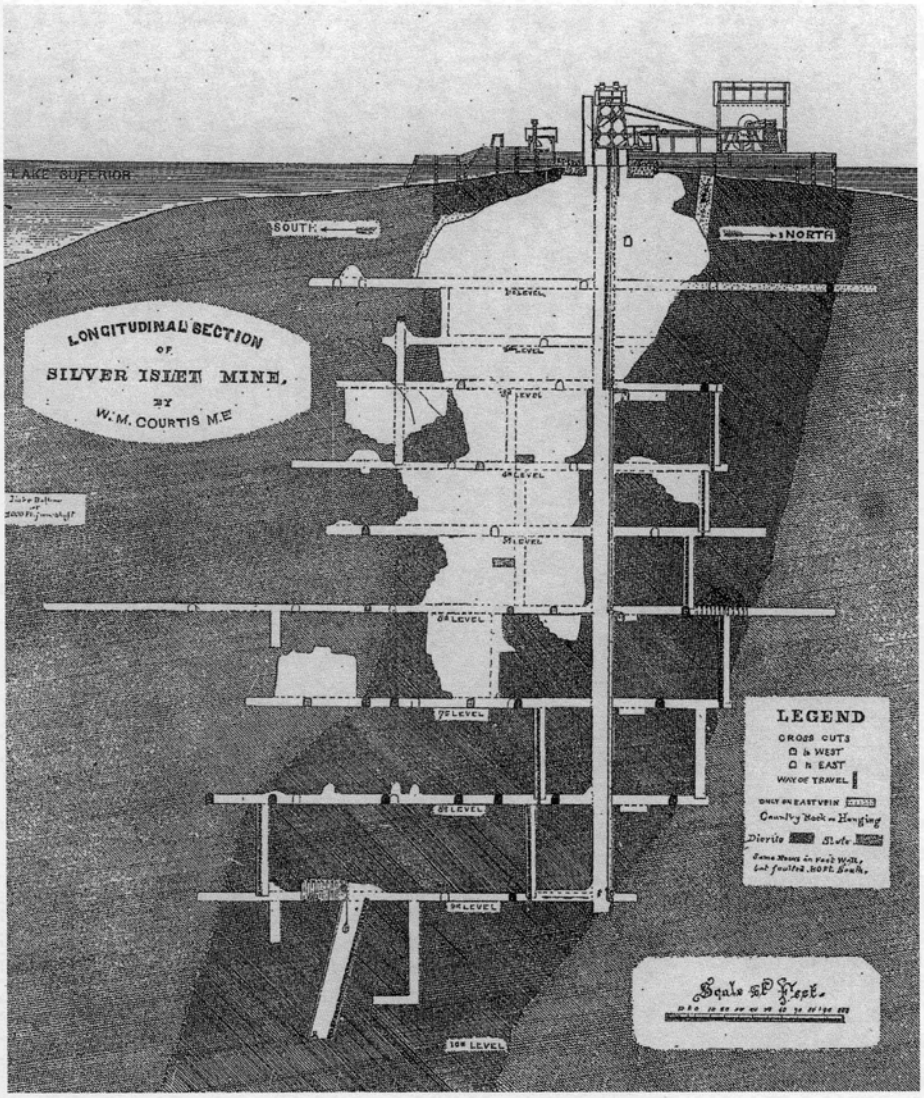


Figure 16. *LONGTITUDINAL SECTION OF SILVER ISLET MINE* (from *Engineering and Mining Journal)*

Figure 17. *ADVERTISEMENT FOR THE IMPROVED FRUE VANNER CONCENTRATOR* (from *Engineering and Mining Journal*)

which originally appeared in the New York-based *Engineering and Mining Journal* in December 1878, reveals the mine's complexity. Beneath a small island, the company constructed an intricate work environment, consisting of a series of horizontal levels connected by a main shaft. Steam power drove the hoist as well as the mine pumps. The white space underground indicates the area already mined, while the darker shaded section running through the centre of the engraving depicts the ore body.[20] This layout remained the standard pattern for most Canadian metal mines over the next century: for example, the illustration bears a strong resemblance to the typical metal mine depicted by a provincial government department in 1980: see Figure 33. The invention of the Frue Vanner at Silver Islet during the early 1870s also reflected the mine's relatively sophisticated level of development. A significant contribution to milling technology, the vanner became a standard fixture in mine mills across North America over the next several decades.

The other notable mining region of this pioneer period was in Quebec, in the copper region of the Eastern Townships. By the early 1860s, the first commercial properties in this area—notably the Acton Mine—were beginning to attract considerable attention.[21] Indeed, such was the novelty of the first properties that in 1860 special trains ran from Montreal to Acton, to enable the curious to visit the mines. A correspondent from the British periodical, *The Illustrated London News*, reported that the owner was able to charge admission to those sight-seers who were keen to see the mine:

> *The commercial part of the community who reside in Montreal and the neighbourhood have lately been thrown into a state of considerable excitement by the discovery of an immense deposit of copper ore in the hillside near the village of Acton, Canada East, about forty miles from Montreal.... Excursion-trains run from Montreal expressly to visit the mines; and, as the proprietor makes a charge for admission to the mine, he is likely to make a rich harvest of gold and silver, as well as copper, by his discovery.*
>
> *The approach to the mine is through a wood of the ordinary character, about half a mile of which having been passed through, the visitor arrives at a wicket gate, where a fee is demanded for liberty to inspect the*

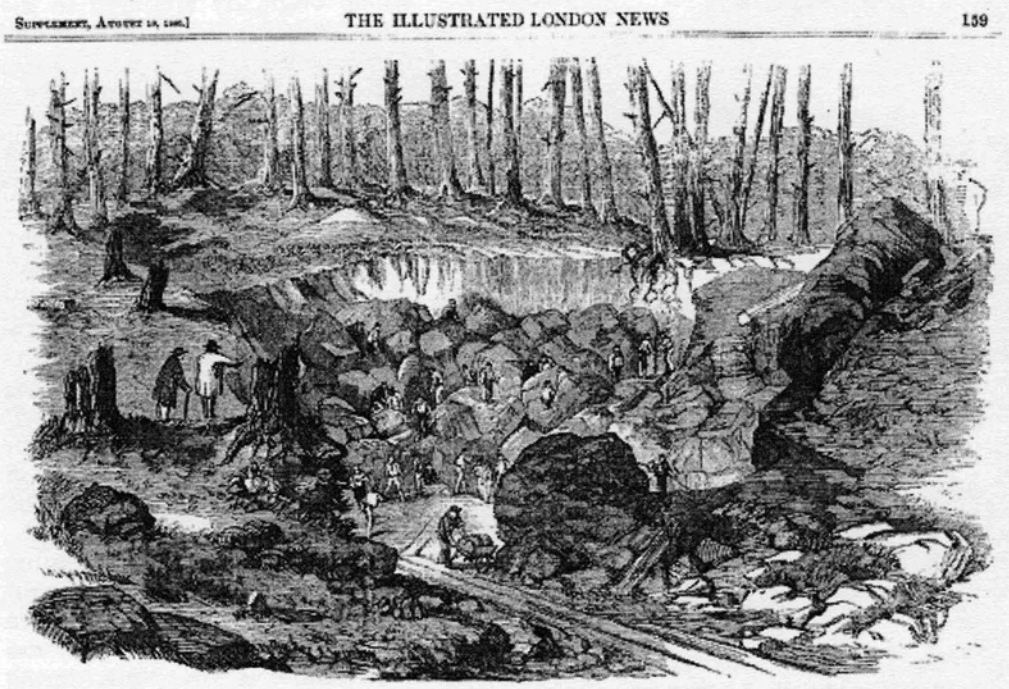


Figure 18. *COPPER MINE OR QUARRY, NEAR MONTREAL, CANADA An engraving from* The Illustrated London News *of August 1860, showing off the recent mining development in the Eastern Townships.*

> *works. Entering the inclosure [sic], an extraordinary scene presents itself. The face of a considerable hill has been laid open, and what appears a large stone quarry is being worked by about a hundred men, who are continually blasting with gunpowder, and using all the ordinary means for getting out blocks of dark grey stone, which, on a closer examination, will be found to be good rich copper ore. Two or three quarries have been opened on the side of the hill, and a shaft has been sunk to a considerable depth...*[22]

The American Civil War soon pushed up the price of copper, and a number of companies were formed to take advantage of the favourable economic climate for mining. Perhaps the most notable of these properties was the Eustis Mine near Sherbrooke, which remained in production for 70 years, from 1865 until 1939. It contributed to the early success of an American entrepreneur who later helped to found the International Nickel Company of Canada.[23]

Despite the relatively modest profits of mines in Quebec in the 1860s, metal mining in Canada had not yet overcome the difficulties of operating in a very large country, where distance from both markets and fuel created very real obstacles to success. A British visitor offered a perceptive analysis of both the promise and the challenges facing Canada's mining industry in the early 1860s:

> *The copper mines of the Eastern Townships in Lower Canada, and those abounding on the northern shores of Lake Huron, and the western regions of Lake Superior, are the most important, and if judiciously developed, will doubtless be productive of great and gratifying results. The former are diffused over an extensive tract of country, extending from Lake Champlain in a north-easterly direction as far as Quebec; thus occupying a breadth of nearly fifty miles, while the latter occupies a lineal extent of four hundred miles. Notwithstanding the abundance of copper ore in the country, only one thousand and eleven tons were mined in 1861, the value of which was a little under thirty-three thousand dollars....*
>
> *Owing to the internecine war in America [the Civil War], the progress of mining in Canada has been seriously interrupted. The suspension of specie payments operating upon the production of copper in the States, must have the effect of increasing its value, as its consumption still remains undiminished. The great drawbacks to the successful and profitable operation of mining in the Province are the scarcity and consequently exorbitant cost of labour; the charges incidental to transportation, which twice exceed those in England; and having to send the ore to Wales for the purpose of being smelted. A few smelting works have been tried in the neighbourhood of Lake Superior, but they did not answer. It was found necessary to amalgamate the ore with metal of a similar description so as to render it marketable; and, besides, its production cost less by shipping it to Wales than if it had been manufactured in the Province. These impediments, however, are likely to be but of short duration, as mining bids fair to become an "institution" with the Canadians. The immigration of Cornish miners, the erection of smelting works, and the concentration of ore near the mines, or at the nearest coal country in English America, will change the aspect of affairs considerably. It is thought that Nova Scotia will in time occupy a similar position with regard to the mining region of Lower Canada that South Wales holds with respect to Cornwall. It is well known that the Canadian ores are richer, and in every way superior, to those of Wales. Their greater proximity to the surface of the earth precludes the necessity for expensive machinery, the erection and working of which absorb a good share of the profits.*[24]

This optimistic assessment was only partially realized in the years ahead. The modern age of mining only dawned after the arrival of the railway, a technological system capable of overcoming the tyranny of both climate and distance.

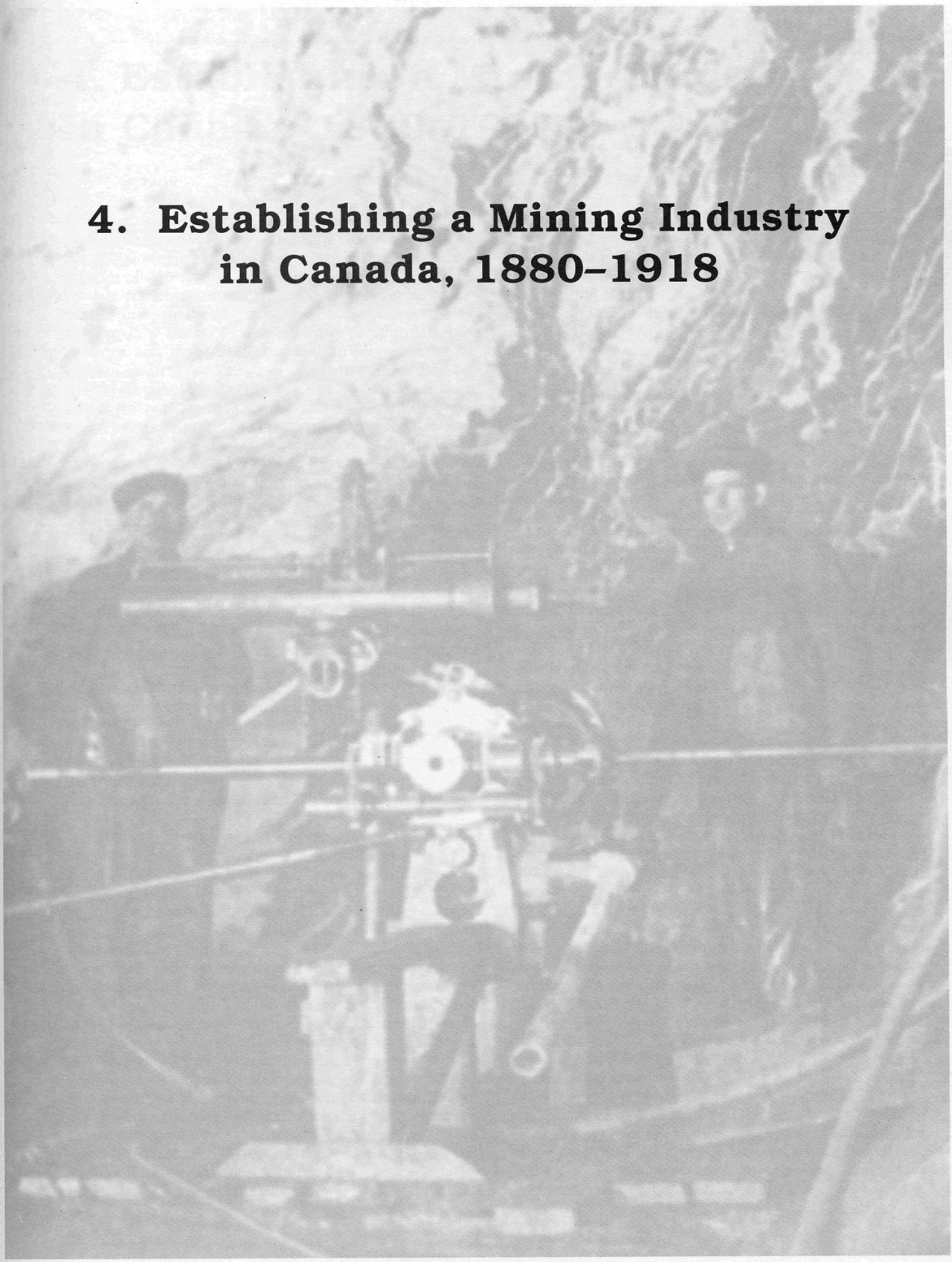
Railways brought the second industrial age to Canada, literally and symbolically.[25] This brave new world encouraged an abiding fascination with engineering, for railways were engineering projects on a massive scale, and it facilitated European expansion into areas other than those that seemed suitable to a traditional agriculturally-based economy. The new imperative was to exploit the land and its resources to the fullest, barring the limits set by the availability of technology, labour and capital.[26] This new age, then, was one ideally suited to the growth and expansion of the Canadian mining industry.

Notes

1. See the "Journal of Father Claude Allouez's Voyage into the Outaouac Country" in Father François-Joseph le Mercier, "Relation for 1666-67"; reprinted in *The Jesuit Relations and Allied Documents: A Selection*, S. R. Mealing, ed. (Toronto: McLelland and Stewart, 1963), p. 95. Cf. the "Relation for 1659–60," written by Father Jérôme Lalemant, *The Jesuit Relations*, pp. 91-92.
2. See the comments in Conrad Heidenreich, "Early French Exploration in the North American Interior," in John Logan Allen, ed., *North American Exploration*, vol. 2, *A Continent Defined* (Lincoln: University of Nebraska Press, 1997), pp. 124-25; also, James A. Mulholland, "The History of Metals in North America: 1580 to 1800" (PhD thesis, University of Delaware, 1975), pp. 116-20.
3. Alexander Henry, *Travels & Adventures in Canada and the Indian Territories Between the Years 1760 and 1776*, James Bain, ed. (New York: Burt Franklin, 1969) p. 226; reprint of the 1901 edition, first published in 1809. The previous quotation in the text is from pp. 212-13. On Henry's career, see Bain's preface to *Travels & Adventures in Canada*, as well as David A. Armour, "Alexander Henry," *Dictionary of Canadian Biography, Volume VI, 1821-1835* (Toronto: University of Toronto Press, 1987) pp. 316-19.
4. See the accounts in William B. Gates, Jr., *Michigan Copper and Boston Dollars* (Cambridge, Mass.: Harvard University Press, 1951); David J. Krause, *The Making of a Mining District: Keenenaw Native Copper, 1500-1870* (Detroit: Wayne State University Press, 1992); and Larry Lankton, *Beyond the Boundaries: Life and Landscape at the Lake Superior Copper Mines, 1840-1875* (New York: Oxford University Press, 1997).
5. "The Copper Mines of Lake Superior," *Montreal Transcript and Commercial Advertiser*, 27 August 1846, p. 2.
6. See Gerald J. J. Tulchinsky, *The River Barons: Montreal Businessmen and the Growth of Industry and Transportation 1837-53* (Toronto: University of Toronto Press, 1977), pp. 26-7 and passim, and Suzanne Zeller, *Inventing Canada: Early Victorian Science and the Idea of a Transcontinental Nation* (Toronto: University of Toronto Press, 1987), esp. pp. 65-74, as well as the comments in Elizabeth Arthur, ed., *Thunder Bay District 1821-1892: A Collection of Documents* (Toronto: University of Toronto Press, 1973), pp. xi-xii; Dianne Newell, *Technology on the Frontier: Mining in Old Ontario* (Vancouver: UBC Press, 1986), pp. 63-69; and W. Robert Wightman and Nancy M. Wightman, *The Land Between: Northwestern Ontario Resource Development, 1800 to the 1990s* (Toronto: University of Toronto Press, 1997), pp. 18-20.
7. Charles Robb, "Mineral Resources of British North America: A Sketch of the Nature, Extent and Value of the Metals and Other Useful Minerals Found in Canada, Nova Scotia, New Brunswick, and British Columbia, With an Account of the Progress of Mining Industry in these Provinces," in *Eighty Years' Progress of British North America; Showing the Wonderful Development of Its Natural Resources, by the Unbounded Energy and Enterprise of its Inhabitants; Giving, in a Historical Form, the Vast Improvements Made in Agriculture, Commerce, and Trade, Modes of Travel and Transportation, Mining, and Educational Interests, etc., etc., with a Large Amount of Statistical Information from the Best and Latest Authorities* (Toronto: L. Stebbins, 1863), p. 322.
8. Dianne Newell points out that "The list of original shareholders and directors of companies formed to work the Lake Huron and Superior mineral locations reads like a 'who's who' for the Province of Canada." Newell, *Technology on the Frontier*, note 6, p. 167. The Montreal Mining Company's original trustees, for example, included Peter McGill, George Moffatt, George Simpson (of the Hudson's Bay Company), Allan MacNab, and James Ferrier. See *An Act to Incorporate the Montreal Mining Company* 10 & 11 Vict., Cap. 68 (Montreal: Lovell & Gibson, 1850), p. 4. Others closely involved with the company included Hugh Allan (who served as president), James Logan (brother of William Logan, the founder and first director of the Geological Survey of Canada), as well as notable members of Montreal's francophone business community (including George Cartier, Pierre Beaubien, Augustin Norbert Morin, and Joseph Bourret) and the city's Jewish community (see Tulchinsky, *The River Barons*, pp. 14-15, 45). Tulchinsky gives the capitalization of various Montreal-based companies floated in the 1840s and 50s, and these figures suggest that at £200,000 the Montreal Mining Company had a relatively high capitalization: see *The River Barons*, p. 26.
9. William Gibbard's "Report on the Mines of Lakes Huron and Superior" was published in the *Sessional Papers* of the Province of Canada, 1863, Vol. 41 (Paper No. 5, Appendix, No. 43); the report is dated 18 December 1862. Cf. the comments of Thos. W. Gibson, *Mining in Ontario* (Toronto: King's Printer, 1937), p. 44. For evidence of the company's disastrous career, see the *Report of the Committee of Investigation Read to Stockholders of Montreal Mining Company, 28th March, 1855* (Montreal: James Potts, 1855), and Newell, *Technology on the Frontier*, pp. 63-72.
10. For a good description of the difficulties of the early years, see Walter William Palmer, "A Pioneer's Mining Experience on Lake Superior and Lake Huron," Ontario Bureau of Mines, *Annual Report* (1892): 171-78 (Palmer worked at Mica Bay, Lake Superior, 1848-49.) Note also the comments of Count de Rottermund, *Return to an Address of the Legislative Assembly for a Copy of the Report of Count de Rottermund, of his Exploration of Lakes Superior and Huron*, submitted by Joseph Cauchon, Commissioner of Crown Lands, 15 April 1856 (Toronto?: n.p., 1856?), pp. 14 & 18. Other accounts of mining along the north shore of Lake Superior in the 1850s and 1860s include McKellar, *Mining on the North Shore, Lake Superior*; the Geological Survey of Canada, *Report of Progress from Its Commencement to 1863; Illustrated by 498 Wood Cuts in the Text, and Accompanied by an Atlas of Maps and Sections* (Montreal: Dawson Brothers, 1863), pp. 698-708; and Newell, *Technology on the Frontier*, pp. 63-65. The Silver Islet mine is discussed separately, since it was a silver property and only began shipping ore at the end of the 1860s.
11. See H. J. Carnegie Williams, "The Bruce Mines, Ontario, 1846-1906," *Journal of the Canadian Mining Institute* 10 (1907), p. 149.

12. Williams, "The Bruce Mines," p. 150. Note also the discussion of technology and technological failure in A. H. Campbell's pamphlet, *A Letter to Hugh Allan, Esq., President, on the Subject of the Report submitted by him at the meeting of stockholders of the Montreal Mining Company, on Wednesday, 18th June, 1852* (Montreal: John C. Becket, 1852). Allan had gone to Bruce Mines and subsequently submitted a very critical account of company affairs there to stockholders; Campbell's pamphlet was a response to Allan's charges of mismanagement, etc. Count de Rottermund briefly describes Bruce Mines in *Return to an Address of the Legislative Assembly for a Copy of the Report of Count de Rottermund, of his Exploration of Lakes Superior and Huron*, p. 17. There is also an account of the company's unhappy early career in the *Report of the Committee of Investigation Read to Stockholders of Montreal Mining Company, 28th March, 1855* (Montreal: James Potts, 1855). The committee reported, inter alia, that during the years 1852, 1853, and 1854 the property ran at a loss (p. 12).
13. Williams, "The Bruce Mines," p. 151. See also the account of the mine's career in Newell, *Technology on the Frontier*, pp. 65-72.
14. W.G. McBride, "Developments in Mining Practice," *Canadian Mining Journal* 50, no. 8 (August 1929): 120. This was a special "Fiftieth Anniversary Number" of the *Canadian Mining Journal*, and was devoted to historical assessments of "50 Years of Progress" in Canadian mining. Writing in 1856, J. C. Taché admitted that "Mining operations in Canada are yet in their infancy, and the improvement of its mineral resources, has been confined, properly speaking, to mere experiments." *Canada at the Universal Exhibition of 1855* (Toronto: John Lovell, 1856), p. 158.
15. Lucien Eaton, "Seventy-five Years of Progress in Metal Mining," in A. B. Parsons, ed., *Seventy-five Years of Progress in the Mineral Industry 1871-1946* (New York: The American Institute of Mining and Metallurgical Engineers, 1947), pp. 42-43, 52-53, 55-56. For confirmation of the general thrust of Eaton's comments as well as their applicability to Canada, see Henry Vennor's description of gold mining in Ontario, in his "Progress Report of Exploration and Surveys in the Counties of Leeds, Frontenac and Lanark, With Notes on the Gold of Marmora," in Geological Survey of Canada, *Report of Progress for 1871-72*, (Montreal: Dawson Brothers, 1872), pp. 120-40, and McBride, "Developments in Mining Practice."
16. On Cornish miners, see Ronald M. James, "Defining the Group: Nineteenth-Century Cornish on the North American Mining Frontier," *Cornish Studies* 2 (1994): 32-47; John Rowe, *The Hard-rock Men: Cornish Immigrants and the North American Mining Frontier* (Liverpool: Liverpool University Press, 1974); and D. B. Barton, "The Cornish Miner in Fact and Fancy," in D. B. Barton, ed., *Essays in Cornish Mining History,* vol.I (Truro, Cornwall: D. Bradford Barton Ltd., 1968), pp. 13-66. Cornish underground mining technique is well illustrated in the slim pamphlet by J. A. Buckley, *Cornish Mining – Underground* (Penryn, Cornwall: Tor Mark Press, 1989).
17. Histories of mining at Silver Islet include Thomas MacFarlane, "Silver Islet," *Transactions of the American Institute of Mining Engineers* 8 (1879-80): 226-53; Archibald Blue, "The Story of Silver Islet," Ontario Bureau of Mines, *Annual Report* 6 (1897): 125-58; Beryl H. Scott, "The Story of Silver Islet," *Ontario History* 49 (1957): 125-37; Newell, *Technology on the Frontier*, pp. 74-83; and Elinor Barr, *Silver Islet: Striking It Rich in Lake Superior* (Toronto: Natural Heritage/Nature History Inc., 1988). Barr's handsomely produced and well researched book is a good place to start.
18. On MacFarlane's activities and the sale of the mine, see MacFarlane, "Silver Islet," and Barr, *Silver Islet*, pp. 21-33.
19. Peter McKellar, *Mining on the North Shore, Lake Superior* (Toronto?: s.n., 1874?), p. 25. (The title page reads: "The substance of this Pamphlet was contained in two papers, read before the Canadian Institute, in Toronto, last February, by the writer", and internal evidence suggests this was in 1874.) Similarly, MacFarlane noted that the story of Silver Islet "ought to teach Canadians . . . to have more confidence in the mineral resources of their country. That over three millions have been extracted from a bare rock, in Lake Superior, with an area not exceeding a thousand square feet, ought to increase our faith in the vast unexplored regions which stretch away to the north and northwest of us." MacFarlane, "Silver Islet," p. 253.
20. The cross section of the mine is included in the article, "Silver Islet Mine, Lake Superior," *Engineering and Mining Journal* 26, no. 25 (21 December 1878), between pages 432 & 33.
21. See Thomas MacFarlane, *Contributions to the History of the Acton Copper Mine, with a plan of the mine and six sections* (Montreal: John Lovell, 1862), taken from the *Canadian Naturalist* for December, 1862; and Herbert Williams, *Copper Mining in Canada East* (Quebec: Hunter, Rose & Co., 1865), p. 6.
22. "The Copper-Mine Near Montreal, Canada," *Illustrated London News* 38 (18 August 1860): 159.
23. See Marc Vallières, *Des mines et des hommes: histoire de l'industrie minérale québécoise* (Quebec: Les Publications du Québec, 1989), pp. 89-95; also, F. B. Howard-White, *Nickel: An Historical Review* (Princeton, N.J.: D. Van Nostrand Co., 1963), pp. 61-63, and D. M. LeBourdais, *Metals and Men: The Story of Canadian Mining* (Toronto: McClelland and Stewart, 1957), pp. 314-15.
24. Samuel Phillips Day, *English America: Or Pictures of Canadian Places and People*, vol. 2 (London: T. Cautley Newby, 1864), pp. 291-94.
25. For an excellent account of the centrality of railway construction to Canadian nationhood, see A. A. Den Otter's *The Philosophy of Railways: The Transcontinental Railway Idea in British North America* (Toronto: University of Toronto Press, 1997).
26. See Vernon C. Fowke, "National Policy and Western Development in North America," *Journal of Economic History* 16, no. 4 (December 1956), esp. p. 462. Note also Bruce Sinclair's thoughtful commentary on how Canadians proceeded to mix and match American and British technological styles in "Canadian Technology: British Traditions and American Influences," *Technology and Culture* 20, no. 1 (January 1979): 108-23.

4. Establishing a Mining Industry in Canada, 1880–1918



4. Establishing a Mining Industry in Canada, 1880–1918

The British Columbia gold rushes and the first underground mines in Ontario and Quebec represent the initial stages of Canada's modern mining industry. A series of significant changes encouraged its growth in the late nineteenth century. Governments, at both the federal and provincial levels, were anxious to facilitate mining: they enacted laws intended to stimulate the industry and they created formal structures such as geological surveys and mining departments, staffed by trained professionals.[1] Despite the industry's rather lacklustre performance in the late 1860s and 1870s, it also began to attract the interest of entrepreneurs and financiers. But the most significant boost to the industry came from a number of new developments in the 1880s, beginning with the construction of several transcontinental railways.

The importance of the transcontinental railways to Canadian socio-economic development in the late nineteenth century can hardly be overemphasized. Historians routinely stress the railway's significance, and the Canadian Pacific Railway appears inextricably linked to the narrative of national growth.[2] Railways were also powerful and complex symbols of modernity, and railway companies quickly became the largest corporate entities on the continent, exercising enormous political and economic influence. For example, they unilaterally re-defined standard time-keeping for the continent in 1883 and were largely responsible for creating a new transcontinental economy by the turn of the nineteenth century.[3] It is hardly surprising that they influenced the mining industry in many ways.

Railways provided an efficient and reasonably-priced transportation network that could operate year round. The mining industry's growing reliance on heavy equipment, as well as the need to ship ore in bulk to smelters for treatment, meant that success depended upon access to reliable and inexpensive transportation. This was no secret: for example, British Columbia's mineral wealth had long been recognized, but lack of transportation facilities had prevented the exploitation of any but the richest deposits. In 1888, George Mercer Dawson, the well-known Canadian geologist, pondered why "development of metalliferous mining in its more permanent forms has been slow," despite British Columbia's early career as a gold producer. He concluded that "one of the chief drawbacks has always been the want of proper means of transport for heavy machinery and for ores."[4] The construction of the Northern Pacific in 1883, followed by the Canadian Pacific Railway in 1885, encouraged prospectors to begin their careful investigations of the ground, to locate and analyze likely-looking outcrops, which stimulated substantial development of British Columbia's mineral resources, notably in the southeast corner of the province.[5]

British Columbia was not the only region where the mining industry followed the railway. "I am forcibly struck," wrote mining entrepreneur Noah Timmins in an article looking back on his career,

> *with the realization of the part the railways have played in the development of the mineral resources of this country. It was in 1883 that the building of the Canadian Pacific Railway led to the discovery of the world's greatest nickel deposits near Sudbury, and the building of the Temiskaming and Northern Ontario Railway twenty years later led to the discovery of the fabulous silver deposits at Cobalt.... extending the Temiskaming and Northern Ontario Railway northward in 1907 contributed indirectly to the discovery of [gold deposits at] Porcupine and Kirkland Lake...*[6]

His account is accurate: the Sudbury basin unquestionably owed its growth to the railway's arrival, which stimulated a boom first in prospecting and staking, and ultimately led to the emergence of a very prosperous mining community.[7] As they had in British Columbia, railways fostered mining and prospecting across northern Ontario.

Other developments contributed to the remarkable growth in mining in the period from 1880 to 1918. The importance of railways to mining, for example, was in part a reflection of a fundamental change in the focus of mining activity. Placer gold deposits, the resource that gave rise to the mid-nineteenth century gold rushes, could be worked profitably by individuals and small groups employing relatively simple tools. But most rich placer deposits were soon depleted, forcing miners to find a way to make a profit from much lower grade material. Techniques such as hydraulicking applied economies of scale and mechanization to placer mining, but even these could not hide the fact that by the 1880s, British Columbia's richest and most accessible placer gold deposits were largely exhausted. The Klondike rush of the late 1890s was something of an anomaly, in many ways the last of the great nineteenth-century placer stampedes.[8]

The decline in British Columbia's gold mining industry was a major economic problem not only for the miners and the communities in which they lived, but also for the provincial government, which had received a major boost in revenue from the booming

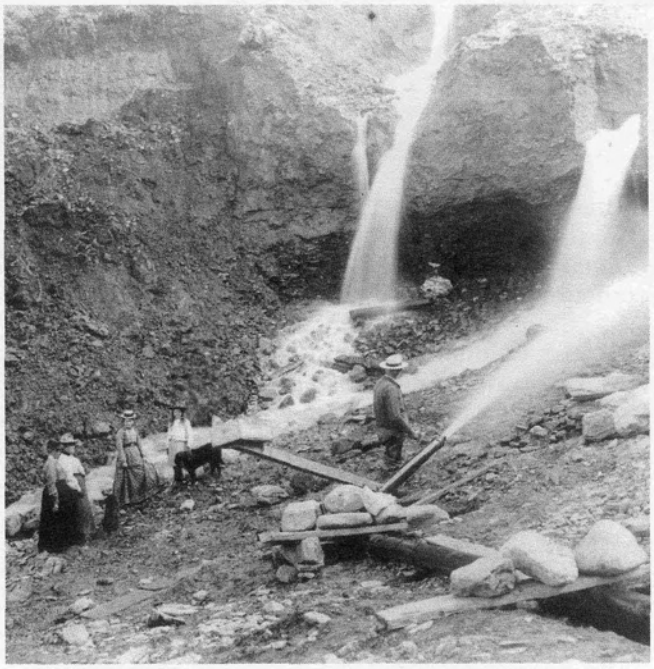


Figure 19. *WILLIAMS CLAIM, MOSQUITO CREEK, HYDRAULIC MINING In this turn-of-the-century photograph from the Cariboo, a group of women pose beyond a man directing the jet's nozzle to a point off-camera.* (B.C. Archives)

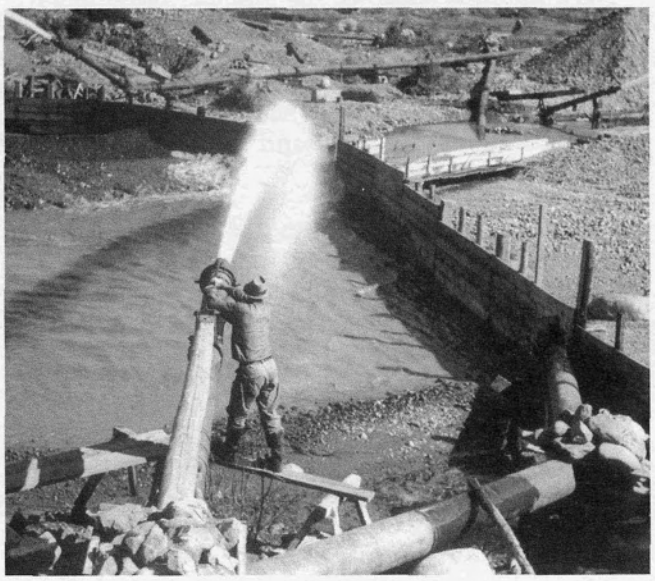


Figure 20. *MCRAE-ACHESON HYDRAULIC OPERATION, PINE CREEK As placer mining shifted in focus and attempted to treat lower grade deposits, mechanization and economies of scale assumed far greater significance. Hydraulicking was developed in California in the 1850s and used powerful jets of water to blast gold-bearing gravels. It was relatively late in coming north, although ultimately it became a significant activity in the post-rush era in British Columbia.*[9] *Taken in the 1920s, this photo reveals the more extensive hydraulic activity in the Stikine region of northwestern British Columbia.* (B.C. Archives)

gold mining industry of the early 1860s.[10] In 1874 the government established a Ministry of Mines, and a recurring theme of its annual reports was the need to devise some means of mining gold from the quartz that occurred around Barkerville, site of the 1860s gold rush, as a way to revitalize the mining industry. However, this form of gold mining—hard-rock mining—was very different from placer mining. The provincial government hired a Cornish mining engineer in 1877 to provide expert assistance, but even his presence in the Cariboo does not appear to have made much difference. By the end of the 1870s miners remained unable to recover a significant percentage of the gold from the region's quartz deposits.[11]

The provincial government did not abandon hope, however. In the mid-1880s it commissioned "Mr Koch, mining expert," to produce a report on the gold quartz deposits, while a second expert from California, William Craib, provided a written response to such questions as "the best method to introduce our quartz interests to capitalists in order that they might be

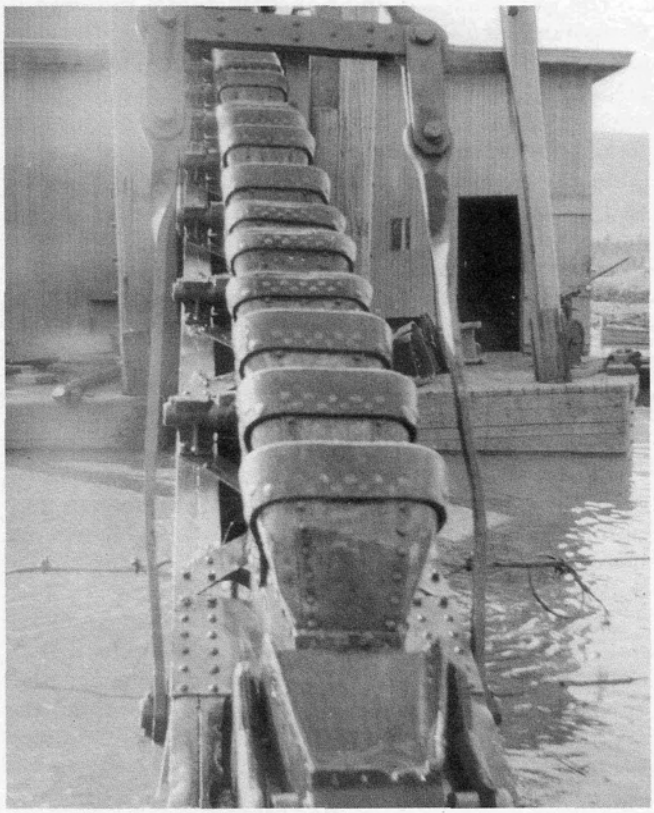


Figure 21. *SCOOP BUCKETS ON GOLD DREDGE AT ATLIN Like hydraulicking, gold dredges were introduced in the wake of the gold rushes to profit from treating the extensive low grade deposits of gold-bearing gravels. First developed in New Zealand in the 1880s, dredges soon appeared in California, British Columbia and the Yukon.*[12] *The photograph of the buckets on an Atlin dredge suggests the factory-like quality of this form of mining.* (B.C. Archives)

induced to advance the means to prospect and open up the same."[13] During the following year, the government reopened its assay office in Barkerville and put in charge "Mr. E. A. Martin... a man who has had much experience with the treatment of refractory ores, by the latest known methods, [who] will be a valuable acquisition in the development of our Quartz Mining Interests."[14] Martin extended the provincial government's role in Barkerville, supervising the erection of an extensive "Government Reduction Works" in 1888. This was an elaborate plant (including a furnace for roasting the ore, as well as a stamp mill for reducing it, a concentrator, a steam engine, and a chlorinating plant), although it appears to have operated for only a short time before being destroyed by fire in the winter of 1889-90.[15] At about the same time, a municipally supported reduction works was built in Rat Portage, present-day Kenora in northwestern Ontario. Like its counterpart in Barkerville, the purpose of the reduction works was to facilitate mining by providing an economic means of treatment for properties in the early stages of development, although its career appears to have been relatively brief and unsuccessful.[16]

The government plants in Barkerville and Rat Portage did not produce immediate or dramatic wealth in the mining regions they served, but their construction and operation suggest the optimism of those within the mining industry. Few doubted that the application of appropriate technology, similar to that used in Nevada and California where the transition from placer to quartz mining had already been made, would enable the mining industry to prosper in Canada. In 1886, for example, a member of the Geological Survey of Canada noted that British Columbia's gold production had steadily declined since the earlier rush era, "due to the more or less complete exhaustion of the richer or more readily worked creeks; while 'quartz mining' can scarcely yet be said to have been initiated. Once successfully begun with proper appliances, knowledge and sufficient capital, it is believed that the gold production of the province will again show a rapid increase."[17] The Cariboo's gold commissioner was equally confident: "science has demonstrated the fact that the infinitesimally fine gold locked up in sulphuret ore can be nearly all extracted and saved."[18] But the introduction of the latest processes to treat gold ore (such as chlorination and cyanidation) did not bring the anticipated success. Those who believed that applied science and improved technology were sure panaceas for the economic difficulties of the post-rush era underestimated the complexities involved in the wholesale transfer of new equipment or the implementation of new processes.

Figure 22. *DREDGE NO.4 IN THE KLONDIKE RIVER, JUNE 14, 1914 The photograph of No. 4 Dredge on the Klondike River in the summer of 1914 indicates their method of working as well as their considerable environmental impact.* (Yukon Archives)

Early underground mining activity, such as the shallow workings around Barkerville and the mines in the Eastern Townships or at Silver Islet on Lake Superior, had a relatively straightforward goal: to dislodge and bring to the surface readily identifiable ore. As late as 1893, an official with Ontario's Department of Mines noted that "In Ontario there has hitherto been no deep mining by the sinking of shafts, with perhaps the two exceptions of the Silver Islet mine in Lake Superior and the Copper Cliff mine at Sudbury."[19] As ores became more complex and as the scale of activity increased dramatically, traditional mining techniques were increasingly inadequate.

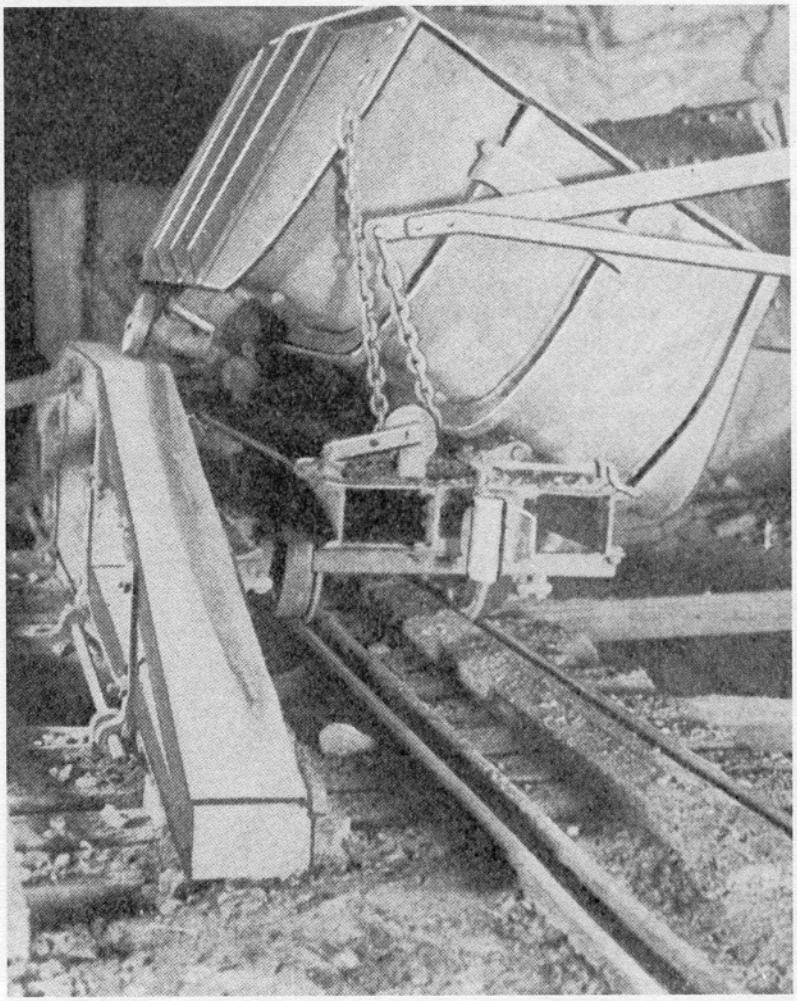


Figure 23. *THE 75-FOOT GRANBY MINE CAR Like the copper properties in the southern United States—notably in Utah's Bingham Canyon—British Columbia's Granby mines were a pioneer in developing techniques to treat very large tonnages of low grade ore in the early years of the twentieth century. It was no coincidence that Canada's most notable contribution to mining technology during this period was the Granby car, a side-dumping car that facilitated the movement of ore. During their period of peak production during the First World War, the Granby mines shipped four thousand tons of ore every day to the company's smelter.* (from Campbell, *Engineering and Mining Journal*)

Mining changed dramatically as the industry began to rely more on low grade ore bodies. Rich and easily-worked bonanza deposits were soon depleted—the industry's survival in the long term depended not on chance discoveries of rich ore but the ability to work the extensive lower grade ore at a profit. Major advances in metallurgy around the turn of the century, especially the development of the cyanide process (for gold) and flotation (for lead, copper and zinc), made working such deposits economically feasible.[20]

As with other technologies of the late nineteenth and early twentieth centuries, mining technology came to Canada most often from south of the border. As Christopher Armstrong and H. V. Nelles argued in their book, *Monopoly's Moment*, "it was U.S. rather than European styles, standards, and systems that were transferred to Canada."[21] Just as the gold rush had ultimately moved north to the Fraser River from California, and Michigan's copper mining industry had shaped events on Lake Superior's north shore, so too did innovations in mining methods come into Canada from the United States.[22] Examples include dynamite, rock drills, techniques such as shrinkage stoping, and the compressed air and electrical equipment necessary for non-selective mining. Two branch plants of American companies arrived: the Ingersoll Rock Drill Company of Canada began to supply the Canadian market in 1882, followed by the Canadian Rand Drill Company in 1890.[23]

A notable exception to the rule of imported technology was the Granby mine car, an automatic side-dumping car.[24] In 1905, B.C.'s Minister of Mines noted that:

> *The costs of mining and smelting have been gradually reduced in this section [the Boundary district], thanks to as fine equipments as money could buy, in the hands of intelligent and scientific men, until they are now reported to be about the lowest in the world. To quote from a recent editorial in the leading American scientific journal: "Ten years ago the idea of smelting for a dollar a ton and mining for $1.10 a ton would have been scouted as impossible. Yet this has been done at the Granby mines..."*[25]

Thus the Granby mines in southeastern British Columbia took a leading role in reducing mining costs and moving very large amounts of low-grade ore at a profit.

Mine mills could now recover the mineral content from ore that only a few years earlier would not have been worth bringing to the surface. To be cost effective, however, lower

grade properties had to produce much larger tonnages of ore, and working costs had to be kept as low as possible.[26] In addition, because metal mining required considerable capital for the extensive plants needed to recover and treat underground ore, investors began to rely on the supervisory talents of experienced mining engineers.

Indeed, one scholar has argued that the rise of the American mining engineering profession was largely a response to this situation:

> *What was increasing the demand for mining engineers? Mines were becoming larger as eastern capitalists sought to expand their operations and achieve vertical and horizontal integration of their metals-related industries. The change to large scale mining was also helped by the introduction of new machinery: the jack-leg drill which ran on compressed air and enabled much faster ore removal; the use of electricity in mines for hoists; and wire rope which made faster transportation of men and ore possible. The combination of new technologies and the demands of new economic structures together produced the push for more mining engineers.*
>
> *Mining schools in America then rose in response to financiers' interest in reliable information about mining prospects, a need to plan large scale ventures, and a need for metallurgists to treat difficult ores which were met when the easily recovered placer gold and weathered outcroppings gave out.... American mining schools did not become a common phenomenon until there was a fundamental change in the scale of mining operations and a corresponding change in industrial organization.*
>
> *Thus American mining schools rose primarily in response to the development of industrial capitalism. This is not to say that needs for planning mines and more importantly, metallurgical requirements, were unimportant in the founding of American mining schools, only the full implementation of these required the transition from small to large scale mining.*[27]

As mining operations expanded and grew in complexity, new skills were needed: "The mining engineer of the present day [1909] ... finds his chief work not in doing those things he was trained to do as a specialist, but in making use of the knowledge of geologists, chemists, and electrical and mechanical engineers. He must be to a large extent not only an engineer, but an economist, a sociologist, and even a politician."[28]

About the same time as the industry was becoming complex in scale and organization, mining engineers became more professional. The country's leading periodical of the industry, the *Canadian Mining Review*, began publishing in 1882; its title was similar to that of one in Chicago. The presence of American mining engineers in most of the country's mining regions perhaps explains why the first national organization of mining engineers—the Canadian Mining Institute, formed in 1898—was modelled on the American Institute of Mining Engineers.[29]

Efforts were also made to promote mining education and the training of mining engineers within Canada, particularly after the report of Ontario's *Royal Commission on the Mineral Resources of Ontario and Measures for their Development* was published in 1890.[30] Its careful investigation, the Commissioners reported sombrely,

> *...leads to the conclusion that more than one-half of the capital invested in mining operations in Ontario is American.... The evidence also leads to the conclusion that the American investments are managed as a rule by experienced and trained men, who are capable of giving intelligent direction to the operations under their charge. It is quite evident in most cases that practical education of a thorough character has been acquired by these American mine captains in connection with the prosecution of mining enterprises in the United States, and many of them have also received the advantages of technical education in American mining schools. Canadian prospectors and miners are found as a rule to possess intelligence and energy, but in many cases they have lacked opportunity to obtain either practical or technical education. It is evident that a Canadian school of mines would do good service.*[31]

The subsequent establishment of a School of Mines at Queen's University in Kingston (1893) owed much to the Royal Commission, which also encouraged Ontario to create a provincial mining department in 1891, something that Quebec had done the year before.[32]

The emergence of a group of trained mining engineers in Canada reflected more than the recommendations of a Royal Commission, of course, or the graduates of a single university. It was inevitably the result of changes in the industry. For example, a 1901 article in the *Engineering Magazine*—with the revealing title, "Principles and Methods of Profitably Working the Mine"—stressed that "*The efficiency of the general management* is the master-key to the success of a mining undertaking."[33]

When the distinguished mining engineer, Henry Louis, gave his inaugural address at the Durham College of Science in October 1895, he touched on the financial reasons for the new role of engineers:

> *Do not think that I am taking too candid a view of the mining engineer's duties: the sole justification for his existence is that he can make mining pay, and mining, I repeat, is a purely commercial pursuit. Accordingly, as I have said, the mining engineer must be first and foremost a man of business, and must study science, not for its own sake, but for the profit in pounds, shillings, and pence that he can get out of its application.*[34]

Figure 24. *STRIKING MINERS' PARADE, PORCUPINE, ONTARIO The many ethnic groups working in Canadian mining camps gave special meaning to the familiar rallying cry, "Workers of the World Unite," seen here carried by striking miners marching in Porcupine, Ontario, during the long and bitter 1912-13 strike.* (from Barnes, *Timmins*)

Such considerations made the mining engineer's job a difficult one, as Herbert Hoover ruefully acknowledged. In an aside in his book, *Principles of Mining*, Hoover—a very well-known mining engineer by the early 1900s, before becoming President of the United States a quarter of a century later—expressed the frustrations of having to work within a tight budget:

> *...the immediate commercial result limits the mining engineer's every plan and design... The question of capital and profit dogs his every footstep, for all mines are ephemeral; the life of any given mine is short. Metal mines have indeed the shortest lives of any.*
>
> *...Our engineer cousins can, in a greater degree by study and investigation, marshal in advance the factors with which they have to deal. The mining engineer's works, on the other hand, depend at all times on many elements which, from the nature of things, must remain unknown. No mine is laid bare to study and resolve in advance. We have to deal with conditions buried in the earth....*
>
> *Weary with disappointment in his wisest conception, many a mining engineer looks jealously upon his happier engineering cousin, who, when he designs a bridge, can know its size, its strains, and its cost, and can wash his hands of it finally when the contractor steps in to its construction. And, above all, it is no concern of his whether it will pay. Did he start to build a bridge over a water, the width or depth or bottom of which he could not know in advance, and require to get its cost back in ten years, with a profit, his would be a task of similar harassments [as that of the mining engineer].*[35]

Managers and engineers introduced mining methods that emphasized the extraction of maximum amounts of ore. Intentionally or not, the adoption of such methods effectively ended the earlier reliance on miners' expertise and independent judgement, critical to mine high grade ore successfully. As margins of skill became less important in the operation of a mine, mine management exercised greater control over the work-place.[36] A successful mining engineer had to possess sophisticated geological knowledge, the ability to select and install appropriate mining and milling technology with an eye to both budgetary constraints and potential dividends, and the talent to supervise a skilled workforce.

The establishment of mining schools in Canada arose out of the need for well-trained mining engineers,

yet few people saw any need to encourage the training of underground miners, even though by the early twentieth century, they worked in what had become one of the most technologically sophisticated environments. Occasionally, employers and others derided miners' shortcomings, as in the following comment by an Inspector with the Ontario Bureau of Mines in 1899: "The lack of such a body of well-trained miners is a serious drawback to the mining industry in Ontario.... The inexperience of the miners is shown perhaps most conspicuously in their misuse of dynamite, and their false setting of shots. I have rarely seen a hole drilled in any mine in the Province in such a position as to give the highest efficiency to the blast..."[37]

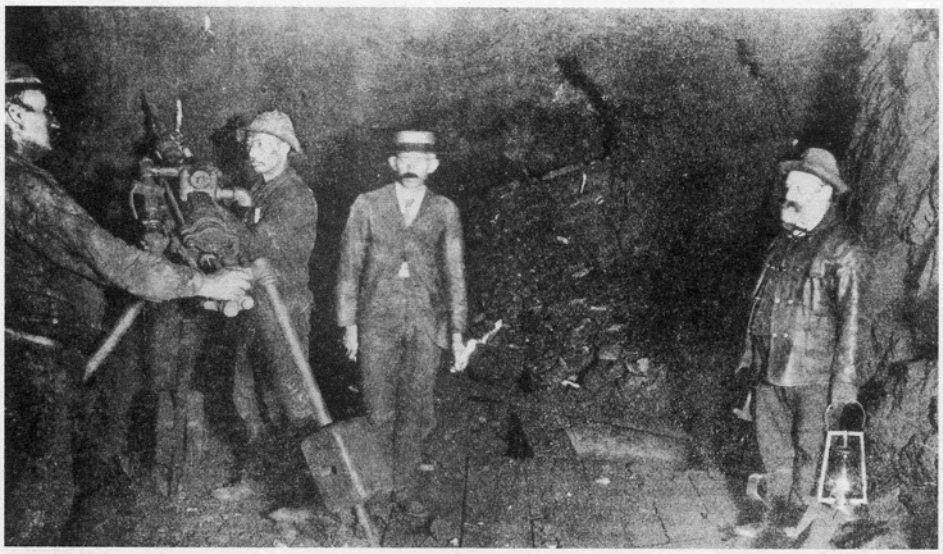


Figure 25. *MACHINE DRILL IN THE CENTRE STAR MINE, ROSSLAND* (B.C. Archives)

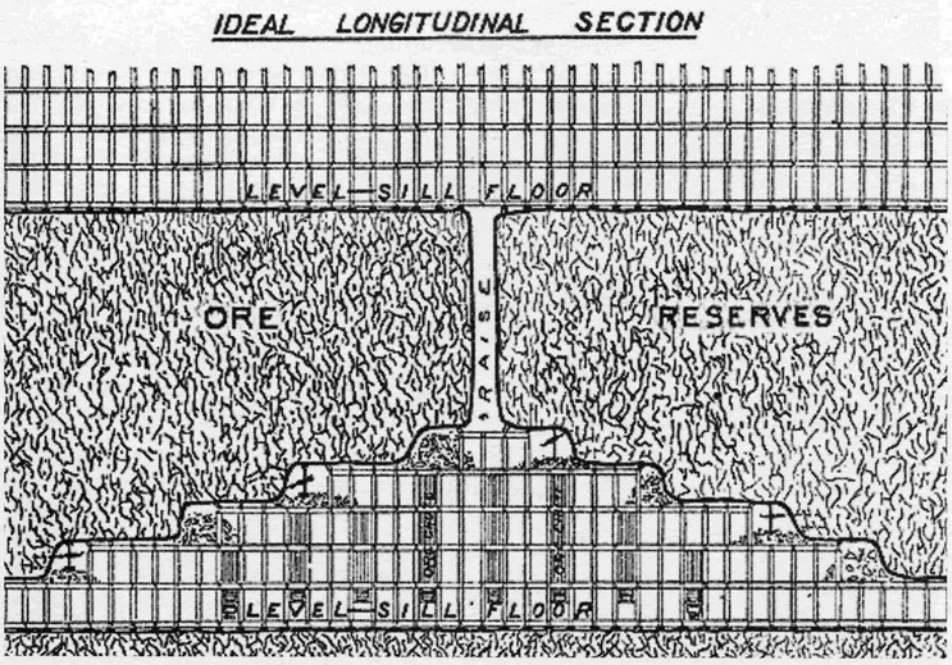


Figure 26. *IDEAL LONGITUDINAL SECTION By the late 1890s, machine drills were a common feature in underground workings, although as Figure 25 suggests, they tended to be large and unwieldy. The drills were soon incorporated into an overall plan for the efficient and systematic extraction of ore, as in the idealized sketch of a Rossland mine published in 1903 (Figure 26). Working mines never developed in such an orderly fashion, but the drawing provides useful detail, with the square set timbers, machine drills on platforms, and ore chutes situated to facilitate extraction along the floor of the level.* (from MacDonald, *Journal of the Canadian Mining Inst.*)

Such critical comments may or may not have been justified; the views of the miners themselves are difficult to trace in the surviving evidence. Most were likely attracted to the industry by its relatively high wages and sought only to accrue some modest savings before moving on to a more settled occupation. Certainly, the work of mining did not attract much enthusiastic comment; as Lewis Mumford points out, it was traditionally "one of the lowest in the human scale":

> *...no one entered the mine in civilized states until relatively modern times except as a prisoner of war, a criminal, a slave. Mining was not regarded as a humane art: it was a form of punishment: it combined the terrors of the dungeon with the physical exacerbation of the galley.*[38]

By the early 1890s, a distinctive pattern of labour relations was taking shape in the mining industry, and this too was brought north as part of the cultural baggage of both workers and managers. In the late 1890s, locals of the American miners' union, the Western Federation of Miners (WFM), were established in the mining communities of western Canada, beginning with Rossland in 1895.[39] The WFM's appearance in Canada can be explained by the fact that many miners had prior experience in American camps and consequently had certain expectations regarding working conditions, wage rates and so on.[40] An affiliation with the WFM was a way of ensuring conformity with the industry's common practices.

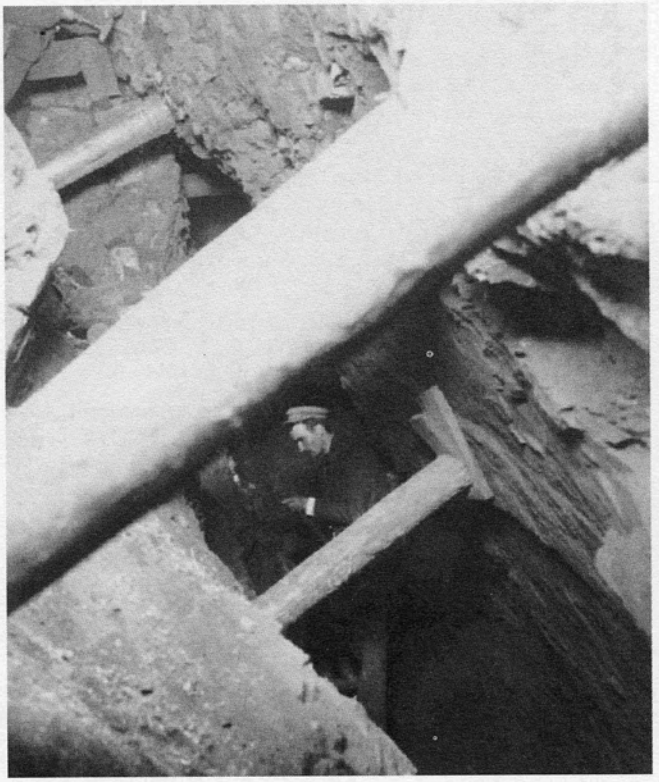


Figure 27. *STOPE IN CLIFF MINE, ROSSLAND, B.C.* (from Pierce, *Canada*)

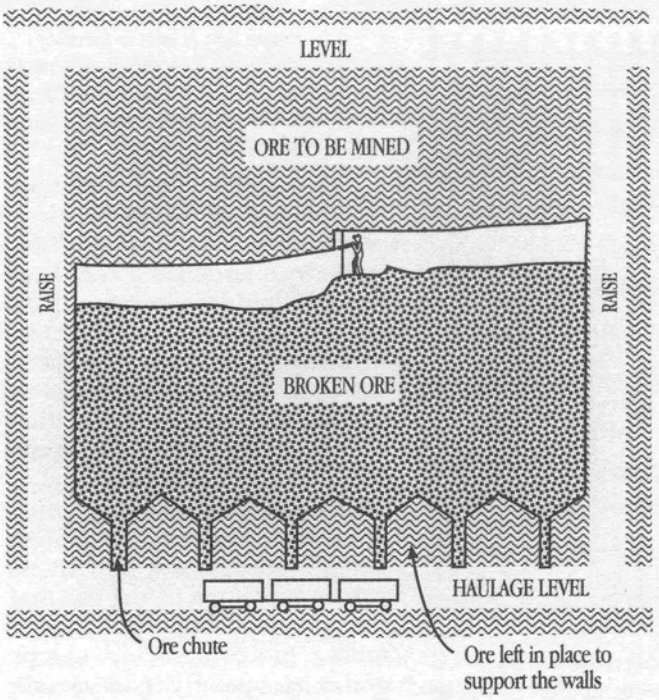


Figure 28. *SHRINKAGE STOPING Despite the carefully-drafted blueprints of mining engineers, working conditions underground were far less neat and tidy, as even the staged photograph from 1897 suggests (Figure 27).* (from Barger & Schurr, *Mining Industries*)

The rapid expansion of mining operations created numerous new jobs, and the labour force became increasingly diverse. During the First World War, one of the managers of the Hollinger mine in Northern Ontario described the ethnic composition in Porcupine, for the benefit of a British Royal Commission:

> *The mine workers are a most cosmopolitan population. For common labour and shovellers, Italians and Russians are mostly employed; underground drilling is mostly done by Finlanders, Swedes, and Austrian Poles. Canadians, English, Irish and Scotch are employed as mechanics, wood workers, in the mills and other surface operations, while the engineers' staffs are practically all Canadian.... It is worthy of mention that there have been no disturbances of any kind between the different nationalities.*[41]

This assessment is a little too optimistic. Considerable evidence suggests that not only were ethnic tensions present, they were deliberately cultivated by managers to weaken the influence of unions and the ability of miners to act in concert. In an oft-quoted remark, for example, a mine manager in British Columbia claimed, in a letter to a leading Toronto businessman, that "a mixture of races" was necessary to strengthen the employer's position and weaken the hold of unionism: "How to head off a strike of muckers or laborers for higher wages without the aid of the Italian labor which is offered so plentifully here, I do not know."[42]

The changing ethnic composition of the mining workforce also reflected the sweeping transformation of the nature of the work. In 1913, for example, the *Engineering & Mining Journal* acknowledged that "the itinerant, self-reliant miner, jack of all trades, and master of several" was a disappearing breed:

> *The new type of miner is not so intelligent, but is more obedient and more industrious. He works generally for less than the scale established at such camps as Butte and Goldfield. By himself, he is far less efficient, but as part of a system employing a multiplicity of bosses, he probably delivers a lower labor cost per ton. To many companies he is a more desirable employee than a skilled miner, even when the latter will work for the same wages.*[43]

As the passage suggests, the work of mining was increasingly reorganized along lines that emphasized the lowest cost. Unskilled labourers and semi-skilled machine tenders became essential underground workers, eclipsing the skilled miners whose decisions at the workface had earlier shaped the design of the mine. Mass mining and milling techniques, as well as the successful application of engineering principles to the organization of labour, brought people and machines together into a measurable and controllable engineering system. Skilled miners were relegated to employment in small operations or, in the larger mines, to those few tasks which had not been standardized. By 1918 most mine employees worked at single, repetitive tasks such as drilling, blasting, timbering, mucking, chute pulling,

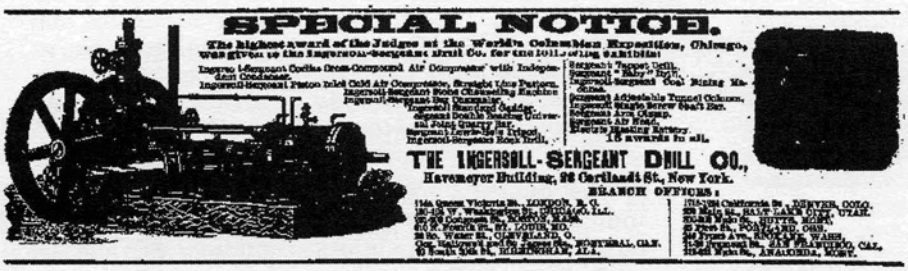


Figure 29. *ADVERTISEMENTS FOR THE INGERSOLL-SERGEANT DRILL CO. & THE RAND DRILL CO. Advertisements for the two leading drill manufacturers from an issue of an 1894 industry journal. Both companies had subsidiaries in Canada, and in 1912 they merged to form the Canadian Ingersoll-Rand Co., Ltd., seven years after the merger of the two parent companies in the U.S.* (from *Engineering and Mining Journal*)

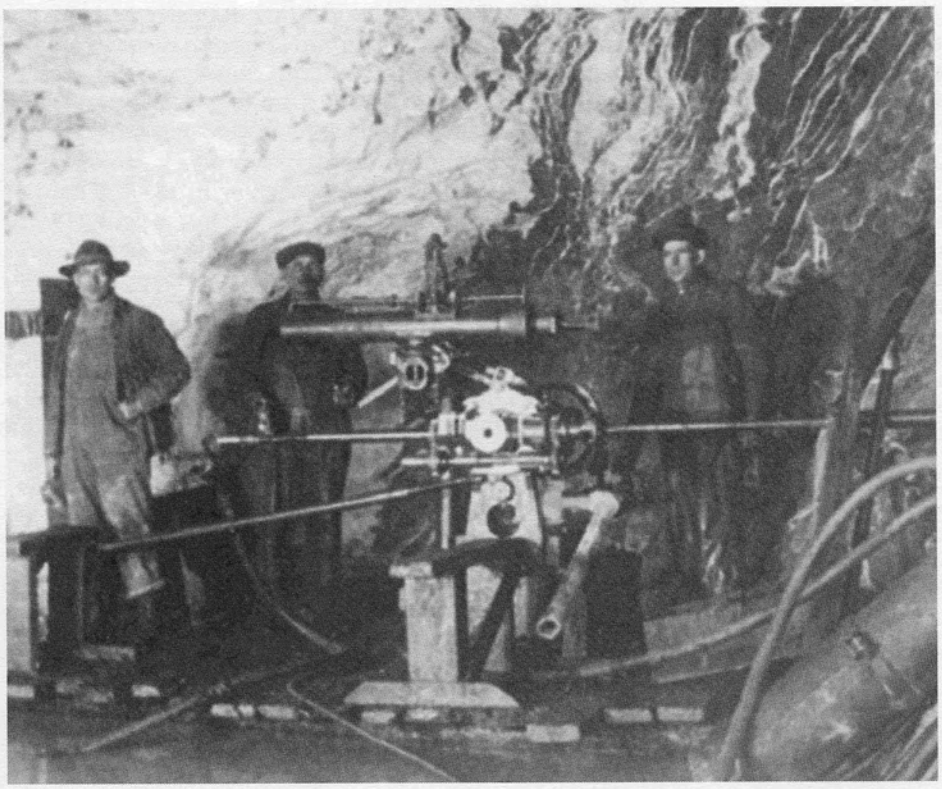


Figure 30. *MINERS WITH A DIAMOND DRILL IN THE HOLLINGER MINE Diamond drills were a major innovation of this period; their core samples enabled engineers to map the extent and richness of an ore deposit reasonably accurately, information which allowed them to determine with some precision the most efficient way to develop a mine.* (from Barnes, *Timmins*)

and tramming. Formerly, all such jobs had been part of the all-around miner's stock and trade.[44]

Changes in the scale and scope of mining led to new concerns about health and safety, fuelling demands for a reduction in the number of hours miners spent underground. The annual meeting of the Trades and Labour Congress of Canada in 1898 passed a motion calling for an eight-hour day in "the Metalliferous Mines of British Columbia and Ontario," and the following year the provincial government in B.C. enacted an eight-hour law for hard rock-miners.[45] The passage of an eight-hour law in Ontario did not come until 1913, in the wake of a strike and a lengthy government investigation.[46]

By this time, authorities were becoming uncomfortably aware of the possible dangers facing underground workers. Such health concerns had a long history—in the sixteenth century, Agricola had warned of the "corrosive qualities" of dusty air in some underground mines, and its deadly effect on workers[47]—but the growing knowledge that miners risked contracting silicosis stirred some jurisdictions into action. South Africa was the first country to confront the obvious threat of occupational disease to underground workers; other countries, including Canada, were slower to respond.[48]

In 1912, the province of Ontario took the first step to regulate underground working conditions in the interest of miners' health, as a mining engineer explained the following year:

> *Miners' phthisis has recently been classed by a South African Commission as an industrial disease, and subject to compensation as such. No class of mine labor is exempt from it, but machine drillers are most subject to this disease. Recent*

attempts to overcome this dust difficulty are of general interest to all branches of the mining industry. During 1912 a clause was inserted in the Mining Act of Ontario, under which the mine inspector has power to insist on means being adopted to keep down the dust. The clause is section 164, subsection 60: "Every dusty place where work is being carried on in a mine shall be adequately supplied at all times with clean water under pressure or other approved appliances for laying the dust caused by drilling or blasting operations."

Both piston and hammer drills are used in the mines of Northern Ontario, but the hammer drills are the greater offenders as dust makers and spreaders. A number of different makes of hammer drills are now operating in the mines at Cobalt and Porcupine, the principal ones being the Rand, Sullivan, and Waugh. For each of these machines a sprayer or dust allayer has been introduced, and already working conditions have been improved.... Although these innovations are introduced primarily for the benefit of the employee, and the employer only benefits indirectly by the increased efficiency of the labor employed, the principal difficulty in their adoption lies with the employee. This is another case of the common experience where companies find it extremely difficult to make their miners observe even the more simple necessary precautions. In all kinds of work men willingly court known and certain hazards rather than take a little trouble to guard against them.[49]

Despite the grudging acknowledgement of the possible threats to health posed by working underground, many years passed before the health and safety of miners attracted the attention it deserved.[50]

A distinct Canadian mining engineering profession had emerged by the end of this period, and soon enjoyed a good reputation.[51] When the *Bulletin of the Canadian Mining Institute* claimed jokingly in July 1916 that all of the most important mines in the United States were managed by Canadian engineers, the editor of the San Francisco-based *Mining and Scientific Press* responded in kind:

That "all the really important mining undertakings are directed by Canadian engineers" is manifestly true because to the Canadian only the undertakings so directed are of real importance. Joking apart, it is remarkable what a splendid group of metallurgists has been given to this continent by McGill University.[52]

The dramatic expansion of the Canadian mining industry around the turn of the century was mirrored by a similar growth in mining communities. Cities such as Sudbury and Cobalt in Ontario, and Rossland and Sandon in British Columbia, seemed to appear almost overnight. Formal and informal institutions soon followed: trade unions and churches, schools and hospitals, and the experiences and memories that shape a people.[53] Well-known and important labour disputes, in particular, focused public attention on mining and miners, one reason miners were one of the only two groups of workers targeted by the federal government in its landmark labour legislation, the Industrial Disputes Investigation Act of 1907.[54]

Mining production attained a new significance during the First World War, since base metal production played a crucial role in the munitions industry. Copper mining, particularly in British Columbia, had grown dramatically since the turn of the century and profited from wartime conditions. As early as 1905 the Minister of Mines' *Annual Report* described the Granby Consolidated Mining, Smelting and Power Company—with mines and a smelter in the Boundary region of the province—as "the largest and most important mining and smelting company in British Columbia."[55] Sudbury's mines went through a similar expansion.[56] Like copper, nickel was an extremely valuable metal in wartime. Indeed, so sensitive was the production of "strategic minerals" such as copper, nickel, and zinc that during the First World War several commissions were formed to study the best way to bolster their production within Canada.[57] The significance of the mining and smelting areas in southeastern British Columbia and Sudbury reflect the importance and maturity that the Canadian mining industry had attained by 1918.

Notes

1. On the creation of the Geological Survey of Canada, and much else besides, see Morris Zaslow, *Reading the Rocks: The Story of the Geological Survey of Canada 1842-1972* (Toronto: Macmillan Company of Canada, 1975), and Suzanne Zeller, *Inventing Canada: Early Victorian Science and the Idea of a Transcontinental Nation* (Toronto: University of Toronto Press, 1987). Briefer accounts of the role of Logan—the influential pioneer director of the Survey—in hastening mining development in Canada include A. H. Lang, "Sir William Logan and the Economic Development of Canada," *Canadian Public Administration* 12, no. 4 (December 1969): 551-65, and C. Gordon Winder, "Sir William Edmond Logan," *Dictionary of Canadian Biography, Volume X*, 1871-1880 (Toronto: University of Toronto Press), pp. 444-49. See also the important work by Robert A. Stafford, *Scientist of Empire, Sir Roderick Murchison, Scientific Exploration and Victorian Imperialism* (Cambridge: Cambridge University Press, 1989), and his article, "Geological Surveys, Mineral Discoveries, and British Expansion, 1835-71," *Journal of Imperial and Commonwealth History* 12 (1984): 5-32. On the creation of mining law, see—for the gold rush era—Morley Arthur Underwood, "Governor Douglas and the Miners, 1858-1859" (BA thesis, University of British Columbia, 1974), and David Ricardo Williams, "The Administration of Criminal and Civil Justice in the Mining Camps and Frontier Communities of British Columbia," in Louis A. Knafla, ed., *Law & Justice in a New Land: Essays in Western Canadian Legal History* (Toronto: Carswell, 1986), pp. 215-32. Tina Loo's *Making Law, Order and Authority in British Columbia 1821-1871* (Toronto: University of Toronto Press, 1994), as the title suggests, examines the social construction of law on B.C.'s mining frontier. For the later period, see Thos. W. Gibson, *The Mining Laws of Ontario and the Department of Mines* (Toronto: King's Printer, 1933); Logan W. Hovis, "The Extralateral Right in British Columbia and the Western United States: A Comparison of the Mining Law, 1850-1900," *BC Studies*, nos. 91-92 (Autumn-Winter 1991-92): 79-97; Warren James Jestin, "Provincial Policy and the Development of the Metallic Mining Industry in Northern Ontario: 1845-1920" (PhD thesis, University of Toronto, 1977); and Marc Vallières, *Des mines et des hommes: histoire de l'industrie minérale québécoise* (Quebec: Les Publications du Québec, 1989), pp. 51-71.
2. The most recent—and most useful—analysis of railway development in Canada is A. A den Otter's *The Philosophy of Railways* (Toronto: University of Toronto Press, 1997). Eric Hobsbawm has argued that "the railways collectively constituted the most massive effort of public building as yet undertaken by man. They employed more men than any other industrial undertakings. They reached into the centres of great cities, where their triumphal achievements were celebrated in equally triumphal and gigantic railway stations, and into the remotest stretches of the countryside, where no other trace of nineteenth-century civilization penetrated." E. J. Hobsbawm, *The Age of Empire 1875-1914* (London: Weidenfeld and Nicolson, 1987), p. 27. See also Nicholas Faith, *The World the Railways Made* (London: Pimlico, 1994), which is a general history of the railway's impact in various corners of the globe.
3. See Stephen Kern, *The Culture of Time and Space 1880-1918* (Cambridge, Mass.: Harvard University Press, 1983), p. 12; David Landes, *Revolution in Time: Clocks and the Making of the Modern World* (Cambridge, Mass.: Harvard University Press, 1983), esp. pp. 285-9; Derek Howse, *Greenwich Time and the Discovery of the Longitude* (Oxford: Oxford University Press, 1980), esp. pp. 81-115; and Wolfgang Schivelbusch, *The Railway Journey: The Industrialization of Time and Space in the 19th Century* (Leamington Spa: Berg Publishers, 1986), pp. 42-44. On the relationship between railways and the new economy, see Alfred Dupont Chandler's *The Visible Hand: The Managerial Revolution in American Business* (Cambridge, Mass.: Belknap Press, 1977), passim.
4. G. M. Dawson, *Summary Reports of the Operations of the Geological Survey For the Years 1887 and 1888* (Montreal: Dawson Brothers, 1889), p. 65A. In a monograph written the following year, Dawson repeated this analysis: see George M. Dawson, *The Mineral Wealth of British Columbia* (Montreal: Dawson Brothers 1889), published with the *Annual Report*, n.s., vol. 3, pt. 2, 1887-88, of the Geological Survey, especially pp. 14-15, 55, 59.
5. The ore deposits along Kootenay Lake—familiar to Europeans since the 1840s—were the first to be staked in the spring of 1882, when construction of the Northern Pacific stimulated a flurry of prospecting. See the article by B. Richard (Dick) Atkins, "A History of the Kootenay District in the 19th Century," in E. L. Affleck, ed., *Columbia River Chronicles* (Vancouver: Alexander Nicolls Press, 1977), pp. 76-80. In his discussion of the Ainsworth claim, Atkins points out that prospectors had gone to the region "to stake out promising camps which had been discovered in previous decades but heretofore discarded on the grounds of inaccessibility" (p. 76). For the subsequent mining boom, focused chiefly on the silver mines of the Slocan and the copper gold mines of Rossland, see Harold A. Innis, *Settlement and the Mining Frontier* (Toronto: Macmillan Company of Canada, 1936), pp. 270-320; Cole Harris, "Industry and the Good Life around Idaho Peak," *Canadian Historical Review* 66 (1985): 315-343; and Jeremy Mouat, *Roaring Days: Rossland's Mines and the History of British Columbia* (Vancouver: UBC Press, 1995), pp. 5-16.
6. N. A. Timmins, "A Reminiscent History," *Canadian Mining Journal* 56 (September 1935): 353, 355.
7. Useful historical accounts of the Sudbury nickel industry may be found in the *Report of the Royal Ontario Nickel Commission* (Toronto: King's Printer, 1917); D. M. LeBourdais, *Sudbury Basin (The Story of Nickel)* (Toronto: Ryerson, 1953); O. W. Main, The Canadian Nickel Industry: *A Study in Market Control and Public Policy* (Toronto: University of Toronto Press, 1955); J. F. Thompson and Norman Beasley, *For the Years to Come: A Story of International Nickel of Canada* (New York: Putnam, 1960); and H. V. Nelles, *The Politics of Development: Forests, Mines and Hydro-electric Power in Ontario, 1849-1941* (Toronto: Macmillan of Canada, 1974), pp. 87-102, 326-35, 349-61.
8. For a fascinating revisionist treatment of the Klondike gold discovery, see Julie Cruikshank's "Images of Society in Klondike Gold Rush Narratives: Skookum Jim and the Discovery of Gold," *Ethnohistory* 39, no. 1 (Winter 1992): 20-41. An edited version of this article ("Discovery of Gold on the Klondike: Perspectives from Oral Tradition") was reprinted in Jennifer S. H. Brown and Elizabeth Vibert, eds., *Reading Beyond Words: Contexts for Native History* (Peterborough, Ont.: Broadview Press, 1996), pp. 433-59. The standard narrative of the rush itself, even after the inevitable avalanche of books commemorating the Klondike centenary, remains Pierre Berton's *Klondike: The Last Great Gold Rush 1896-1899*, rev. ed. (Toronto: McClelland and Stewart, 1972) usefully complemented by Berton's superb photographic collection, *The Klondike Quest: A Photographic Essay 1897-1899* (Toronto: McClelland and Stewart, 1983). One of the better first-person accounts of the Klondike rush was recently re-issued: E. Tappan Adney,

The *Klondike Stampede* (Vancouver: UBC Press, 1994), originally published New York: Harpers, 1899. The best of the recent crop of histories is Charlene Porsild's *Gamblers and Dreamers: Women, Men and Community in the Klondike* (Vancouver: UBC Press, 1998). The history of mining in the Klondike after the gold rush is discussed in Harold A. Innis, *Settlement and the Mining Frontier* (Toronto: Macmillan Company of Canada, 1936), esp. pp. 213-69; Lewis Green, *The Gold Hustlers* (Anchorage: Alaska Northwest Publishing Co., 1977); and William Rodney, *Joe Boyle: King of the Klondike* (Toronto: McGraw-Hill Ryerson, 1974).

9. On the development of hydraulicking, see Randall E. Rohe, "Hydraulicking in the American West: The Development and Diffusion of a Mining Technique," *Montana: The Magazine of Western History* 35, no. 2 (Spring 1985): 18-35, and Philip Ross May, *Origins of Hydraulic Mining in California* (Oakland: Holmes Book Co., 1970). Hydraulicking did not become common in British Columbia until the late 1870s. For example, the 1879 Report of the Minister of Mines mentioned "the greatly increased attention which the system of hydraulic mining is receiving. This effective mode of extracting gold from the alluvial deposit in which it may be embedded *has not until lately* taken the position it is now holding in the estimation of the miners." Report of the Minister of Mines for 1879, "Cariboo," *British Columbia Sessional Papers*, 1880, p. 236 [emphasis added]. See also the discussion in Jill Wade, "Pre-1885 Cariboo Mining Methods" (unpublished paper prepared for the B.C. Heritage Conservation Branch, Victoria, 1981), pp. 30-31.
10. See the comments of Paul Phillips, "Confederation and the Economy of British Columbia," in W. George Shelton, ed., *British Columbia & Confederation* (Victoria: Morriss Printing Co., 1967), pp. 43-65, esp. pp. 47- 48.
11. For a contemporary analysis of the failure of quartz mining in the Cariboo, see Mr. Koch, Mining Expert, "Report on the Cariboo Quartz Ledges," *Annual Report of the Minister of Mines of British Columbia*, 1886, pp. 215-24.
12. On the development of dredges, see Clark C. Spence, "The Golden Age of Dredging: The Development of an Industry and Its Environmental Impact," *Western Historical Quarterly* 11, no. 4 (October 1980): 401- 14; J. H. M. Salmon, *A History of Goldmining in New Zealand* (Wellington: R. E. Owen, Government Printer, 1963), pp. 230-39; and Otis E. Young, Jr., with the technical assistance of Robert Lenon, *Western Mining: An informal account of precious metals prospecting, placering, lode mining and milling on the American frontier from Spanish times to 1893* (Norman: Oklahoma University Press, 1970), pp. 132-36. Dredges were particularly prominent in the Yukon's post-rush era; for discussions of their use there, see Green's *The Gold Hustlers* and David Neufeld and Patrick Habiluk, *Make It Pay! Gold Dredge #4* (Missoula, Montana: Pictorial Histories Publishing Co., 1994).
13. Ibid, pp. 215-24; "Report of Mr. Wm. Craib," ibid., p. 199.
14. "Cariboo," *Annual Report of the Minister of Mines of British Columbia*, 1887, p. 256.
15. For details of the plant, see Martin's Reports for 1888 and 1889, in *Annual Report of the Minister of Mines of British Columbia*, 1888, pp. 293-94, and *Annual Report, 1889*, pp. 275-76. The reference to its destruction by fire is in the *Annual Report* for 1890, p. 361.
16. See the comments in the Ontario Bureau of Mines, *Third Report of the Bureau of Mines 1893* (Toronto: Warwick Bros. & Rutter, 1894), pp. 31-34, and Patrick R. Chapin, "Northwestern Ontario Gold Mining, 1880-1902: The Gold Boom that Didn't Pan Out" (MA thesis, Lakehead University, 1996), pp. 103-06. For contemporary references to the works, see "The Mining Commission," *The Globe*, 10 September 1888, p. 2 (calls for a government-supported mill); "Rat Portage Items," *Manitoba Free Press*, 8 July 1890, p. 2 (the reduction works under construction); "Rat Portage Items," *Manitoba Free Press*, 24 July 1890, p. 2 (the reduction works soon to operate); "Rat Portage Budget," *Manitoba Free Press*, 2 May 1892, p. 2 (a chlorination plant to be added to the reduction works). Similarly, an official with Ontario's Department of Mines suggested in 1893 that the government purchase two diamond drills, to assist with prospecting and encourage mining development. Ontario, Department of Mines, "Diamond Drills," *Annual Report of the Ontario Bureau of Mines*, 1893, vol. 3, pp. 164-66.
17. The Geological Corps [of Canada], *Descriptive Catalogue of a Collection of the Economic Minerals of Canada* (London: Alabaster, Passmore & Sons, 1886), p. 57. This publication was an annotated list describing the Canadian minerals on display at the Colonial and Indian Exhibition, held in London during 1886.
18. *Annual Report of the Minister of Mines of British Columbia*, 1886, p. 209.
19. Ontario, Department of Mines, "Diamond Drills," *Annual Report of the Ontario Bureau of Mines, 1893*, vol. 3, p. 166.
20. For the historiography of flotation and the cyanide process, see the bibliographical essay appended to the text.
21. They continue: "The telephone, electric light, and trolley took different routes into Canada, but they all came from the same place, entering the main Canadian cities in the first wave of diffusion from centers of innovation in the northeastern United States. Canada became tied into a continental technological network despite its strong political and economic connections with Great Britain...." Christopher Armstrong and H. V. Nelles, *Monopoly's Moment: The Organization and Regulation of Canadian Utilities, 1830-1930*, (Philadelphia: Temple University Press, 1986), p. 91. For a discussion of how this process unfolded in terms of mining equipment—the rock drill—see James Otto Petersen, "The Origins of Canadian Gold Mining: The Part Played By Labor In The Transition From Tool Production To Machine Production" (PhD thesis, University of Toronto, 1977), pp. 265-66.
22. As Hugh Aitken observed, "the machine drill, the selective flotation process..., the cyanidation process, and a wide variety of milling, hoisting, and excavating devices, most of them originating in the United States, were... crucial to the successful exploitation of Canada's ore deposits." Hugh G. J. Aitken, *American Capital and Canadian Resources* (Cambridge, Mass., Harvard University Press, 1961), p. 101. Note also the comments in E. S. Moore, *American Influence in Canadian Mining* (Toronto: University of Toronto Press, 1941), pp. 90-98.
23. Jeffrey L. Rodengen, *The Legend of Ingersoll-Rand* (Ft. Lauderdale: Write Stuff Syndicate, 1995), pp. 21, 26. For references to the history of the rock drill, see the bibliographical essay following this text.
24. On the development of the car, see also Campbell, "The Granby Mines at Phoenix," Canadian Institute of Mining and Metallurgy, *Transactions* 22 (1919): 177-78 and Campbell, "Boundary District, British Columbia," *Engineering and Mining Journal* 109, no. 17 (24 April 1920): 972. For general descriptions of Granby's mass mining techniques, see Campbell, "Granby Mining Methods," *Journal of the Canadian Mining Institute* 11 (1908): 392-406 (reprinted in the *Engineering and Mining Journal* 87 [30 January 1909]: 252-56); A. W. B. Hodges, "Handling Three Thousand Tons of Ore per Day at the Granby Mines and Smelter, Phoenix and Grand Forks, B.C.," *Journal of the Canadian Mining Institute* 11 (1908): 407-14; and Roy Hutchins Allen, "Mines of the Granby Consolidated, Phoenix, B.C.," *Engineering and Mining Journal* 88 (25 December 1909): 1260-62. For useful overviews of Granby's operations in the Boundary, see W. B. Wilcox, "Early History of Granby," *Northwest Mining Truth* 5, no. 1 (16 February 1920): 19-20; Campbell, "The

Granby Story: The Phoenix Project," *Western Miner* 22, no. 7 (July 1949): 46-50; Campbell, "The Granby Story: The Grand Forks Smelter," *Western Miner* 22, No. 7 (July 1949): 51-2; Campbell, "My Sixteen Years in Phoenix," Boundary Historical Society, 3rd Report (1960): 1-10; and L. E. Carter, "Granby: Seventy-five Years of British Columbia Copper Mining" (BA Hons Essay [Geography], Simon Fraser University, 1979), pp. 17-24.

25. British Columbia, *Annual Report of the Minister of Mines for 1905*, J 25.
26. From 1903 to 1905, for example, the *Mining and Scientific Press* carried numerous articles on "The Costs of Mining," later collected and published as a book, edited by T. A. Rickard, *The Economics of Mining* (New York: Hill Publishing Co., 1905); a second edition of this book appeared in 1907. James Ralph Finlay, one of the contributors to this debate, subsequently expanded his articles into a book-length treatment, *The Cost of Mining: An Exhibit of the Results of Important Mines Throughout the World* (New York: McGraw-Hill Book Company, 1909).
27. Kathleen Ochs, "Government, Industry and Mining Education: The European Background," *The Mines Magazine* 72, no. 4 (April 1984): 13.
28. William Kent, in discussion of David W. Brunton's Presidential Address, "Modern Progress in Mining and Metallurgy in the Western United States," *Transactions of the American Institute of Mining Engineers* 40 (1909): 881-82. Similarly, in 1907 J. R. Finlay argued that no one person could now master all the skills and knowledge of the mining industry, for it had become too complex: "pretension to know the whole mining business can be nothing but a fraud." "Requirements of Modern Mining," *Canadian Mining Journal* 28 (1907): 139-40.
29. The influence of the American Institute of Mining Engineers in Canada is discussed by E. Tina Crossfield, *Pride and Vision: The Canadian Institute of Mining, Metallurgy and Petroleum, 1898-1998* (Montreal: Canadian Institute of Mining, Metallurgy and Petroleum, 1998), pp. 1-32. See also J. Rodney Millard, *The Master Spirit of the Age: Canadian engineers and the politics of professionalism 1887-1922* (Toronto: University of Toronto Press, 1988), p. 162, note 5, and H. Mortimer-Lamb, "Some Notes on the History and Recent Development of the Canadian Mining Institute," *Journal of the Canadian Mining Institute* 13 (1910): 588-95. For an insightful commentary on the *Weltanschauung* of Canadian engineers in the nineteenth century, see Bruce Sinclair, "Canadian Technology: British Traditions and American Influences," *Technology and Culture* 20, no. 1 (January 1979): 108-23.
30. On the impact of the 1890 Royal Commission, see Nelles, *The Politics of Development*, pp. 140-41; A. L. Clark, *The First Fifty Years: A History of the Science Faculty at Queen's University 1893-1943* (Kingston: n.p., 1944), pp. 1-11; Philip Smith, *Harvest From the Rock: A History of Mining in Ontario* (Toronto: Macmillan of Canada, 1986), pp. 74-87; and Natalie R. Neville, "The School of Mining and Agriculture at Kingston: A Case Study in the Development of Canadian Engineering Education" (MA thesis, Queen's University, 1987), esp. pp. 83-90.
31. *Report of the Royal Commission on the Mineral Resources of Ontario and Measures for their Development* (Toronto: Warwick & Sons, 1890), pp. 208-09.
32. The best account of the establishment of the School of Mines at Queen's is Neville's MA thesis, cited above. For comparative purposes, see also C. R. Young, *Early Engineering Education at Toronto 1871-1919* (Toronto: University of Toronto Press, 1958), which discusses the Queen's School of Mines in the context of rivalry with the University of Toronto. For the establishment of provincial mining departments, see Vallières, *Des mines et des hommes*, p. 59, and Thos. W. Gibson, *The Mining Laws of Ontario and the Department of Mines* (Toronto: King's Printer, 1933), pp. 81-84. Earlier, in the mid 1880s, the federal government worried that the Geological Survey of Canada was neglecting mining: see Zaslow, *Reading the Rocks*, 1975, pp. 131-45.
33. A. G. Charleton, "Principles and Methods of Profitably Working the Mine: Office Organisation, Cost-Keeping, and Records of Work Done," *Engineering Magazine* 20, no. 4 (January 1901), p. 702 (italics in the original). Over 15 years earlier, Robert Hunt, writing in *British Mining: A Treatise on the History, Discovery, Practical Development and Future Prospects of Metalliferous Mines in the United Kingdom* (London: Crosby Lockwood and Co., 1884), pointed out that "The success attendant on driving levels and sinking shafts by means of machinery is only partly dependent on the boring-machines [rock drills]. These machines now constitute but one of a series of highly important inventions. Had it not been for the construction of efficient air compressors, suitable machine carriages, properly jointed air pipes, the discovery of strong explosives, the development of a new system of arranging the shot-holes, the application of quick charging and blasting these holes, together with *thorough organization of the work*, boring machines, however good in themselves, would have afforded unsatisfactory results." (op. cit., Volume II, p. 538; italics in the original).
34. Henry Louis, "The Training of a Mining Engineer," *Canadian Mining Review* 14, no. 12 (December 1895): 220-21.
35. Herbert C. Hoover, *Principles of Mining: Valuations, Organization and Administration* (New York & London: McGraw-Hill Book Company, 1909), pp. 188-90. Hoover's book was a compilation of his lectures at Stanford and the Columbia School of Mines; see *Principles of Mining*, p. iii, and the comments in George H. Nash, *The Life of Herbert Hoover: The Engineer, 1874-1914* (New York: W. W. Norton & Company, 1983), pp. 478-79.
36. See Logan Hovis and Jeremy Mouat, "Miners, Engineers, and the Transformation of Work in the Western Mining Industry, 1880-1930," *Technology & Culture* 37, no. 3 (July 1996): 429-56.
37. Courtenay De Kalb, Inspector, "The Condition of Ontario Mines," *Annual Report of the Ontario Bureau of Mines*, 1899, Vol. 8, p. 29; cf. the comments in Donald Macleod, "Miners, Mining Men and Mining Reform: Changing the Technology of Nova Scotian Gold Mines and Collieries, 1858 to 1910" (PhD thesis, University of Toronto, 1981), pp. 98-99.
38. Lewis Mumford, *Technics and Civilization* (New York: Harcourt, Brace and Co., 1934), p. 67. In similar fashion, David Gilbert argues that English miners are rarely treated as truly "English": see his "Conference Report: Imagined communities and mining communities," *Labour History Review* 60, no. 2 (Autumn 1995): 47-55.
39. See Jeremy Mouat, "The Genesis of Western Exceptionalism: British Columbia's Hard Rock Miners, 1895-1903," *Canadian Historical Review* 71, no. 3 (September 1990): 317-45.
40. For an indication of the movement of hard-rock miners around the west (both sides of the border), see Cole Harris, "Industry and the Good Life around Idaho Peak," *Canadian Historical Review* 66 (1985): 315-343.
41. Notes of A. R. Globe, Assistant General Manager of the Hollinger Mine, in "Porcupine Gold-mining District of Ontario," *Royal Commission on the Natural Resources, Trade, and Legislation of Certain Portions of His Majesty's Dominions, Minutes of Evidence Taken in the Central and Western Provinces of Canada in 1916, Part II* (London: His Majesty's Stationery Office, 1917 [Cd. 8459]), p. 307. In 1913, an Ontario government report observed that "There are no statistics as to the men's nationality, but the

great majority of them are foreign born, especially in the Sudbury and Michipicoten districts, coming largely from Italy, Finland, Austria and Poland." S. Price, "Report Re Limitation of the Hours of Labor of Underground Workmen in the Mines of Ontario," Legislative Assembly of Ontario, Sessional Papers 45, Pt. 13 (1913), Paper 82, p. 4. See also the comments in *Report of the Royal Ontario Nickel Commission* (Toronto: King's Printer, 1917), p. 225.

42. Edmund Kirby to T. G. Blackstock, 31 January 1901, Rossland, #53085, in Laurier Papers, National Archives of Canada, MG 26, G.
43. *Engineering and Mining Journal* 95 (8 March 1913): 534.
44. For a study of the transition in one mine, see Logan W. Hovis, "Technological Change and Mining Labour: Copper Mining and Milling Operations at the Britannia Mines, British Columbia, 1898-1937" (MA thesis, University of British Columbia, 1986). Note also the perceptive analysis in Guy Gaudreau, "Ethnicité et division du travail dans la modernisation d'une enterprise minière: la Canadian Copper Company, 1886-1928," in Guy Gaudreau, ed., *La mobilité des ouvriers-mineurs du Nord ontarien et québécois 1900-1939* (Sudbury: Laurentian University/Université Laurentienne, 1998), pp. 7-35.
45. *Proceedings of the Fourteenth Annual Session of the Trades and Labor Congress of Canada* (Toronto, 1898), p. 35. For a discussion of the introduction of the eight-hour day in B.C.'s hard-rock mines, see Mouat, *Roaring Days*, pp. 75-87, as well as the contemporary federal inquiry: "Report of the commission in relation to mines and mining in British Columbia," Roger Conger Clute, commissioner (typescript, 1899, 1900).
46. See Vasiliadis, *Dangerous Truth*, p. 81, and S. Price, "Report Re Limitation of the Hours of Labor of Underground Workmen in the Mines of Ontario," Legislative Assembly of Ontario, *Sessional Papers*, Vol. 45, Pt. 13 (1913), Paper 82. The Ontario government's legislation was passed in 1913, although the eight-hour day underground did not become mandatory until the first of January 1914.
47. The relevant passage reads: "Some mines are so dry that they are entirely devoid of water, and this dryness causes the workmen even greater harm, for the dust which is stirred and beaten up by digging penetrates into the windpipe and lungs, and produces difficulty in breathing.... If the dust has corrosive qualities, it eats away the lungs, and implants consumption in the body; hence in the mines of the Carpathian Mountains women are found who have married seven husbands, all of whom the terrible consumption has carried off to a premature death." Georgius Agricola, *De Re Metallica*, trans. Herbert Clark Hoover and Lou Henry Hoover (New York: Dover Publications, 1950), p. 214. Note however the critique of the Hoovers' account, in George S. Rice, "Historical Review of Silicosis," in Edwin Higgins, A. J. Lanza, F. B. Laney, and George S. Rice, *Siliceous Dust in Relation to Pulmonary Disease Among Miners in the Joplin District*, Missouri, U.S. Bureau of Mines, Bulletin 132 (Washington: Government Printing Office, 1917), pp. 81-82, as well as the critical assessment of the Hoover translation in J. de Fenton, "On some diseases of the respiratory organs incidental to miners, as portrayed by Dr. Agricola, in A.D. 1550," *Journal of the Chemical, Metallurgical and Mining Society of South Africa* (May 1916): 223-27.
48. For the historiography of silicosis, see the bibliographical essay.
49. Arthur A. Cole, "The Mining Industry in that Part of Northern Ontario Served by the Temiskaming and Northern Ontario Railway," Legislative Assembly of Ontario, *Sessional Papers*, Vol. 45, Pt. 13 (1913), Paper 70, pp. 35-37. These comments were echoed in S. Price's report on the eight-hour day for miners: "I am convinced that the popular idea of hardship and injuriousness of working underground is only partly right. The mines of Ontario, I believe, as a whole, are naturally as healthful as any in the world.... There seems, however, to be better basis for the fear of harm arising from the breathing of the dust caused by the drilling and other operations, and especially from the hammer drills where no water is used to allay the dust, and particularly in the quartz workings. Phthisis or miners' consumption is at present a disease little known in Ontario, but the time has been short for its development and it is undoubtedly a matter to be considered and as far as possible guarded against. Our inspectors are fully alive to this necessity and no doubt will do their best to minimize the evil, but I may here mention that one of their difficulties is that the men are not always as willing as they should be to co-operate in precautionary measures.... I think it cannot be questioned either that underground mining though not the most hazardous of occupations, must be distinctly classed as a hazardous one." "Report of S. Price, Re Limitation of the Hours of Labor of Underground Workmen in the Mines of Ontario," p. 11. Despite appeals from locals of the Western Federation of Miners and the B.C. Federation of Labour in 1912-13, silicosis did not become a compensatable disease in British Columbia until an amendment to the Workmen's Compensation Act was passed in November 1936. Sadly, even this belated measure did little to guarantee adequate compensation: see the chapter, "The Compensation Board That Didn't," in John Stanton, *Never Say Die! The Life and Times of a Pioneer Labour Lawyer* (Ottawa: Steel Rail Publishing, 1987), pp. 169-86.
50. As the following chapter describes, silicosis did not become a compensatable disease in Ontario until 1926; another decade passed before a similar measure was enacted in B.C. Two important government studies examining health and safety issues in the mining industry are Gordon Sloan's "Report of the Commissioner relating to the Workmen's Compensation Board" (typescript, Victoria, 1942) esp. pp.142-169, and Ontario, *Report of the Royal Commission on the Health and Safety of Workers in Mines* (Toronto: Ministry of the Attorney-General, 1976), see esp. "Silicosis and dust," pp. 18-65. See also Dieter Grant Hogaboam, "Compensation and Control: Silicosis in the Ontario Hardrock Mining Industry, 1921-1975" (MA thesis, Queen's University, 1997), as well as Lloyd Tataryn, *Dying for a Living* (Ottawa: Deneau and Greenberg, 1979), and Elliott Leyton, *Dying Hard: The Ravages of Industrial Carnage* (Toronto: McClelland and Stewart, 1975).
51. For the growing role of Canadian mining engineers, note the number of Canadians featured in T. A. Rickard, *Interviews with Mining Engineers* (San Francisco: Mining and Scientific Press, 1922). When E. P. Matthewson became president of the American Institute of Mining and Metallurgy in 1923, someone mistakenly claimed that he was the first Canadian-born person to serve in that capacity. It was soon pointed out that in fact he was the Institute's *fourth* Canadian-born president; see "Canada and the American Institute," *Engineering and Mining Journal* 115, no. 18 (5 May 1923): 787. His predecessors were Richard P. Rothwell in 1882; James Douglas (1899 & 1900); and David W. Brunton (1909 & 1910).
52. "Editorial," *Mining and Scientific Press*, 22 July 1916, p. 111. At the time of this editorial, a [illegible] controversy was raging between English and American j[illegible]als over the alleged takeover of the British mining indus[illegible]y by American engineers. This feuding provoked the ironic comment, noted in the text (see the monthly *Canadian Mining Institute Bulletin* [July 1916]: 580-81).
53. For an introduction to the social/urban history of Sudbury and area, see Gilbert A. Stelter "The Origins of a Company Town: Sudbury in the Nineteenth Century," *Laurentian University Review* 3 (1970-71): 3-37; Stelter, "Community Development in Toronto's Commercial Empire: The Industrial Towns of the Nickel Belt, 1883-1931," *Laurentian*

University Review 6 (1974): 3-53; Eileen A. Goltz, "A Corporate View of Housing and Community in a Company Town: Copper Cliff, 1886-1920," *Ontario History* 82, no. 1 (March 1990): 29-51; Gail Cuthbert Brandt, "The Development of French-Canadian Social Institutions in Sudbury, Ontario, 1883-1920," *Laurentian University Review* 11, no. 2 (February 1979): 5-22; and Donald Dennie, "Sudbury 1883-1946: A Social Historical Study of Property and Class" (PhD thesis, Carleton University, 1989). For Cobalt, see Charlie Angus and Brit Griffin, *We Lived a Life and Then Some: The Life, Death and Life of a Mining Town* (Toronto: Between the Lines, 1996); for Sandon, Veronika Pellowski, *Silver, Lead & Hell: The Story of Sandon* (Sandon, B.C.: Prospectors' Pick Publishing, 1992), and Harris, "Industry and the Good Life around Idaho Peak"; and for Rossland, Michael Ripmeester, "Mines, Homes, and Halls: Place and Identity as a Gold Miner in Rossland, British Columbia, 1898-1901," *The Canadian Geographer/ Le Géographe canadien* 38, no. 2 (1994): 98-110; Ripmeester, "Everyday life in the golden city: a historical geography of Rossland, British Columbia" (MA thesis, UBC, 1990); and Mouat, *Roaring Days*, pp. 142-69.

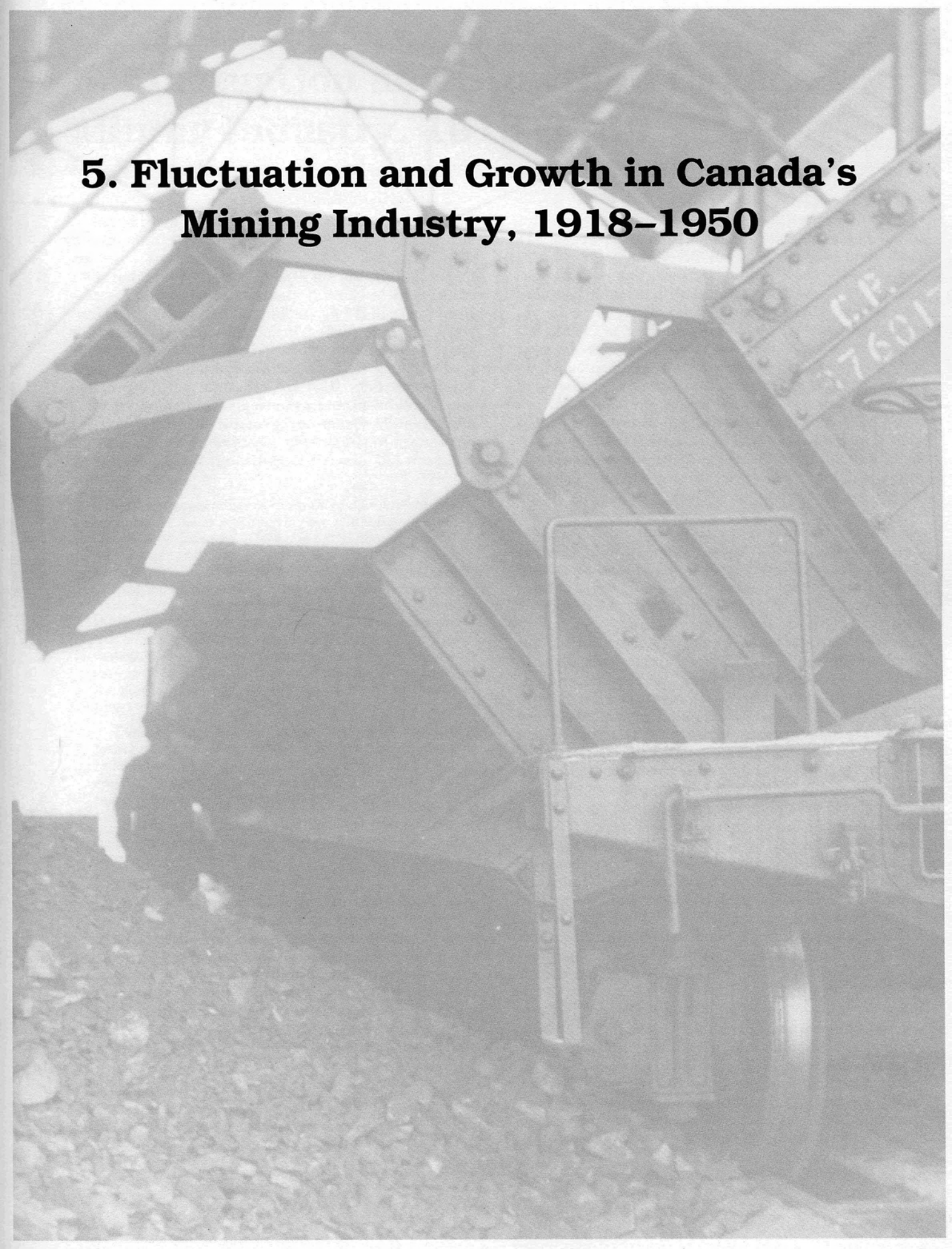
54. The Act was proclaimed 22 March 1907, its provisions covering transportation workers and miners. See the discussion in Paul Craven, *"An Impartial Umpire": Industrial Relations and the Canadian State 1900-1911* (Toronto: University of Toronto Press, 1980), pp. 271-317, and Jeremy Webber, "Compelling Compromise: Canada Chooses Conciliation Over Arbitration 1900-1907," *Labour/Le Travail*, no. 28 (Fall 1991): 15-57.

55. *Annual Report of the Minister of Mines of British Columbia*, 1905, J 175. This phrase was used again the following year (*Annual Report of the Minister of Mines of British Columbia*, 1906, H 160), and three years later the Report noted that the Granby mines shipped over a million tons of ore in 1909, adding that "cost of mining, including the crushing of the ore to furnace size and delivering same on board cars, was 84 cents a ton—a performance well worthy of special note." *Annual Report of the Minister of Mines of British Columbia*, 1909, K 131.

56. For conditions in Sudbury during this period, see Nicholson, "A Sordid Boon," esp. pp. 127-68; O. W. Main, *The Canadian Nickel Industry: A Study in Market Control and Public Policy* (Toronto: University of Toronto Press, 1955), esp. pp. 61-89; Nelles, *The Politics of Development*, esp. pp. 348-61; Noel Beach, "Nickel Capital: Sudbury and the Nickel Industry, 1905-1925," *Laurentian University Review* 6, no. 3 (1974): 55-74; and Philip Smith, *Harvest From the Rock: A History of Mining in Ontario* (Toronto: Macmillan of Canada, 1986), pp. 204-21. For mining technology and mineral treatment, see the magisterial account by Joseph R. Boldt, Jr., *The Winning of Nickel (Its Geology, Mining and Extractive Metallurgy)* (Toronto: Longmans, 1967).

57. See Ontario, *Report of the Royal Ontario Nickel Commission* (Toronto: King's Printer, 1917), and Canada, Imperial Munitions Board, *A Record of the Investigation, Report and Subsequent Action of the Commission... To investigate the feasibility of Refining Copper and Producing Metallic Zinc on a Commercial Scale in the Dominion of Canada* (Ottawa: Dominion Printing and Loose Leaf Co., 1916).

5. Fluctuation and Growth in Canada's Mining Industry, 1918–1950



5. Fluctuation and Growth in Canada's Mining Industry, 1918–1950

In the years following the First World War, Canada's mining industry gained recognition as one of the country's key resource industries. In large part, this reflected the emergence of base metals mining, which was assuming an increasingly prominent role in the industry.[1] Places such as Sudbury and Trail exemplified the growth and sophistication of the base metals industry: these towns could boast two of the world's most significant mining-smelting complexes. This came to be a source of pride for those involved with the mining industry, something that comes across clearly in a pamphlet issued by the federal government's Mines Branch in 1924. Noting the recent importance of the mining and metallurgical industries of Canada, the pamphlet went on:

> *...their development has been rapid, and Canada to-day occupies no mean place among the mineral producing countries of the world. The value of the annual mineral output of the Dominion, which was less than $10,250,000 in 1886, was $227,859,665 in 1920, the year of maximum production, and, in the same year, Canada ranked first in asbestos, nickel, and cobalt, third in silver, fourth in gold, and tenth in coal, among the mineral producing countries of the world.... The variety of her mineral resources includes, with few exceptions, all the useful minerals, though only a small fraction of her mineral bearing territory has been prospected.*
>
> *Canada's metallurgical works, also, will compare favourably with those of any country. The smelters, reduction plants and refineries at Sudbury, Trail, Anyox, Thorold, Deloro, and Deschenes, and the gold mills of Porcupine, are all models of their kind....*
>
> *Of even greater interest than Canada's past achievement and present development, however, are her possibilities in the future.*[2]

Such optimism was common in the 1920s, reinforced by mineral discoveries in Quebec, Manitoba, and other areas. The Depression of the 1930s did little to dampen enthusiasm for mining; if anything, the industry acquired an additional lustre, since the economic downturn of those years did not affect mining to the same extent that it did other industries. Thus in 1933, Prime Minister R. B. Bennett offered the following homily for those troubled by melancholy during that grim period:

> *Sometimes when you feel depressed, as I dare say some of you do, sometimes when you feel everything is wrong in the world, there is nothing I should ask you to think of more than Canada's mining industry if you wish to revive your faith.*[3]

Three years later, the federal Minister of Mines gave a series of weekly talks on mining, broadcast on national radio, in which he offered a particularly optimistic assessment of the industry's future. Mining, he argued, provided opportunities similar to those of an earlier period, when European settlers had flocked to western Canada. "The vast prospect before us," he assured his listeners, "reminds me of the opening of the western plains 30 or more years ago, when the Dominion was fired with enthusiasm over its prairie heritage, when settlers poured in, when the railways were jammed with traffic, and the whole country prospered."[4] Although such rhetoric was likely intended as a feel-good message for a nation reeling from the impact of the Depression, it also reflected the hopes that some politicians placed on the mining industry.[5]

Those within the industry took a more realistic view, although they too were proud of mining's progress.[6] This is evident in the series of overviews chronicling mining's evolution in Canada, published in the *Canadian Mining Journal* in 1939 to commemorate the journal's 60th anniversary.[7] More understated than the politicians' enthusiasm for mining, these articles provide a useful overview of the significant developments in Canadian mining. Most authors tended to describe the industry's growth in terms of an incremental process of change, rather than a narrative reflecting the achievements of any particular person, place, or event. In his history of mining methods, for example, Charles Jackson argued that the "progress of the past 60 years has been based upon methods and practices conceived for the most part prior to 1900 and developed and perfected during the succeeding years. Throughout the progress of these years runs the thread of increased mechanization and electrification and improvements in materials, design, and construction without which modern methods would be impossible."[8] Eighteen years later, the author of a background study on the mining industry for the Royal Commission on Canada's Economic Prospects offered a similar analysis in his discussion of "Advances in Mining Practice."[9]

Although mining grew in importance in the years after the First World War and gained recognition as a major contributor to the national economy, it also experienced severe fluctuations. The period immediately following the war, for example, was not particularly favourable for the mining industry. The high wartime prices for base metals soon ended, and this fact, coupled with widespread labour unrest in 1919, closed properties across the country. The industry recovered by the end of the 1920s, only to feel the effects of the

Great Depression, which held the country in its grip through the 1930s. The production of copper and gold was not seriously hampered by the economic downturn, unlike other minerals produced by underground mining in Canada. The Second World War brought economic recovery to the mining industry. Although a slight slump followed the war's end, by 1950 the post-war boom was underway. Only gold mining, which had collapsed in 1942, was slow to recover, as the graph of Canadian gold production suggests [figure 31].

In common with other mining regions of the world, mining in Canada had now moved beyond a reliance on bonanza discoveries and high-grade properties. Extensive low-grade properties could be worked profitably—as the copper deposits in the Boundary district of British Columbia had proved in the 1900s—as long as operations were geared to economies of scale and costs kept to a minimum. Industry observers acknowledged this trend. In a background study for the Royal Commission on Canada's Economic Prospects in the mid-1950s, for example, John Davis noted that "the mining of lower-grade ore bodies has made necessary, for economic reasons, large-scale mining operations." Davis continued:

> *As the smaller high-grade ore bodies become less numerous, the trend is toward the mining of lower-grade large tonnage ore bodies using non-selective block caving or blast-hole stoping methods. These methods and the latter in particular, are becoming more attractive as cheaper and more efficient drilling, blasting and ore handling techniques are developed....*
>
> *The use of caving, blast-hole stoping, and open-pit mining methods greatly reduces the number of men employed per ton of ore mined. By these methods several tens of tons of ore are mined per man-shift as compared with much less than ten tons by more selective methods. The result is a marked decrease in the labour cost per pound of metal produced. On the other hand, although the capital cost per unit of metal produced may be lower, the initial capital required in setting up large-scale, bulk mining operations is far greater because: a large ore reserve must first be assured to justify the large capital investment; and a large investment in machinery and preliminary development work is necessary to get the operation started.*[10]

All of this had profound consequences for the mining industry, not least for those who worked underground.[11]

The last chapter suggested that increasing mechanization meant that skilled labour was less critical for successful mining operations, an analysis confirmed by various economists, engineers, and geologists connected with the U.S. government during the 1930s and 1940s. Their studies—notably those associated with the Work Projects Administration's Mineral Technology and Output per Man studies—examined the impact of technological change on mine labour. Emphasizing the mining industry's increased productivity and its reduced labour requirements, they accurately forecast the limited employment prospects in the post-Depression era.[12]

Despite an uncertain economic climate, the industry continued to expand for much of the period. In both Manitoba and Quebec, new discoveries led to the emergence of large and very successful mining companies. These developments were not

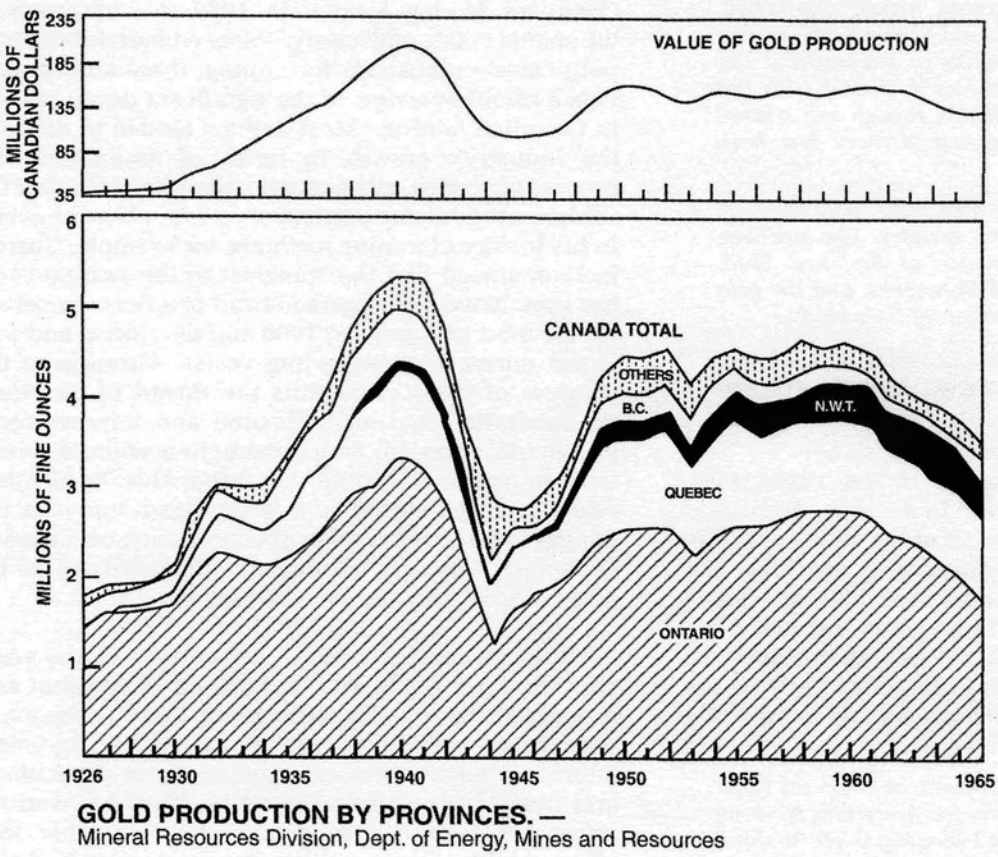


Figure 31. *VALUE OF GOLD PRODUCTION, 1926-1965* (from Walkom, *Canadian Mining Journal*)

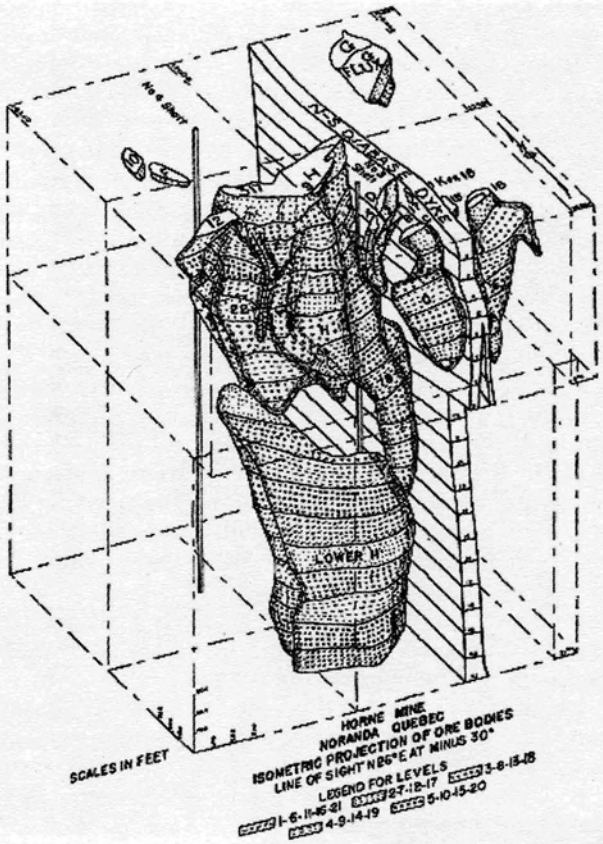


Figure 32. *ORE BODIES OF THE HORNE MINE, NORANDA* (from Hall, "Mining at Noranda")

wholly unexpected—a number of people had speculated on the untapped mineral wealth in the North[13] —and in many ways the new mines opened up in Flin Flon and Rouyn-Noranda were logical extensions of existing mining activity. Well-established mining regions tended to encourage hopeful prospectors to search further afield. Many of Ontario's new mines around Cobalt, Kirkland Lake and Porcupine had gone into production prior to or during the First World War, and continued to expand in the 1920s. The region was the base from which the prospector Ed Horne travelled into northwestern Quebec, where he located the deposit that was to become the basis of the Noranda empire.[14]

More importantly, perhaps, much of Noranda's early financing came out of the profits of Ontario's booming gold mining industry.[15] As John Davis suggested in his comments quoted earlier, one consequence of the increasing reliance on low-grade ore deposits was that mining projects now tended to have high start-up costs. This in turn meant that such new projects could only be initiated by companies with considerable capital at their disposal, one reason a small group of large corporations came to dominate the industry during this period.[16] The history of both Noranda and the Hudson Bay Mining and Smelting Company (owner of the Flin Flon mine) supports such an analysis.

The story of Noranda's growth has been told by a number of people, and only several points need to be repeated here.[17] The first concerns the initial steps taken by those who were to work the mine. After securing an option on the property, they spent a good deal of time methodically drilling test holes in the area, to determine both the nature and extent of the ore deposit. Further development followed only when this process had demonstrated the mine's potential. At this point, the company approached railway companies operating in the region, in an effort to persuade them to build branch lines to the mine. It also began construction of both a mine and smelter, and laid out the townsite of Noranda. All of this cost money. According to Leslie Roberts, the company negotiated a special loan of $3 million from Hollinger Consolidated Gold Mines, "for the purpose of providing the necessary buildings, plant and machinery to fully equip the company to carry on its operations as a Mining and Smelting Company and to provide working capital."[18] This scale of development was well outside the reach of pioneer entrepreneurs active in earlier periods of mining activity. In 1933—that is, within 10 years of the company's initial drilling program—Peter Price completed his doctorate at McGill University on "The Geology and Ore Deposits of the Horne Mine, Noranda, Quebec."[19] His careful plot of the "H" and "Lower H" ore bodies revealed their size and dimensions over 2,000 feet beneath the surface. During the years to follow, mine managers carefully studied the best means of mining this ore.[20]

The mine at Flin Flon in Manitoba followed a similar pattern of growth, although the parent company in this instance, the Hudson Bay Mining and Smelting Company, remained an American-based enterprise. The mine itself was staked in 1915, but the complexities of the ore deposit frightened away a series of potential investors. Finally, in 1925, New York financiers took up the option on the property, and began the process of turning it into a mine.[21] As with Noranda, this took considerable time and even more money: more than $20 million was raised through shares and a bond issue to finance the costs of building a railway line into the mine, constructing a large power plant to supply electricity, as well as developing the mine and smelter. The mine finally went into production in 1930, 15 years after its location.

Noranda and Flin Flon were not the only new mines of the period, of course. A number of other significant properties also went into production, including the Falconbridge Nickel Mines in Sudbury, Sherritt Gordon in Manitoba, a series of gold properties in British Columbia, Ontario and Quebec, as well as mines in the North.[22] Only the first two of these properties matched the scale of developments at Noranda and Flin Flon. In fact, by the close of the period, six firms dominated the mining industry: the

two Sudbury firms of Inco and Falconbridge; the Manitoba-based firms, Hudson Bay Mining and Smelting Company and Sherritt-Gordon; Quebec's Noranda, and the CPR subsidiary, Cominco.[23] They were all established and profitable firms, and their success helped to legitimize the industry. Even the money markets began to accept the fact that mines were now sufficiently reputable as to be trusted with debt financing. As one writer noted, "The uncertainties involved in locating and bringing a mine into production have been too great a barrier, heretofore, to attract the interest of the normally conservative bond investor." He concluded, however, that "Debt financing has a very definite place in the raising of capital for the mining industry. It is especially suitable where the development is of a major character and large sums are required."[24]

If the corporate world of mining changed fundamentally during this period, the same could be said of the work of mining in the years following 1919. The shift to non-selective mining methods committed mine operators to ever greater levels of mechanization and the handling of escalating tonnages of ore per day. Miners had little choice but to accept the consequences of this rapidly-changing workplace.[25]

Miners' unions were quick to arrive in most mining camps, and were well-established in British Columbia by the first years of the twentieth century.[26] These were all locals of the American-based Western Federation of Miners, a union with a reputation for militancy and violence. (Although this reputation was largely the result of a determined smear campaign by mine management, it was nonetheless very difficult to overcome.) In an effort to distance itself from its turbulent past, the Western Federation of Miners changed its name to the International Union of Mine, Mill and Smelterworkers in 1916. The increasingly moderate views of union officials clashed with the growing militancy of the rank and file miners, and by the spring of 1919, virtually all the Mine Mill locals in British Columbia had collapsed, replaced by the units of the newly-formed One Big Union. This was a relatively short-lived phenomenon, however: OBU locals did not survive the strike wave of 1919 and the subsequent post-war depression.[27] The labour movement was in disarray throughout the 1920s, a period characterized by retrenchment and anti-union sentiment.[28] Company unions or "workers' co-operative committees," such as the one introduced at Cominco, were the only organizational forms that managers would allow.[29]

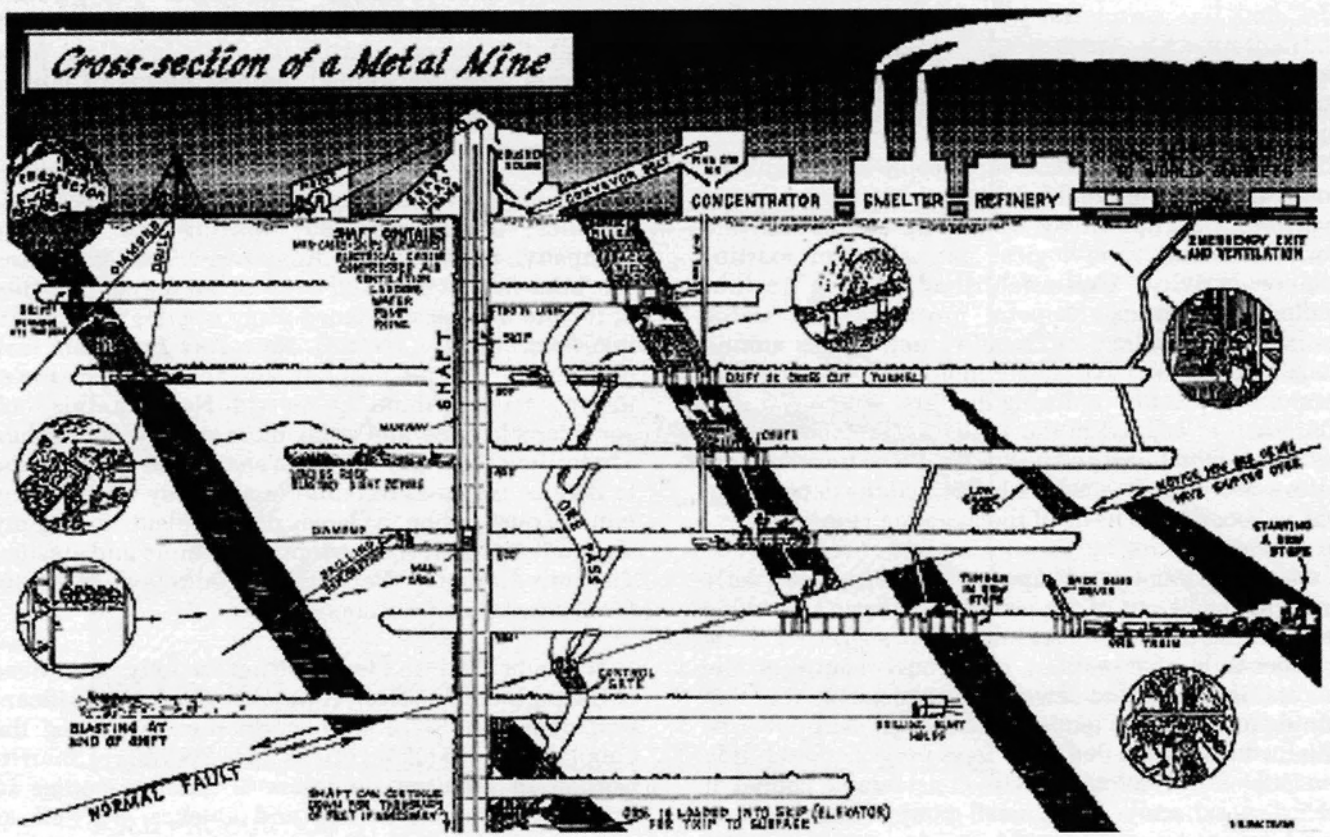


Figure 33. *CROSS-SECTION OF A METAL MINE A government pamphlet carried this idealized cross-section of a typical mine, which demonstrates something of the complexity of the underground environment by the close of the period.* (from Zahalan, *Mining in Manitoba*)

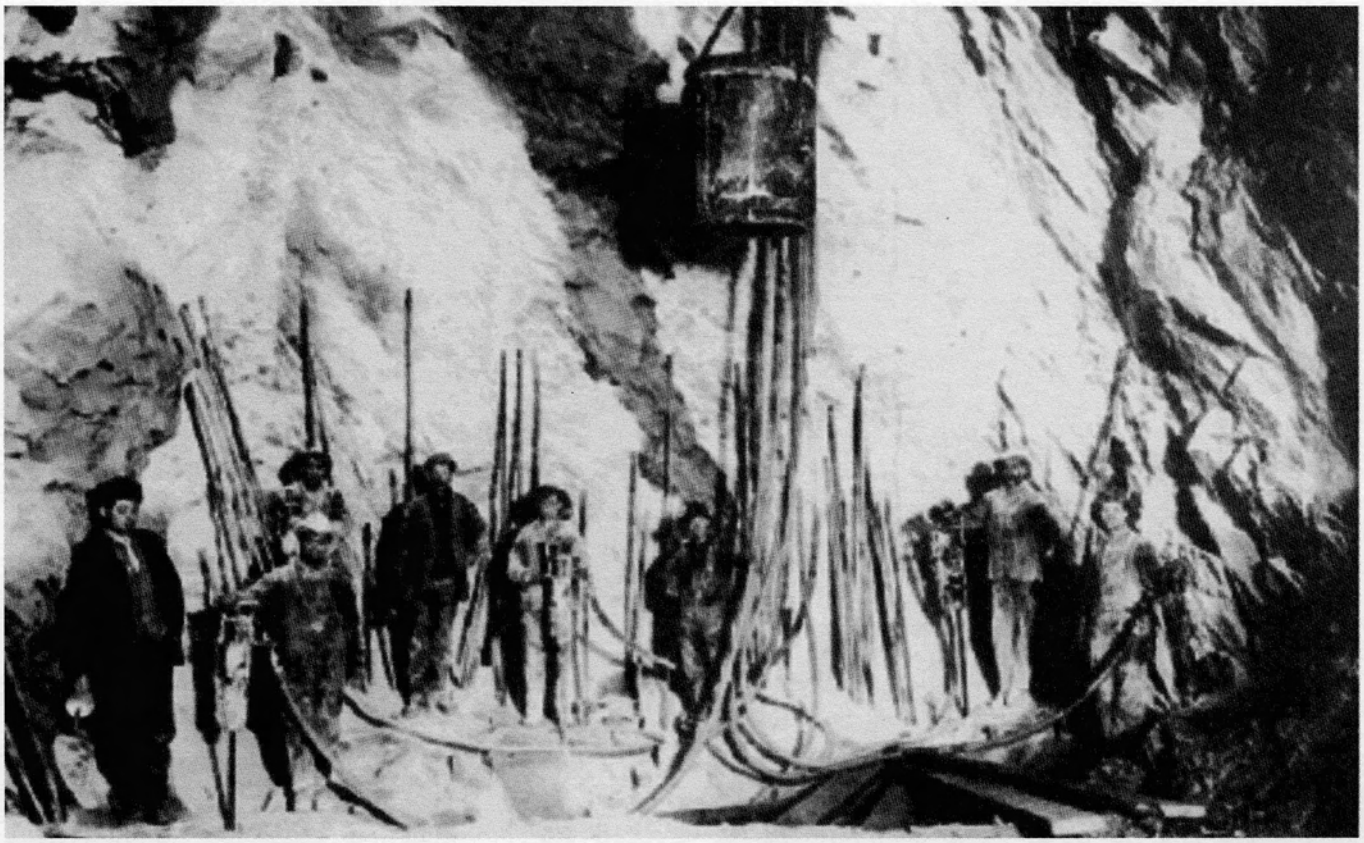


Figure 34. *DEVELOPMENT MINERS SINKING A SHAFT IN THE DOME MINE These were often the most skillful miners, and usually the highest paid. Note the absence of dust on the visitor on the left, hinting at the amount of dust that these miners were inhaling as they worked.* (from Barnes, *Timmins*)

Despite the anti-union attitudes and rhetoric of mine managers, the industry's reputation for good wages and steady work was a powerful incentive for working people. However, the hidden cost of mining to the health of underground workers also attracted attention in the 1920s. Medical authorities in Ontario began to study the incidence of silicosis, a disease that debilitated miners exposed to the fine silica particles produced by drilling particular ores. As a result of this work, silicosis was made a compensatable disease in Ontario in 1926. Consequently, greater attention was given to health and safety regulations, in addition to workers' compensation.[30] From 1926 to 1955, Ontario's Silicosis Referee Board recognized that nearly 1,200 people (mostly gold miners) contracted silicosis. Over half of this number died either from silicosis or tuberculosis.[31] Although miners' unions in British Columbia had sought to have silicosis made a compensatable disease as early as 1913, developments in that province lagged behind Ontario. Legislation declaring silicosis a compensatable disease was not enacted until 1936.[32]

Miners renewed their efforts to gain union recognition in the 1930s. They were aided by growing support for industrial unionism across the continent, especially the early victories of the American-based Congress of Industrial Organizations, formed in 1935.[33] Union membership in Canada began to climb, gradually at first and then more dramatically following the outbreak of the Second World War.[34] Despite the growing union numbers, mine owners remained implacably opposed to union recognition; a confrontation was inevitable. The most famous of these battles took place in Ontario, at Kirkland Lake, and although miners lost the strike, ultimately they won the war. Faced with growing anger and resentment across the country, the federal government reluctantly enacted legislation making collective bargaining compulsory in 1944.[35] By 1950, mining companies had recognized their workers' right to belong to a union.

The 1954 annual general meeting of the Canadian Institute of Mining and Metallurgy included a symposium called "The Stature, Scope, and Importance of Canada's Mineral Industry." C.C. Huston, the Institute's President, was the first speaker, and his role was to provide a historical account of mining's progress in Canada. The post-war boom was at its peak and many in the mining industry were doing very well indeed. Huston described these prosperous times:

> *Since the [Second World] war, we appear to have entered, for various reasons—many of which are not*

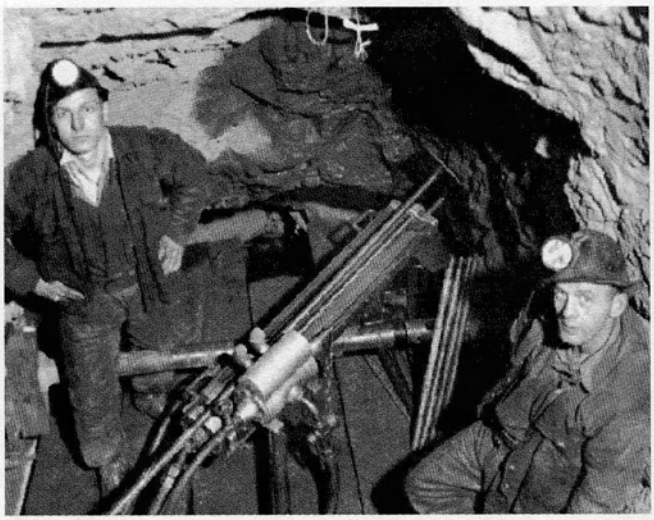


Figure 35. *TWO MINERS IN THE GRANBY CONSOLIDATED COPPER MOUNTAIN MINE* (B.C. Archives)

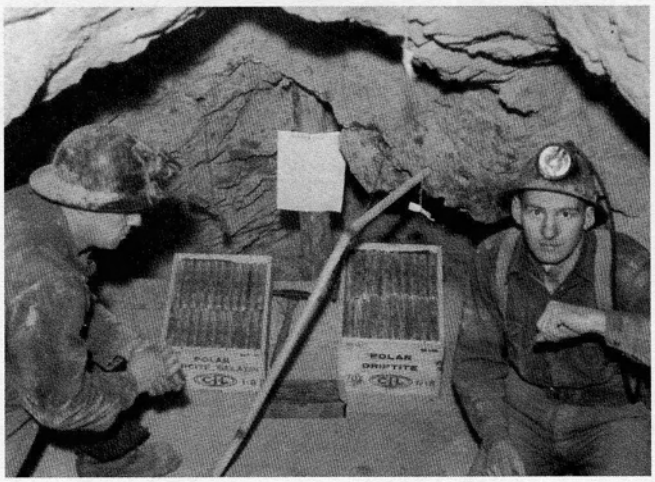


Figure 36. *DYNAMITE PIT IN GRANBY'S COPPER MOUNTAIN MINE* (B.C. Archives)

> *clearly understood even by economists—a great era of industrial expansion and development of as yet inestimable dimension.... Indicative of the vastly increased magnitude of the [mining] industry, it is calculated that between 1900 and 1940 the world produced as much total metal as was produced in all the years before that date, and that Canada has, since 1940, herself produced more metal than in all her productive history before that date.*[36]

Such optimism was understandable: the industry had only recently survived both war and depression. It seemed as if things would only continue to improve; after listing numerous technical improvements ("roof-bolting, blast-hole drilling, the light machine, detachable bits, the mucking machine, improved explosives, ventilation, and safety standards"), Huston reflected that such advances "give promise of a yet greater future for this industry."[37]

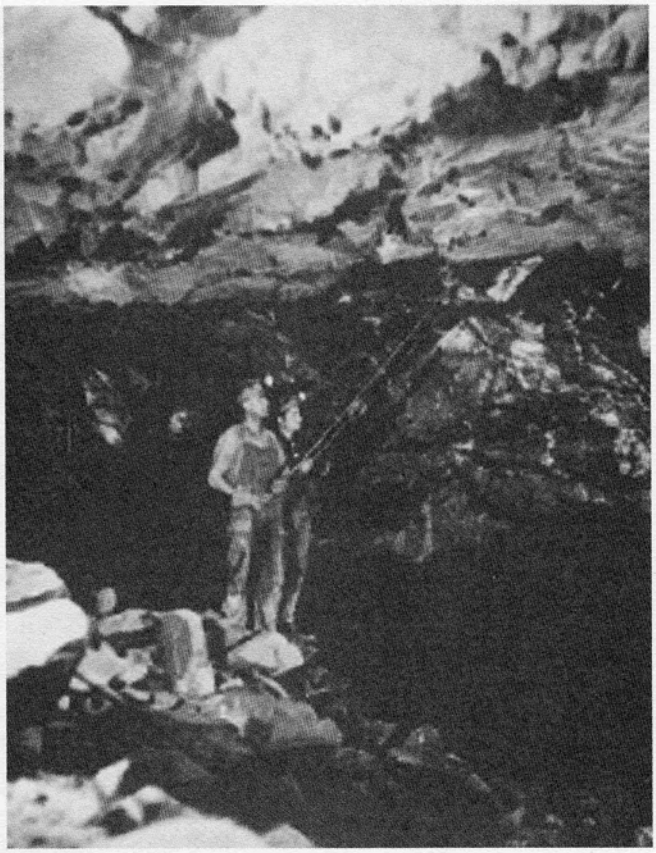


Figure 37. *MINERS BARRING DOWN LOOSE ROCK IN THE HOLLINGER MINE Before and after: in Figure 36, two miners in Granby's Copper Mountain mine get dynamite; in Figure 37, miners bar down loose rock after a blast on the 1,700 foot level of the Hollinger mine.* (from Barnes, *Timmins*)

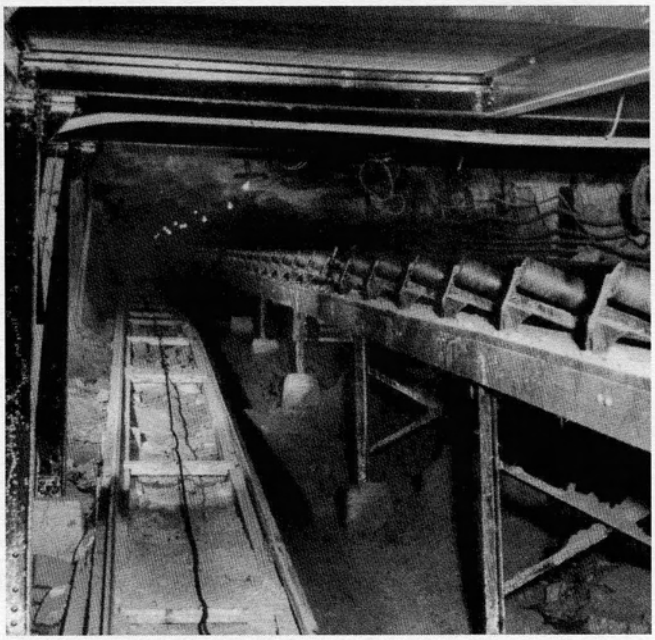


Figure 38. *CONVEYOR BELT IN THE SULLIVAN MINE The underground factory: the photograph of the conveyor belt in the Sullivan mine is dated 1945.* (B.C. Archives)

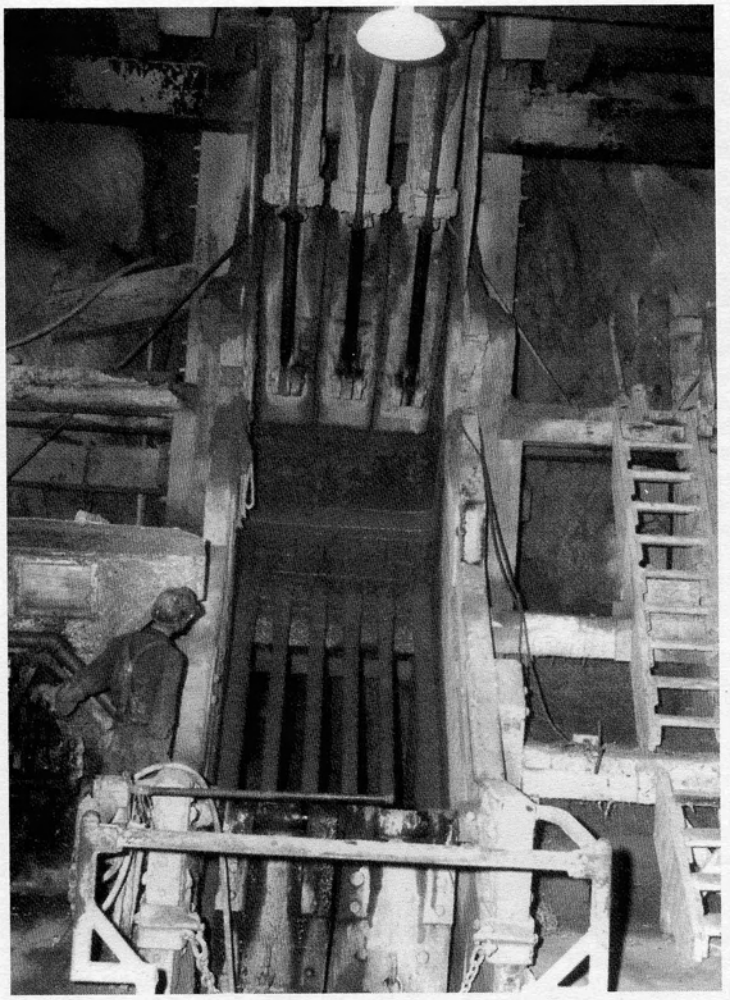


Figure 39. *UNDERGROUND GRIZZLY IN THE BRITANNIA MINE A hydraulically-driven grizzly sorts ore in 1945.* (B.C. Archives)

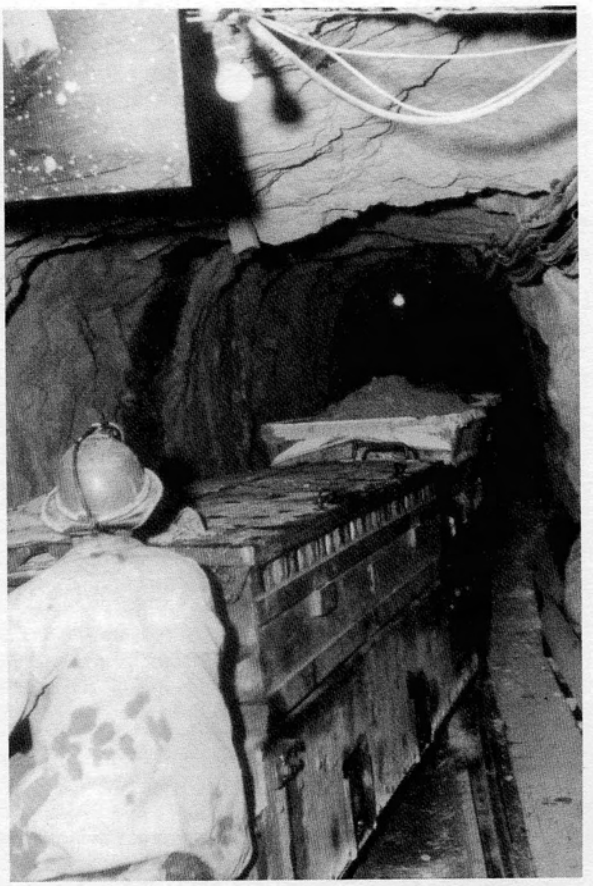


Figure 40. *ORE TRAIN IN THE BRALORNE MINE The ore train in the Bralorne mine is shown moving along a drive, taking its load out to grass in 1937.* (B.C. Archives)

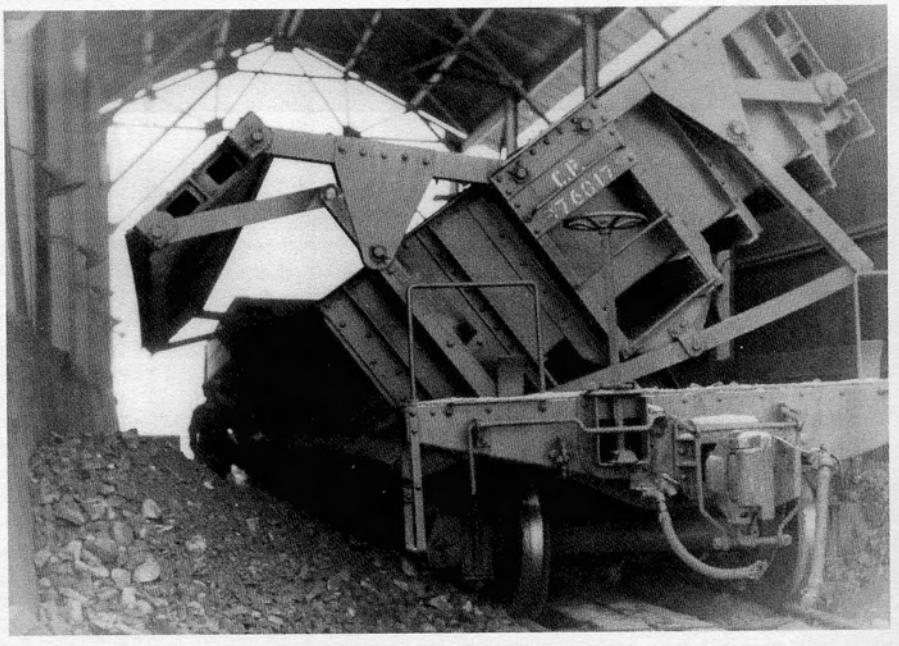


Figure 41. *RAILCAR WITH COARSELY CRUSHED ORE AT COMINCO'S SULLIVAN CONCENTRATOR A rail car dumps its load of coarsely-crushed ore in 1938.* (B.C. Archives)

Notes

1. In a series of publications, Alexander Dow has emphasised the significance of the role of base metal mining. See his dissertation, "The Canadian Base Metal Mining Industry (Non-ferrous) and Its Impact on Economic Development in Canada, 1918-55" (PhD thesis, University of Manitoba, 1980), as well as the following articles: "Finance and Foreign Control in Canadian Base Metal Mining, 1918-55," *Economic History Review* 2nd ser., 37, no. 1 (February 1984): 54-67; "Prometheus in Canada: The Expansion of Metal Mining, 1900-1950," in Duncan Cameron, ed., *Explorations in Canadian Economic History: Essays in Honour of Irene M. Spry* (Ottawa: University of Ottawa Press, 1985), pp. 211-28; "Metal Mining and Canadian Economic Development to 1939," *Business History* 32, no. 3 (July 1990): 146-61; and "Technology, Demand and Canadian Base Metal Markets, 1900-50," *British Journal of Canadian Studies* 8, no. 1 (1993): 18-41. The emergence of base metals was acknowledged by those within the mining industry. Writing in 1939, for example, a prominent metallurgist described the years from 1919 to 1929 as a period "of great achievements and developments in ore dressing operations, ...practically all this progress was linked with the expansion of the base metal mining industry." C. S. Parsons, "Sixty Years of Development in Ore Dressing," *Canadian Mining Journal* 60, no. 11 (November 1939): 693. Note also the comments in John Davis, *Mining and Mineral Processing in Canada* (Hull: Queen's Printer, 1957), p. 9.
2. A. H. A. Robinson, comp., *The Mineral Industries of Canada* (Ottawa: Government Printing Bureau, 1924), p. 11. According to the Preface (p. 9), this booklet was intended "to present in popular form a brief sketch of the more important economic minerals so far discovered in Canada and of the mining and metallurgical industries founded thereon." It was first published in 1913 as *Economic Minerals and Mining Industries of Canada* (Mines Branch Report No. 230). In 1914 it was revised and reprinted for the Panama Pacific Exposition at San Francisco, as Mines Branch Report No. 322. This third edition was published for the British Empire Exhibition held in London during 1924.
3. *Sudbury Star*, feature edition, August 1933, quoted in Dow, "Metal Mining and Canadian Economic Development to 1939," p. 146.
4. T. A. Crerar, *The Future of Canadian Mining* (Ottawa: J. O. Patenaude, 1936), pp. 82-83. The radio broadcasts were subsequently published.
5. As Morris Zaslow noted, "The remarkable growth of metallic mining, particularly in the thirties, contrasted sharply with the impact of the Depression on the other primary industries. Mining of gold and metallic minerals, mainly in the northern sections of the provinces and in the Territories, expanded dramatically...." Zaslow, *The Northward Expansion of Canada*, 1914-1967 (Toronto: McClelland and Stewart, 1988), p. 127. For an insightful analysis of mining and the rhetoric of development, see David S. Trigger, "Mining, Landscape and the Culture of Development Ideology in Australia," *Ecumene: A Journal of Environment, Culture and Meaning* 4, no. 2 (1997): 161-80. Although not specifically concerned with mining, Suzanne Zeller's *Inventing Canada: Early Victorian Science and the Idea of a Transcontinental Nation* (Toronto: University of Toronto Press, 1987), provides an illuminating discussion of similar themes in nineteenth-century Canada.
6. Note for example C. M. Campbell's response to Crerar's optimistic pronouncements: "The Crerar Broadcasts," *The Miner* (May 1936): 29-31. Campbell was a well-known mining engineer who had run Granby's very successful operations in southern British Columbia in the 1900s.
7. Note, for example, the following: C. S. Parsons, "Sixty Years of Development in Ore Dressing," *Canadian Mining Journal* 60, no. 11 (November 1939): 693-711; Noranda Smelter Staff, "Development in Base Metal Smelting and Refining in Canada in the Last Sixty Years," *Canadian Mining Journal* 60, no. 11 (November 1939): 713-23; Chas. F. Jackson, "Metal Mining Practice Over Sixty Years," *Canadian Mining Journal* 60, no. 11 (November 1939): 673-91; Leslie Roberts, "Wings Over The Muskeg," *Canadian Mining Journal* 60, no. 11 (November 1939): 763-68; and W. B. Paton, "Six Decades of Progress in Safety and Welfare," *Canadian Mining Journal* 60, no. 11 (November 1939): 749-53.
8. Jackson, "Metal Mining Practice Over Sixty Years," *Canadian Mining Journal* 60, no. 11 (November 1939): 691.
9. See Davis, *Mining and Mineral Processing in Canada*, pp. 288-90.
10. Davis, *Mining and Mineral Processing in Canada*, pp. 288-90.
11. In addition to Hovis and Mouat, "Miners, Engineers, and the Transformation of Work in the Western Mining Industry, 1880-1930," see Guy Gaudreau, "Ethnicité et division du travail dans la modernisation d'une enterprise minière: la Canadian Copper Company, 1886-1928," and Alain Daoust, "La mobilité interne des ouvriers-mineurs de l'Inco," in Guy Gaudreau, ed., *La mobilité des ouvriers-mineurs du Nord ontarien et québécois 1900-1939* (Sudbury: Laurentian University/Université Laurentienne, 1998).
12. See for example: Vivian Eberle Spencer, *Production, Employment, and Productivity in the Mineral Extractive Industries, 1880-1938* (Philadelphia: Work Projects Administration, 1940); Y. S. Leong, Emil Erdreich, J. C. Burritt, O. E. Kiessling, C. E. Nighman, George C. Heikes, *Technology, Employment, and Output per Man in Copper Mining* (Philadelphia: Work Projects Administration, 1940); F. G. Tryon and E. C. Eckel, eds., *Mineral Economics: Lectures under the Auspices of the Brookings Institution* (New York: McGraw-Hill Book Co., 1932); and Harold Barger and Sam H. Schurr, *The Mining Industries, 1899-1939: A Study of Output, Employment and Productivity* (New York: National Bureau of Economic Research, Inc., 1944).
13. For example, Frank Adams reviewed Quebec's mining history in 1914, concluding that "the Province of Quebec has not up to the present time developed as great an industry in minerals and mining as have several of her sister provinces.... But in the great Laurentian Plateau which stretches away to the Far North,... there is in all probability great mineral wealth awaiting discovery and development." Frank D. Adams, "History of Mining in the Province," in Adam Shortt and Arthur G. Doughty, eds., *Canada and Its Provinces, Vol. 16 - Province of Quebec, Part 2* (Toronto: Publishers Association of Canada, 1914), p. 597.
14. Horne staked the Noranda deposit in 1920, although he had first visited the then-remote area nine years earlier. See Leslie Roberts, *Noranda* (Toronto: Clarke, Irwin & Co., 1956), pp. 15-32, and Marc Vallières, *Des mines et des hommes: histoire de l'industrie minérale québécoise* (Quebec: Les Publications du Québec, 1989), pp. 176-77.
15. See Dow, "Finance and Foreign Control in Canadian Base Metal Mining, 1918-55," *Economic History Review*, 2nd ser., 37, no. 1 (February 1984): 63-64.
16. Thus Davis went on to observe that "Because of the large capital investment required to get such low-grade, large tonnage operations under way[,] it is likely that these developments will continue to be controlled by a relatively few large companies that have the necessary capital (or by reputation can attract the necessary public participation) and experience to develop them and bring them to production." *Mining and Mineral Processing in Canada*, p. 290. Note also Dow's comments in "Finance and Foreign Control

in Canadian Base Metal Mining, 1918-55," passim, as well as Pierre Paquette, "Industries et politiques minières au Québec, une analyse économique 1896-1975," *Revue d'histoire de l'Amérique française* 37, no. 4 (mars 1974), esp. pp. 578-81.

17. See Leslie Roberts, *Noranda*; D. M. LeBourdais, *Metals and Men: The Story of Canadian Mining* (Toronto: McClelland and Stewart, 1957), pp. 194-203; William A. Buik, "Noranda Mines, Ltd.: A Study in Business and Economic History" (MA thesis, University of Toronto, 1973); Nicole Berthiaume, *Rouyn-Noranda, le développement d'une agglomération minière au coeur de l'Abitibi-Temiscamingue* (Rouyn, Québec: Collège du Nord-Ouest, Cahiers du Département d'histoire et de géographie, 1981); and R. C. Rowe, "Historical Sketch of Noranda Mines," *Canadian Mining Journal* 55, no. 4 (April 1934): 144-47 (special issue on Noranda). Several oral histories of Rouyn-Noranda have been published: see Albert Pelletier, *J'ai vu naître et grandir ces jumelles*, 2nd ed. (Rouyn, Quebec: Impr. Lebonfon, 1969), and Annette LaCasse-Gauthier, *Les jumelles à l'âge d'or (Pionniers de Rouyn-Noranda)* (n.p., 1985).
18. Quoted in Roberts, *Noranda*, pp. 87-88; cf. Buik, "Noranda Mines, Ltd.," pp. 25-26; LeBourdais, *Metals and Men*, p. 200, and Dow, "Finance and Foreign Control in Canadian Base Metal Mining, 1918-55," p. 64.
19. See the published digest of this work: Peter Price, "The Geology and Ore Deposits of the Horne Mine, Noranda, Quebec," *Transactions of the Canadian Institute of Mining and Metallurgy* 37 (1934): 108-40. Similarly, in 1917, Everend Lester Bruce had his doctorate (completed at Columbia University) published as *Geology and Ore-Deposits of Rossland. B.C.*, British Columbia Department of Mines Bulletin No. 4, 1917 (Victoria: King's Printer, 1917).
20. See esp. Oliver Hall, "Mining at Noranda," *Transactions of the Canadian Institute of Mining and Metallurgy* 40 (1937): 141-64, and O. Hall, R. V. Porritt, and A. D. Carmichael, "Stoping at Noranda," *Transactions of the Canadian Institute of Mining and Metallurgy* 42 (1939): 133-49.
21. By far the best account of the mine's development is James David Mochoruk, "The Political Economy of Northern Development: Governments and Capital along Manitoba's Resource Frontier, 1870-1930" (PhD thesis, University of Manitoba, 1992); see especially chapters 6, 7 and 9. No other work matches Mochoruk's study, although they occasionally provide some illuminating detail. See W. A. Green, "History of Development and Organization at Flin Flon Mine, Manitoba," *Transactions of the Canadian Institute of Mining and Metallurgy* 33 (1930): 214-21; LeBourdais, *Metals and Men*, pp. 233-42; and George E. Cole, "Mining in Manitoba," *Transactions, Historical and Scientific Society of Manitoba*, ser. 3, no. 5 (1950): 63-82. For the intriguing story of how Flin Flon got its name, see George E. Cole, "Flin Flon—The Name," *Canadian Mining Journal* 70, no. 3 (March 1949): 63-71, and Alan Rayburn, *Naming Canada: Stories about Place Names from Canadian Geographic* (Toronto: University of Toronto Press, 1994), pp. 168-70.
22. For details of the new mining activity in the Canadian North, see A. H. Lang and R. J. W. Douglas, "Minerals and Fuels," in Frank Underhill, ed., *The Canadian Northwest: Its Potentialities/L'Avenir du Nord-Ouest Canadien* (Toronto: University of Toronto Press, 1959), pp. 45-48, and Morris Zaslow, *The Northward Expansion of Canada, 1914-1967* (Toronto: McClelland and Stewart, 1988), pp. 100-29.
23. By 1955, the combined assets of the six companies were over a billion dollars; see Dow, "Finance and Foreign Control in Canadian Base Metal Mining, 1918-55," p. 65.
24. W. J. Lyons, "Bonds Now Well Entrenched in Mine Financing," *The Northern Miner*, 25 November 1954, pp. 19. Lyons' was an authoritative voice: he was the Director of McLeod, Young, Weir & Company. W. G. McBride of McGill University made much the same point 25 years earlier: "Ample provision is made for financing the work.... No attempt is made to produce until the orebody has been opened up to determine its grade, physical character and extent sufficiently to plan production on intelligent and scientific lines. This has eliminated much of the financial hazard of mining, and put the industry on a much firmer footing." "Developments in Mining Practice," *Canadian Mining Journal* 50, no. 8 (August 1929): 119.
25. For accounts of the changes in mining practice, see Harold Barger and Sam H. Schurr, *The Mining Industries, 1899-1939: A Study of Output, Employment and Productivity* (New York: National Bureau of Economic Research, Inc., 1944); Lucien Eaton, "Seventy-five Years of Progress in Metal Mining," in A. B. Parsons, ed., *Seventy-five Years of Progress in the Mineral Industry 1871-1946* (New York: The American Institute of Mining and Metallurgical Engineers, 1947), pp. 40-81; and Jackson, "Metal Mining Practice Over Sixty Years". There is also some illuminating detail in Charles E. Van Barneveld, *Mechanical Underground Loading in Metal Mines* (Rolla, Missouri: Missouri School of Mines and Metallurgy, 1924).
26. For a sketch of mining unionism in British Columbia, see Jeremy Mouat, *Roaring Days: Rossland's Mines and the History of British Columbia* (Vancouver: UBC Press, 1995), esp. pp. 67-108, and Mike Solski and John Smaller, *Mine Mill: The History of the International Union of Mine, Mill and Smelter Workers in Canada Since 1895* (Ottawa: Steel Rail Publishing, 1984), pp. 19-54.
27. See Allen Seager and David Roth, "British Columbia and the Mining West: A Ghost of a Chance," in Craig Heron, ed., *The Workers' Revolt in Canada, 1917-1925* (Toronto: University of Toronto Press, 1998), pp. 231-67; David Bercuson, *Fools and Wise Men: The Rise and Fall of the One Big Union* (Toronto: McGraw-Hill Ryerson, 1978); and Mouat, *Roaring Days*, pp. 160-64. The most significant of the 1919 mining strikes in Ontario is described in Brian F. Hogan, *Cobalt: Year of the Strike 1919* (Cobalt: Highway Book Shop, 1978); cf. John B. Lang, "A Lion in a Den of Daniels: A History of the International Union of Mine Mill and Smelter Workers in Sudbury, Ontario, 1942-1962" (MA thesis, University of Guelph, 1970), pp. 27-29. Valuable detail of the 1919 strike wave may be found in the chapters of Heron's *The Workers' Revolt in Canada*, which supersedes the earlier overview by Gregory S. Kealey, "1919: Canadian Labour Revolt," *Labour/Le Travail*, no. 13 (1984): 11-44. For a discussion of the fate of mining unionism across the continent, Vernon H. Jensen's study remains useful: *Heritage of Conflict: Labor Relations in the Nonferrous Metals Industry up to 1930* (Ithaca, New York: Cornell University Press, 1950).
28. For a perceptive description of conditions in Canada during this period, see John Herd Thompson, with Allen Seager, *Canada 1922-1939, Decades of Discord* (Toronto: McClelland and Stewart, 1985), pp. 139-44, and Bryan D. Palmer, *Working-Class Experience: Rethinking the History of Canadian Labour, 1880-1991*, 2nd ed. (Toronto: McClelland and Stewart, 1992), pp. 214-21.
29. Cominco's "workers' co-operative committees" were based on Rockefeller's "Colorado plan," devised by Mackenzie King for the American magnate in the wake of the embarrassing publicity surrounding the Ludlow Massacre in the spring of 1914, where the Colorado militia killed two women, twelve children, and ten men. For a discussion of the genesis of the Colorado Plan and the role played by Mackenzie King in its creation, see H. M. Gitelman, *Legacy of the Ludlow Massacre: A Chapter in American Industrial Relations* (Philadelphia: University of Pennsylvania Press,

1988). Cominco's general manager, Selwyn Blaylock, was very proud of the company's cooperative committee system: see his two articles: "Industrial Relationship," *Transactions of the Canadian Institute of Mining and Metallurgy* 38 (1935): 243-254, and "The Co-operative Committee System of the Consolidated Mining and Smelting Company of Canada Limited," *Transactions*, vol. 39 (1936): 52-54. For the critical perspective of a unionist, see the interview with Les Walker, 29 July 1964 (typescript), pp. 8-11, Colleen Toppings Bourke Collection, Special Collections Division, University of British Columbia Library. During the Depression, a series of articles described the committees' aims and functions in very positive terms: see for examples *Labour Gazette* 32 (June 1932): 635-36; "Industrial Relations at the Mines," *The Miner* (August 1937): 24-25; "Labour Relations: The Co-Operative Committee System of the Consolidated Mining and Smelting Company of Canada, Limited," *Canadian Mining Journal* 58 (June 1937): 314-15; and H. B. Smith, "Co-operative Working Relations at Consolidated Smelters," *Western Canada Coal Review* 19, no. 1 (January 1936), pp. 7-8. Note also the brief biography of Blaylock by B. A. McKelvie, "Blaylock of Trail," *MacLean's Magazine* 41, no. 10 (15 May 1928), pp. 7, 58, 61, and the speech of W. K. Esling, MP for Kootenay West, Canada, *Parliamentary Debates*, 11 May 1936, pp. 2715-18.

30. See Dieter Grant Hogaboam, "Compensation and Control: Silicosis in the Ontario Hardrock Mining Industry, 1921-1975" (MA thesis, Queen's University, 1997), as well as J. H. Elliott, "Silicosis in Ontario Gold Miners," *Canadian Medical Association Journal* 14 (October 1924): 930-37; Omer G. Hague and R. W. McBain, "Silicosis as an Industrial Hazard in Ontario Gold Mining," *American Journal of Roentgenology and Radium Therapy* 18, no. 4 (October 1927): 315-22; and F. G. Banting, "Silicosis Research," *Canadian Medical Association Journal* 35 (1936): 289-93.
31. Data from Appendix IX, "Silicosis and Accident Prevention in Ontario Gold Mines," *Gold Mining in Ontario*, Report of the Committee of Inquiry into the Economics of the Gold Mining Industry, 1955 (Toronto: Queen's Printer, 1955), p. 76.
32. In August 1935, B.C.'s Minister of Mines commissioned a study of the incidence of silicosis among the province's miners, described by C. H. Vrooman in his paper, "Silicosis and Its Incidence in British Columbia," *Canadian Medical Association Journal* 35 (1936): 293-97. Vrooman—who conducted the study—looked at underground workers in five of B.C.'s leading mines and found that some 8 per cent of the men (105 individuals, of the 1,339 tested) were silicotic. For the subsequent legislation dealing with silicosis in B.C., see "Silicosis Compensation in British Columbia," *The Miner*, (December 1936): 19-20, as well as "An Act to Amend the 'Workman's Compensation Act,' " British Columbia, *Statutes of the Province of British Columbia...*, 1936, Chapter 61, pp. 191-94. The appeals of B.C. locals of the Western Federation of Miners to have silicosis declared a compensatable disease came in their submissions to the B. C. Commission on Labour in May 1913. See B.C. Commission on Labour, 1912-1914, typescript, Box 2, file 8 (pp. A4 & A5), GR 684, B.C. Archives.
33. See the account in Irving Martin Abella, *Nationalism, Communism and Canadian Labour: The CIO, the Communist Party and the Canadian Congress of Labour, 1935-1956* (Toronto: University of Toronto Press, 1973), esp. pp. 86-110.
34. See the graph of union membership in Laurel Sefton MacDowell, *"Remember Kirkland Lake" : The History and Effects of the Kirkland Lake Gold Miners' Strike, 1941-42* (Toronto: University of Toronto Press, 1983), p. xiv.
35. The fullest account is in MacDowell, *"Remember Kirkland Lake"* , but see also Lang, "A Lion in a Den of Daniels." For developments in B.C., see David Michael Roth, "A Union on the Hill: The International Union of Mine, Mill and Smelter Workers and the Organization of Trail Smelter and Chemical Workers, 1938-1945" (MA thesis, Simon Fraser University, 1991). More generally, see Solski and Smaller, *Mine Mill*; Abella, *Nationalism, Communism, and Canadian Labour*; and various contributions to Mercedes Steedman, Peter Suschnigg, and Dieter K. Buse, eds., *Hard Lessons: The Mine Mill Union in the Canadian Labour Movement* (Toronto and Oxford: Dundurn Press, 1995).
36. Huston, "Progress of the Mining Industry of Canada," p. 297.
37. Ibid., p.298.

6. Conclusion

"...mining rarely receives its full recognition for the major contributions that, as an industry, it has made to the development of European civilisation. Indeed, it is probably true to say that, more than any other, European material culture has been based on mining. This has been at once a cause and an effect of European technological superiority."[1] *-D.S.L. Cardwell*

One of Canada's eminent scholars, the political economist Harold Innis, has argued that mining was a key staple in the country's industrial development.[2] The linkages that Innis identified between the mining industry and Canadian society are rarely acknowledged, despite the fact that they can be found in some unexpected places. In the autumn of 1936, for example, William H. Wright bought two Toronto newspapers, *The Globe* and *The Mail and Empire*, merging them to create *The Globe and Mail*. When Wright, a wealthy mining executive, was asked why he had acquired the first of the papers, he answered, "mainly it was my interest in mining. My object in purchasing *The Globe* was not to make money out of it—at least that was not my main object. I thought I could do something for the country by making our mining industries better known. Anything that is of advantage to mining is of advantage to the country as a whole."[3] Another prominent Toronto icon—Maple Leaf Gardens—also owed much to Ontario's mining industry: mining executive J. P. Bickell lent Conn Smythe the money to build the Gardens.[4]

Mining continues to be a very significant economic activity in Canada. In the post-war era, much attention and effort has gone into developing mining properties across Canada's north. Properties such as Pine Point in the Northwest Territories and Cyprus Anvil in the Yukon began shipping ore in the 1960s and 1970s respectively, with significant financial assistance from the federal government.[5] The government was increasingly interested in pushing northern development, an interest dating from 1958 when Prime Minister Diefenbaker first articulated his "northern vision."[6] By the 1980s, mining activity extended into the Far North, with Cominco's Polaris lead zinc mine on Little Cornwallis Island and the Nanisivik mine on Baffin Island's Borden Peninsula.[7]

Nearly 5,000 mineral properties were being worked in 1996 and the industry's output was the country's second highest earner of foreign exchange.[8] The industry has also witnessed its share of new and unexpected opportunities; places that have been worked over by others turn out to be richer than anyone ever dreamed, and others that have been staked and then left unworked have later proved to be bonanzas. The Hemlo area, just north of Lake Superior and close to both railway lines and the Trans Canada Highway, is a fascinating example of how people can travel past a rich gold field for decades. It was staked only 20 years ago, but by 1987 boasted the top two gold producers in the country. Similarly, Canada's first diamond mine opened in October 1998 at Lac de Gras in the Northwest Territories, a joint venture of Dia Met Minerals and Australian mining giant BHP, after years of scepticism about the plausibility of diamonds occurring in the region. Further east, Robert Friedland's Diamond Fields Resources staked a huge nickel deposit in Voisey's Bay, Labrador, which the company later sold to Inco for more than $4 billion.[9]

Despite mining's expansion and growth, there are those who are anxious about its future. A 1991 industry publication from British Columbia, for example, concluded that only five hard-rock mines would be operating in that province by the year 2000, and registered its concern over such issues as the level of taxation and the extent of environmental regulation, as well as the potential impact of Native land claims.[10] The mining industry recently inaugurated a publicity campaign based on the slogan, "Mining Works for Canada."[11]

Alistair MacLeod's short story, "The Closing Down of Summer," describes the thoughts and feelings of a contemporary Canadian miner and suggests that workers in the industry also worry about their future. MacLeod's narrator, who belongs to a crew of development miners, sees the nature of his work clearly.

...when we work we are never still. Never merely entombed like the prisoner in the passive darkness of his solitary confinement. For we are always expanding the perimeters of our seeming incarceration. We are always moving downward or inward or forward or in the driving of our raises even upward. We are big men engaged in perhaps the most violent of occupations and we have chosen as our adversary walls and faces of massive stone. It is as if the stone of the spherical earth has challenged us to move its weight and find its treasure and we have accepted the challenge and responded with drill and steel and powder and strength and all our ingenuity. In the chill and damp we have given ourselves to the breaking down of walls and barriers. We have sentenced ourselves to enclosures so that we might taste the giddy joy of breaking through. Always hopeful of breaking through though we know we never will break free.[12]

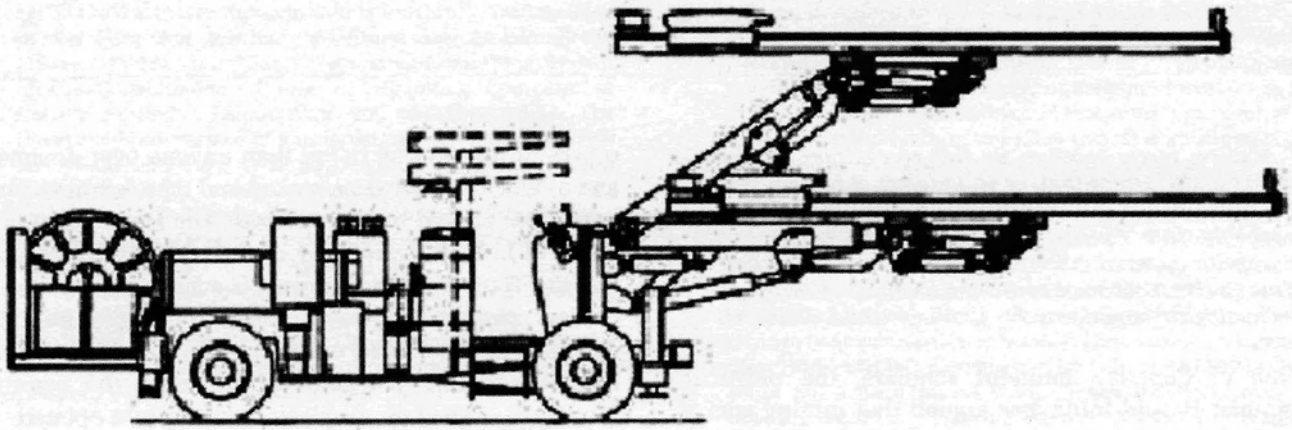


Figure 42. *TWO-BOOM HYDRAULIC JUMBO DRILL RIG The rig was marketed by Mining Technologies International Incorporated.* (From Mining Technologies International website)

The story has a sense of finality, the feeling that the narrator is coming to terms with his own passing. It would not inspire Canadian parents to groom their children for a life underground.

And yet the older images of mining possess a remarkable staying power. Louie Palu and Charlie Angus's recent book, *Industrial Cathedrals of the North/Les Cathédrales industrielles du Nord*, is an evocative and nostalgic tour through the industrial archaeology of northern Ontario and Quebec's mining regions. Although the industry has abandoned many of the once prosperous communities, the headframes remain a stark symbol of bygone activity; indeed, one of the great English poets of the twentieth century, W.H. Auden, treasured abandoned mines as special places, seeing them as powerful symbols of lost belief.[13] Similarly the gold-rush miner crouching over a gold pan is still an icon on Yukon motor vehicle plates. A recent effort by the government in Whitehorse to replace the image met with a howl of protest and was subsequently abandoned.[14] The mining industry itself self-consciously commemorates such anachronisms. Thus the B.C. Chamber of Mines staged a "Mining Week" as part of the celebrations surrounding Vancouver's Golden Jubilee in the summer of 1936, with a parade of "stalwart and picturesque prospectors, appropriately hirsute, duly equipped with the insignia of their calling, and laden with ponderous packs such as were borne by the hardy and indomitable pioneers over untrodden trails."[15] In Stanley Park, gold panning demonstrations were held, as well as a Championship Hand-Drilling Contest, a celebration that—like rodeos—"became prominent at the very time that the skills they glorified were declining in importance."[16]

Nostaglia notwithstanding, current research in mining engineering includes work on sophisticated robotic technology in order to devise remote-controlled automated mining systems.[17] The jumbo drill rigs common in most of today's underground operations would not look out of place on the set of a science fiction movie, and seem a far cry from the days of the hand driller. Along with today's scoop trams, which perform the work of the mucker (clearing the broken ore from the work-face), such innovations demonstrate the ongoing emphasis on the need to streamline the movement of ore. Because of improved efficiency, the number of miners needed underground is steadily declining.

As the industry's need for underground workers has shrunk, its appetite for capital has expanded, as a book entitled *Human Resources in Canadian Mining* explained in 1977: "In the period 1948–73, the dollar value of Canadian mineral production grew almost eightfold.... while the number of production workers remained steady.... All these trends were associated with, and may be partially explained by, an increase in the capital intensity of mining."[18] The industry's growing need for capital has meant that many of the most significant developments now take place in brokers' offices and court rooms, as well as corporate board rooms. The development of the rich Hemlo gold deposit, for example, had to await the outcome of a court case in the mid-1980s, and at least one lesson of the Bre-X fiasco in the late 1990s was the irresponsible and reckless advice of some investment analysts and its contribution to that sorry tale.[19]

The Bre-X debacle may have captured the headlines but it is scarcely a representative story of the contemporary

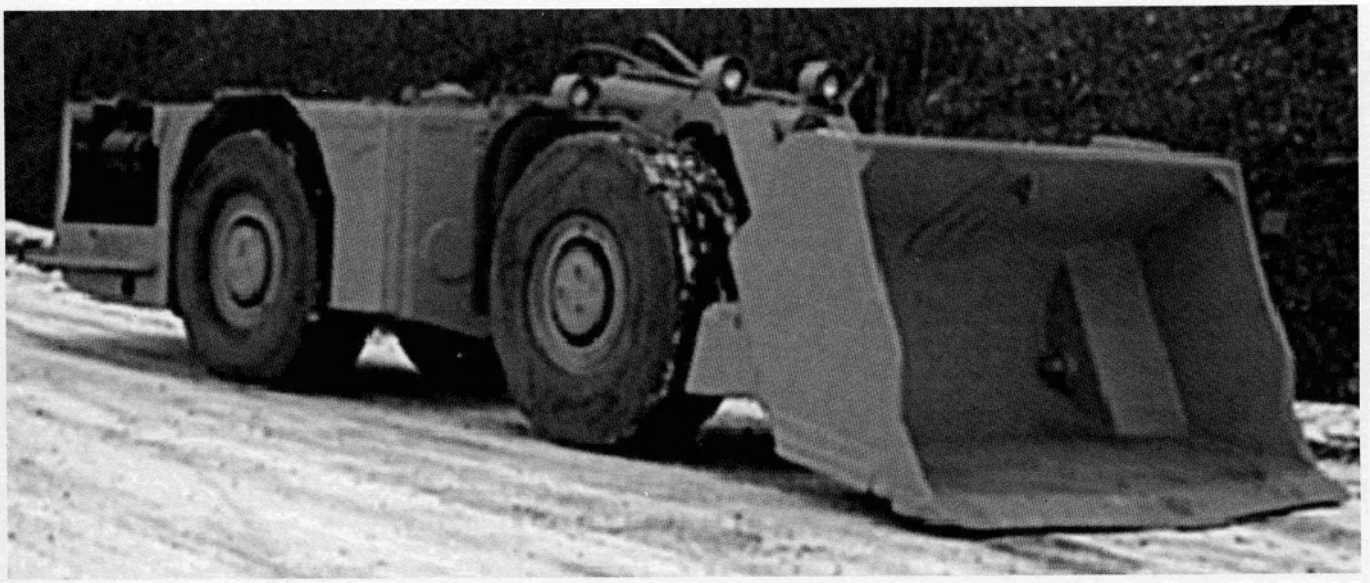


Figure 43. *MODERN SCOOP TRAM* (Mining Equipment Prospector website)

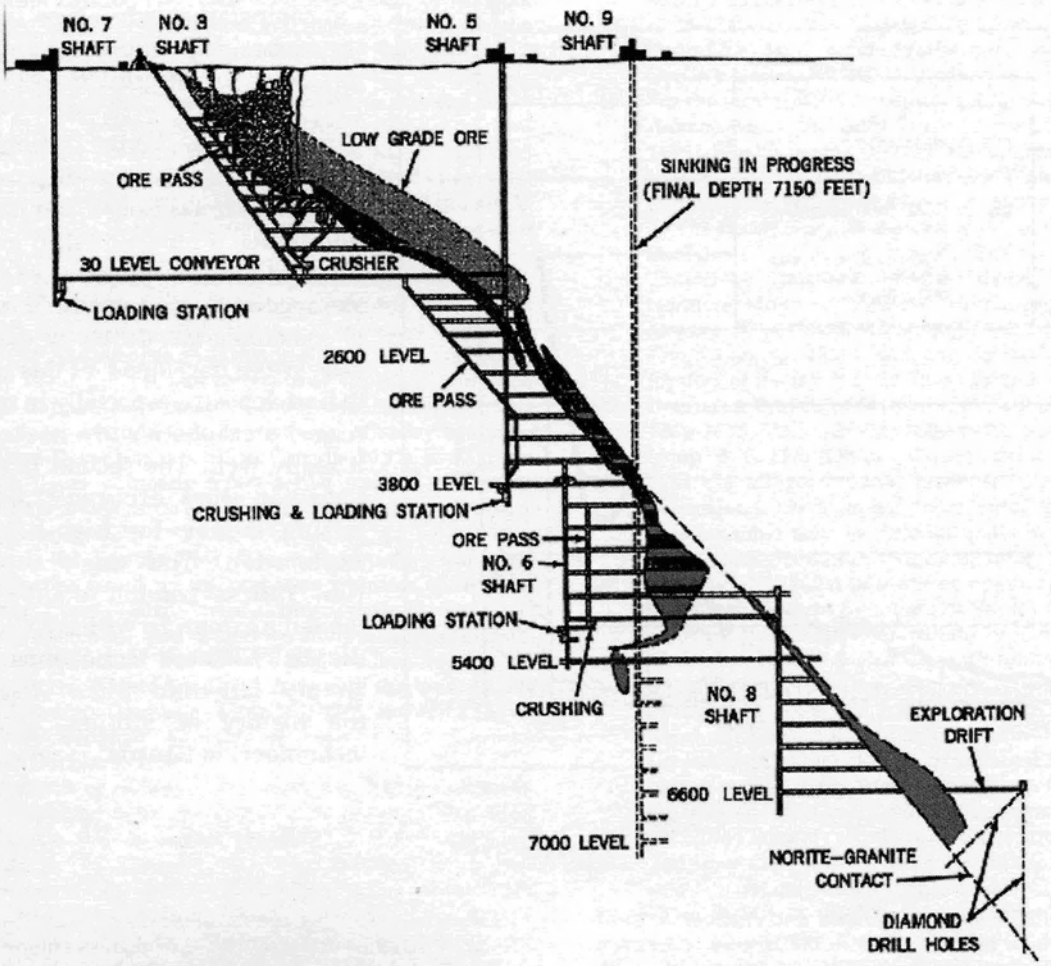
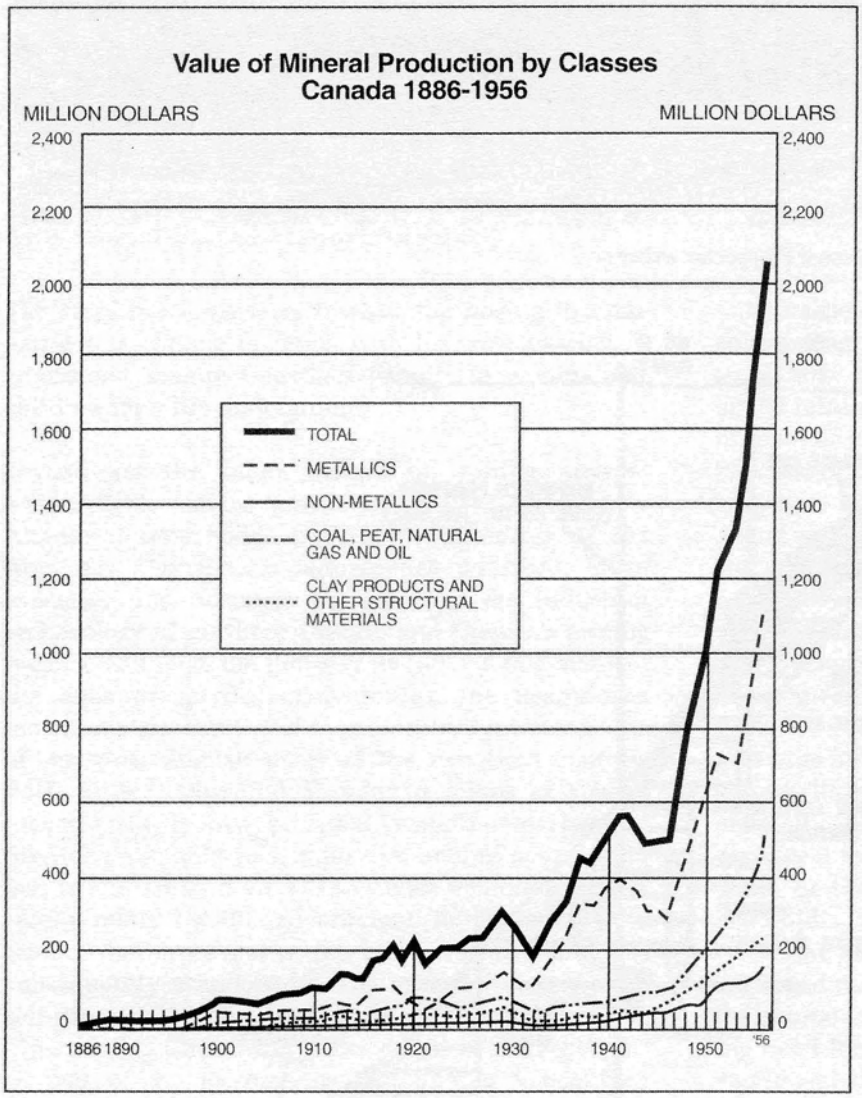


Figure 44. *CROSS-SECTION OF A MODERN NICKEL MINE The organization of a modern mine is geared to facilitate ore haulage, as this diagram of a Sudbury mine suggests. Note that this illustration bears a recognizable likeness to the 1878 sketch of Ontario's Silver Islet mine* (see Figure 16). (from Boldt, Winning)

mining world, which in many ways reflects the growth and success described in earlier chapters. These pages have charted the ways in which the mining industry developed from its beginnings in the mid-nineteenth century. The growing importance of technology in the twentieth century is a major theme, helping to account for mining's impressive trajectory. This is clearly revealed in the graphs in Appendix A, which were produced by the Dominion Bureau of Statistics in the mid-1950s. The data on mining production from 1886 to 1956 show a remarkable expansion, reflecting the increasingly efficient methods of mining and treating ore.[20]

This growth reflects the successful careers of numerous Canadian mining companies. They have emerged as leading players on the international scene, prospecting and operating in many parts of the world, participants in a restless search for mineral wealth. This prominence reflects Canadian mastery of mining technology, as well as the industry's particular needs for venture capital and the willingness of Canadian markets to provide it.[21] The Mining Standards Task Force, created by the Toronto Stock Exchange and the Ontario Securities Commission in the wake of the Bre-X fiasco, could still confidently assert in its Final Report that "Canada is recognised as the mining finance capital of the world.... it is a major player in the exploration and mining industries and in global mining finance, where we enjoy a comparative advantage due to our experience, expertise and a long-standing reputation for integrity."[22]



In April 1997, Vivian Danielson, editor of Canada's leading mining paper, *The Northern Miner*, gave a similar explanation. When a reporter asked her the reason for Canadian prominence in mining, she suggested two reasons: "First, mining is something we do better than anyone else. We've developed all this technology to find deposits, especially in remote and rugged areas. So it's like hockey—we do it really well. The second factor is that Canadian stock exchanges are used to raising money for high-risk mineral exploration. You don't see that in New York or London to anywhere near the same extent. So we have all the ingredients."[23] These conditions did not simply fall into place; they reflect the history of mining, and mining technology, in Canada.

Notes

1. D.S.L. Cardwell, *Technology, Science and History: A Short Study of the Major Developments in the History of Western Mechanical Technology and Their Relationships with Science and Other Forms of Knowledge* (London: Heinemann, 1972), p. 73. Cardwell went on to observe that "The mining areas of Europe in medieval, renaissance and modern times were centres of technology and science as well as of financial organisations and business enterprise," pointing out that "a number of basic technologies and sciences converge in mining—chemistry, metallurgy, medicine, civil engineering, geology and mechanics, hydraulics and transport." Op. cit., pp. 73-74.

2. For Innis's work on mining, see his book, *Settlement and the Mining Frontier* (Toronto: Macmillan Company of Canada, 1936), as well as his introduction to E. S. Moore's *American Influence in Canadian Mining* (Toronto: University of Toronto Press, 1941); reprinted as "The Canadian Mining Industry" in Harold A. Innis, *Essays in Canadian Economic History* (Toronto: University of Toronto Press, 1956). Note also the recently-issued collection of Innis's essays, *Staples, Markets, and Cultural Change: Selected Essays of Harold Innis*, ed. Daniel Drache (Montreal: McGill-Queen's University Press, 1995), which includes a very useful introduction.
3. Quoted in Brian J. Young, "C. George McCullagh and the Leadership League," *Canadian Historical Review* 47, no. 3 (September 1966): 202. Wright was head of Lake Shore Gold Mines and vice president of Wright-Hargreaves Mines.
4. Louie Palu and Charlie Angus, *Industrial Cathedrals of the North/Les Cathédrales industrielles du Nord* (Toronto/Sudbury: Between the Lines/Prise de parole, 1999), p. 18.
5. See Janet E. Macpherson, "The Pine Point Mine," and "The Cyprus Anvil Mine," in Everett B. Peterson and Janet B. Wright, eds., *Northern Transitions: Northern Resource and Land Use Policy Study*, vol. 1 (Ottawa: Canadian Arctic Resources Committee, 1978), pp. 65-110, 111-49, and more generally Kenneth Coates and Judith Powell, *The Modern North: People, Politics and the Rejection of Colonialism* (Toronto: James Lorimer & Co., 1989), pp. 24-32.
6. See Morris Zaslow, *The Northward Expansion of Canada, 1914-1967* (Toronto: McClelland and Stewart, 1988), esp. the chapter "The Northern Vision and Afterwards, 1958-1967," pp. 332-66.
7. See Jacqueline April, "Nanisivik: l'aventure minière au 73 nord," *North/Nord* 25, no. 2 (March/April 1978): 8-15, and "Polaris Mine: Production Success in the Rugged Arctic," *Mining Engineering* (October 1984): 1401-1406. For a recent overview of mining activity in Canada's North, see the theme issue of the *CIM Bulletin* 89, no. 1005 (November/December 1996), on Arctic mining.
8. See the Final Report of the Mining Standards Task Force, *Setting New Standards: Recommendations for Public Mineral Exploration and Mining Companies* (Toronto: Toronto Stock Exchange and Ontario Securities Commission, January 1999), pp. 1-3, and *Overview of Trends in Canadian Mineral Exploration*, Canadian Intergovernmental Working Group on the Mineral Industry (Ottawa: Ministry of Public Works and Government Services Canada, 1997), p. 97. Note that the figure of nearly 5,000 active mineral properties includes the broad range of company activity, through exploration to production.
9. Details of the Lac de Gras diamond property—the Ekati Mine—can be found on the corporate websites of Dia Met Minerals and BHP. See http://www.diamet.com/version2/mine.html and http://www.bhp.com.au/minerals/diamonds/index.htm. For Voisey's Bay, see Jacquie McNish, *The Big Score: Robert Friedland, Inco, and the Voisey's Bay Hustle* (Toronto: Doubleday Canada, 1998), and Mick Lowe, *Premature Bonanza: Standoff at Voisey's Bay* (Toronto: Between the Lines, 1998).
10. See *The State of the Minerals Industry in British Columbia: Working Toward 2000*, presented by the Mining Association of B.C., the B.C. & Yukon Chamber of Mines, the Coal Association of Canada, and the Mining Suppliers, Contractors & Consultants Association of B.C., September 1991. One of the five hard-rock properties that this brochure forecast would remain active until the year 2000—the Highland Valley mine—has recently closed.
11. See the description of the campaign at the URL http://www.miningworks.mining.ca/english/mwfc_campaign/index.html.
12. Alistair MacLeod, "The Closing Down of Summer," in *As Birds Bring Forth the Sun and Other Stories* (Toronto: McClelland and Stewart, 1992), p. 25.
13. See Alan Myers and Robert Forsythe, *W. H. Auden: Penine Poet* (Cumbria: Northern Penines Heritage Trust 1999), and David Wood, "W. H. Auden's 'greatest good place' revealed," *The Guardian*, 9 August, 1999, p. 20.
14. See the fascinating essay by David Neufeld, "Public Memory and Public Holidays: The Goldpanner, Corporate Capital, Tourism and Yukon's Discovery Day Holiday" (unpublished paper presented at the 1998 meeting of the National Council on Public History, Austin, Texas).
15. "Vancouver Jubilee Celebration—Mining Week," *The Miner*, August 1936, pp. 24-25.
16. Ronald C. Brown, *Hard Rock Miners: The Intermountain West, 1860-1920* (College Station: Texas A&M University Press, 1979), p. 54. As another historian has pointed out, "The West began to promote the Wild West when it recognized that the real thing was just about gone." Michael Kammen, *Mystic Chords of Memory: The Transformation of Tradition in American Culture* (New York: Knopf, 1991), p. 401.
17. In 1993, for example, members of Laurentian University's School of Engineering set up a Mining Automation Laboratory in Sudbury, with a particular interest in developing tele-remote/automated mining systems. This is only part of the work carried out at Laurentian University's Centre in Mining and Mineral Exploration Research (CIMMER).
18. A. MacMillan, G. S. Gislason, S. Lyon, *Human Resources in Canadian Mining: A Preliminary Analysis* (Kingston: Queen's University, 1977), p. xiv.
19. For the legal battle for Hemlo's gold, see Ken Lefolii, *Claims: Adventures in the Gold Trade* (Toronto: Key Porter Books, 1987). Bre-X's bizarre career is the subject of no less than five books: Douglas Goold and Andrew Willis, *The Bre-X Fraud* (Toronto: McClelland and Stewart, 1997); Diane Francis, *Bre-X: The Inside Story* (Toronto: Key Porter Books, 1997); Vivian Danielson and James Whyte, *Bre-X: Gold Today, Gone Tomorrow: Anatomy of the Busang Swindle* (Toronto: Northern Miner, 1997); Brian Hutchinson, *Fools' Gold: The Making of a Global Marketing Fraud* (Toronto: Alfred A. Knopf Canada, 1998); and Jennifer Wells, *Fever: The Dark Mystery of the Bre-X Gold Rush* (Toronto: Viking, 1998).
20. Dominion Bureau of Statistics, *Canadian Mineral Statistics, 1886-1956; Mining Events 1604-1956*, Reference paper No. 68, comp. A. R. Deir (Ottawa: Queen's Printer, 1957).
21. It is not all good news, however. On 6 July 1998, CBC Television's *The National* documented the collapse of dams at three mine sites in different parts of the world, all controlled by Canadian mining companies. "On April 24, 1998, a tailings dam burst in southern Spain, spewing out four billion litres of waste from the Los Frailes mine. The mine site is owned by Boliden, a Canadian-based mining company. On March 24, 1996, a sealed drainage tunnel at a tailings pit at the Marcopper Mine on Marinduque Island in the Philippines collapsed, sending the tailings into the Boac River. Marcopper was operated by the Marinduque Mining Corporation, which was partly owned by one of Canada's biggest mining companies, Placer Dome. On August 19, 1995, the tailing dam at Omai Gold Mine in Guyana, burst, sending out 3.2 billion litres of cyanide-laced waste into the Essiquibo River. The Omai Gold Mine is owned by Montreal-based Cambior." - http://tv.cbc.ca/national/pgminfo/ugly/index.html.
22. Final Report of the Mining Standards Task Force, *Setting New Standards: Recommendations for Public Mineral Exploration and Mining Companies* (Toronto: Toronto Stock Exchange and Ontario Securities Commission, January 1999), pp. 2-3.
23. "Other Business: Winning Ugly," *Canadian Business* 70, no. 4 (April 1997): 33.

Bibliographical Essay

No thorough history of Canadian mining exists, nor is there an up-to-date bibliographical guide to the diverse body of literature relating to Canadian mining. W. George Richardson's bibliography, *A Survey of Canadian Mining History* (Montreal, 1974), remains useful, although much new work has appeared since its publication 25 years ago. This brief essay offers a rather subjective summary of works that I would consider particularly relevant to the history of mining technology in Canada.

Many of the best narrative accounts of the history of mining technology have come from the pen of mining engineers, particularly in various commemorative reviews. Two such works are W. G. McBride, "Developments in Mining Practice," *Canadian Mining Journal 50*, no. 8 (August 1929) and Chas. F. Jackson, "Metal Mining Practice Over Sixty Years," *Canadian Mining Journal* 60, no. 11 (November 1939). T. A. Rickard's *Interviews with Mining Engineers* (San Francisco, 1922), includes conversations with a number of Canadian-born engineers. Particularly useful, given its concern with charting change over time, is A. B. Parsons, ed., *Seventy-five Years of Progress in the Mineral Industry 1871-1946* (New York, 1947).

The heavy American influence on Canadian mining means that much can be learned from American mining history. In addition to the Parsons volume, the following are especially valuable: Harold Barger and Sam H. Schurr, *The Mining Industries, 1899-1939: A Study of Output, Employment and Productivity* (New York, 1944); Clark C. Spence, *Mining Engineers & the American West: The Lace-Boot Brigade, 1849-1933* (New Haven, 1970); Otis E. Young, Jr., with Robert Lenon, *Western Mining: An Informal Account of Precious Metals Prospecting, Placering, Lode Mining and Milling on the American Frontier from Spanish Times to 1893* (Norman, 1970); James E. Fell, Jr., *Ores to Metals: The Rocky Mountain Smelting Industry* (Lincoln, 1979).

More international histories include W. H. Dennis, *A Hundred Years of Metallurgy* (Chicago, 1964), and R. F. Tylecote, *A History of Metallurgy*, 2nd. ed. (London, 1991). Several other works attempt to tell the "whole story": Robert Raymond, *Out of the Fiery Furnace: The Impact of Metals on the History of Mankind* (University Park, PA, 1986), and Rickard, *Man and Metals: A History of Mining in Relation to the Development of Civilization*, 2 vols. (New York and London, 1932). Raymond's work was based on a television series of the same name, and videotapes may yet be available.

The one attempt at a comprehensive history of Canadian mining has not aged well: D. M. LeBourdais, *Metals and Men: The Story of Canadian Mining* (Toronto, 1957), although it remains worth consulting. Similarly, Harold A. Innis's *Settlement and the Mining Frontier* (Toronto, 1936) includes some useful information, but has been accurately described as his worst book.[1] Although the country has not fared well with general histories of mining, several excellent provincial narratives have been published. Easily the best of these is Marc Vallières, *Des mines et des hommes: histoire de l'industrie minérale québécoise* (Quebec, 1989). The Ontario equivalent suffers a little from its official sponsorship, but remains a very good overview: see Philip Smith, *Harvest From the Rock: A History of Mining in Ontario* (Toronto, 1986). The more narrowly focused book by Dianne Newell, *Technology on the Frontier: Mining in Old Ontario* (Vancouver, 1986), is excellent on technological diffusion and change in the nineteenth century. Viv Nelles's *The Politics of Development: Forests, Mines and Hydro-electric Power in Ontario, 1849-1941* (Toronto, 1974) is broader in its sweep, but remains a model study of the political economy of Ontario's resource development. Wendy Martin provides a good narrative account of Newfoundland mining in *Once Upon a Mine: Story of Pre-Confederation Mines on the Island of Newfoundland*, special vol. 26 (Montreal, 1983). Perhaps the weakest of the provincial histories is Geoffrey Taylor's *Mining: The History of Mining in British Columbia* (Saanichton and Seattle, 1978). Manitoba does not have a good mining history widely available, but there is a fine unpublished study: see Jim Mochoruk's Phd thesis "The Political Economy of Northern Development: Governments and Capital along Manitoba's Resource Frontier, 1870-1930," (University of Manitoba, 1992).

Mention should also be made of two other excellent unpublished works, which arguably provide the best case studies of Canadian mining technology: James Otto Petersen, "The Origins of Canadian Gold Mining: The Part Played By Labor In The Transition From Tool Production To Machine Production," PhD thesis

[1] "H. A. Innis's worst book," in Cole Harris, "Industry and the Good Life around Idaho Peak," *Canadian Historical Review* 66, no. 3 (September, 1985): 317; cf. the comments in Carl Berger, *The Writing of Canadian History, Aspects of English-Canadian Historical Writing: 1900 to 1970* (Toronto: Oxford University Press, 1976), pp. 107-08.

(University of Toronto, 1977), and Logan W. Hovis, "Technological Change and Mining Labour: Copper Mining and Milling Operations at the Britannia Mines, British Columbia, 1898-1937," MA thesis (University of British Columbia, 1986). Another valuable unpublished work, although broader in scope and more concerned with business history than technology, is Alexander C. Dow's "The Canadian Base Metal Mining Industry (Non-ferrous) and Its Impact on Economic Development in Canada, 1918-55," PhD thesis (University of Manitoba, 1980). Although not directly interested in mining history, much useful detail may be found in Morris Zaslow's encyclopedic *Reading the Rocks: The Story of the Geological Survey of Canada 1842-1972* (Toronto, 1975).

Mining engineering in Canada has its own history and a good deal of relevant information may be found in the official history of its central organization. See E. Tina Crossfield, *Pride and Vision: The Canadian Institute of Mining, Metallurgy and Petroleum, 1898-1998* (Montreal, 1998). Also worth consulting is the broader narrative delineated by J. Rodney Millard in *The Master Spirit of the Age: Canadian engineers and the politics of professionalism 1887-1922* (Toronto, 1988).

McGill and Queen's were the most notable of the country's early training grounds for mining engineers. For the Kingston School of Mines, see Natalie R. Neville, "The School of Mining and Agriculture at Kingston: A Case Study in the Development of Canadian Engineering Education," MA thesis (Queen's University, 1987), and Charles F. A. Hews, *A History of Mining Engineering at Queen's, The First 100 Years: 1893 to 1993* (Kingston, Ontario, 1993). The efforts to establish mining engineering at McGill are discussed in Stanley Brice Frost, *McGill University: For the Advancement of Learning,* vol. 1, 1801-1895 (Montreal, 1980), and in Edgar Collard, "Sir William Dawson's Principalship, 1855-1893," in Hugh MacLennan, ed., *McGill: The Story of a University* (London, 1960). On McGill's methods of teaching, see John Bonsall Porter, "The Education of Mining and Metallurgical Engineers," *Journal of the Canadian Mining Institute* 9 (1906). (Porter was Professor of Mining Engineering at McGill, and the article outlines what he considers an ideal education for a mining engineer.) For discussions of the emergence of francophone engineers and engineering in Quebec, see Arthur Maheux, "P.-J.-O. Chauveau, promoteur des sciences," *Mémoires de la Société royale du Canada,* 4ième série, vol. 1 (Juin 1963); Yakov M. Rabkin and J. Ann Lévi-Lloyd, "Technology and Two Cultures: One Hundred Years of Engineering Education in Montreal," *Minerva* 22 (Spring 1984); Yves Gingras and Robert Gagnon, "Engineering Education and Research in Montreal: Social Constraints and Opportunities," *Minerva* 26 (Spring 1988); and Robert Gagnon, "La Formation d'un Groupe Social: Les Ingénieurs Francophones au Québec (1870-1960)," *scientia canadensis: Journal of the History of Canadian Science, Technology and Medicine* 15, no. 1 (1991).

The situation in the Maritimes is touched on in Richard A. Jarrell, "Science Education at the University of New Brunswick in the Nineteenth Century," *Acadiensis* (1973), and described in some detail in Donald Eric Macleod, "Miners, Mining Men and Mining Reform: Changing the Technology of Nova Scotian Gold Mines and Collieries, 1858 to 1910," PhD thesis (University of Toronto, 1981), as well as Macleod's subsequent article, "Practicality Ascendant: The origins and establishment of technical education in Nova Scotia," *Acadiensis* 15, no. 2 (1985-86). As early as February 1878, Edwin Gilpin argued for the importance of trained mining engineers: see his article, "On the Necessity for Preliminary Scientific Training for Civil and Mining Engineers," *Proceedings and Transactions of the Nova Scotian Institute of Natural Science* 4 (1878). Discussions of mining education south of the border are also relevant, such as R. H. Richards, "American Mining Schools," *Transactions of the American Institute of Mining Engineers* 15 (1886-87), and Samuel B. Christy, "The Growth of American Mining Schools and their Relation to the Mining Industry," *Transactions of the American Institute of Mining Engineers* 23 (1893). See also Clark C. Spence, *Mining Engineers and the American West,* and several articles by Kathleen H. Ochs: "The Rise of American Mining Engineers: A Case Study of the Colorado School of Mines," *Technology & Culture* 33, no. 2 (April 1992); "Government, Industry and Mining Education: The European Background," *The Mines Magazine* 72, no. 4 (April 1984); and "Mining Engineers, Mining Education and the American Technological System," *American Society for Engineering Education Conference Proceedings,* vol. 2 (1984).

Although I would argue, in common with most scholars, that technological change is best understood as a broad process, individual tools and innovations certainly had an impact on mining practice. The most well-known and most written about of these specific tools is the rock drill. Perhaps the best treatment is Larry D. Lankton's "The Machine *under* the Garden: Rock Drills Arrive at the Lake Superior Copper Mines, 1868-1883," *Technology & Culture* 24, no. 1 (January 1983). There's also some historical background in C. E. Nighman and O. E. Kiessling, *Rock Drilling* (Philadelphia, 1940); Gösta E. Sandström, *The History of Tunnelling* (London, 1963); Graham West, *Innovation and the Rise of the Tunnelling Industry* (Cambridge, 1988); Petersen, "The Origins of Canadian Gold Mining"; Otis E. Young, Jr., with the technical assistance of Robert Lenon, *Black Powder and Hand Steel: Miners and Machines on the Old Western Frontier* (Norman, 1976); Young, *Western Mining*; Clive Carter, "The Boring Machine–Introduction of

Compressed Air Powered Rock Drills into The Cambourne Mines," *Journal of the Trevithick Society* (1993); and Janice Helen Wegner, "Croydon: Technology Transfer on a North Queensland Goldfield, 1885-1915," PhD thesis (James Cook University of North Queensland, 1995).

Valuable contemporary discussions of early machine technology include E. Gybbon Spilsbury, "Rock-Drilling Machinery," *Transactions of the American Institute of Mining Engineers* 3 (1874- 1875); B. L. Thane, "Stoping with Machine Drills," *Transactions of the American Institute of Mining Engineers* 29 (1899); and W. L. Saunders, "Rock-Drilling Economics," *Transactions of the American Institute of Mining Engineers* 47 (1913). Technical journals also published some useful historical accounts, notably H. L. Sinclair, "The Development of the Air Hammer Drill," *Engineering and Mining Journal* 83, no. 15 (13 April 1907); Charles A. Hirschberg, "History of the Water Leyner Drill," *Mines and Minerals* 31, no. 3 (October 1910); Hirschberg, "Development of the Rock Drill in America," *Engineering and Mining Journal* 108, no. 17 (25 October 1919); and C. C. Hansen, "Rock Drill History," *Compressed Air Magazine* 42, no. 4 (April 1937).

Another important innovation was the progress in mine explosives, which can be followed in the exhaustive book by Arthur Pine Van Gelder and Hugo Schlatter, *History of the Explosives Industry in America* (New York, 1972). Although its more than 1,100 pages chiefly concern the U.S., the book does describe branch plant development of the explosives industry in Canada: see pp. 294-302, 451-53, & 703-14. For more succinct and recent accounts, see Graham West, *Innovation and the Rise of the Tunnelling Industry*, pp. 55-59; Gösta E. Sandström, *The History of Tunnelling*, pp. 271-85; Young, *Black Powder and Hand Steel*, pp. 24-40; and Young, *Western Mining*, pp. 212-14. The mining engineer Rossiter W. Raymond provides some perceptive contemporary comments on the introduction of dynamite, to which he devotes a chapter ("Giant Powder and Common Powder"), in his book, *The Mines of the West: A Report to the Secretary of the Treasury* (New York, 1869), see esp. pp. 33-36. Raymond describes the opposition of California miners to early dynamite; Michigan's copper miners also opposed the new and more powerful explosive: see Larry D. Lankton, *Cradle to Grave: Life, Work, and Death at the Lake Superior Copper Mines* (New York and Oxford, 1991).

Two very important metallurgical breakthroughs—the cyanide process and flotation—exerted a profound impact on mining by the early twentieth century. Although technically beyond the scope of this study, it is worth noting the relevant historiography. For the cyanide process, see S. G. Checkland, *The Mines of Tharsis: Roman, French and British Enterprise in Spain* (London, 1967), see esp. pp. 124-33; Jas. Gray & J. A. McLachlan, "A History of the Introduction of the MacArthur-Forrest Cyanide Process to the Witwatersrand Goldfields," *Journal of the Chemical, Metallurgical and Mining Society of South Africa* (June 1933); David I. Harvie, "John Stewart MacArthur: pioneer gold and radium refiner," *Endeavour*, n.s., 13, no. 4 (1989); Sybil M. Jack, "The Introduction of Cyaniding in New Zealand: A Case Study in the Role of Technology in History," *Prometheus* 2, no. 1 (June, 1984); Alan Lougheed, "The Cyanide Process and Gold Extraction in Australia and New Zealand, 1888-1913," *Australian Economic History Review* 27, no. 1 (March 1987); Lougheed, "Discovery, development, and diffusion of new technology: the cyanide process of gold extraction, 1887-1914," *Prometheus* 7, no. 1 (June 1989); Lougheed, "'Want of Novelty' and Patent Litigation: The Case of the Cyanide Process of Gold Extraction, 1892-1902," *Prometheus* 13, no. 1 (June 1995); Jan Todd, *Colonial Technology: Science and the Transfer of Innovation to Australia* (Cambridge and Melbourne, 1995); and Robert L. Spude, "Cyanide and the Flood of Gold: Some Colorado Beginnings of the Cyanide Process of Gold Extraction," *Essays and Monographs in Colorado History*, essays, no. 12 (1991).

For the introduction of the cyanide process in Canada, see the following: J. E. Dutrizac and J. B. O'Reilly, "The First Cyanide Leaching Plants in Canada," *CIM Bulletin* 78, no. 876 (April 1985); Dutrizac and O'Reilly, "Further Observations on Canada's First Cyanide Leaching Plant," *CIM Bulletin* 78, no. 880 (August 1985); Dutrizac, "Still Further Observations on Canada's First Cyanide Leaching Plant: Early Ontario Operations," *CIM Bulletin* 81, no. 911 (March 1988); Fathi Habashi, "One hundred years of cyanidation," *CIM Bulletin* 80, no. 905 (September 1987); Jeremy Mouat, "Early Cyanide Plants in British Columbia," *CIM Bulletin* 85, no. 959 (April 1992); and Petersen, "The Origins of Canadian Gold Mining," pp. 194-205.

The history of the flotation process is less well-documented, but see Mouat, "The Development of the Flotation Process: Technological Change and the Genesis of Modern Mining, 1898-1914," *Australian Economic History Review* 36, no. 1 (March 1996); Geoffrey Blainey, *The Rise of Broken Hill* (Melbourne, 1968); Blainey, *The Rush That Never Ended: A History of Australian Mining*, 3rd ed. (Melbourne, 1978); A. B. Parsons, *The Porphyry Coppers* (New York, 1933); Theodore J. Hoover, *Concentrating Ores by Flotation: Being a Description and History of a Recent Metallurgical Development, together with a Summary of Patents and Litigation*, 2nd ed. (London, 1914); Rickard, ed., *Concentration by Flotation* (New York, 1921); and Rickard, "The flotation process in the United States," in Rickard, *A History of American Mining* (New York and London, 1932). For an essay that examines the genesis of both innovations, see Simon

Katzenellenbogen, "Cyanide and Bubbles: Patents and Technological Change in Gold and Non-Ferrous Metals Treatment," in Klaus Tenfelde, ed., *Sozialgeschichte des Bergbaus im 19. und 20. Jahrhundert* (Munich, 1992).

Both cyanide and flotation forced changes in mining and milling technology. For the latter, see the technical accounts by L. E. Djingheuzian, "History of Milling in Canada," in *The Milling of Canadian Ores* (Toronto, 1957); J. J. Denny, "Gold Milling in Canada," *Transactions of the Canadian Institute of Mining and Metallurgy* 33 (1930); and C. S. Parsons, "Fifty Years of Developments in Ore Dressing," *Canadian Mining Journal* 50, no. 8 (August 1929). See also, the later accounts by historians, such as Petersen, "The Origins of Canadian Gold Mining"; Hovis, "Technological Change and Mining Labour"; Douglas Owen Baldwin, "Cobalt: Canada's Mining and Milling Laboratory, 1903-1918," *scientia canadensis: Journal of the History of Canadian Science, Technology and Medicine* 8, no. 2 (1984); Baldwin, "Story of Cobalt and the evolution of Canadian milling technology," *The Northern Miner* (14 April 1977); Dow, "Metal Mining and Canadian Economic Development to 1939," *Business History* 32, no. 3 (July 1990); Dow, "Prometheus in Canada: The Expansion of Metal Mining, 1900-1950," in Duncan Cameron, ed., *Explorations in Canadian Economic History: Essays in Honour of Irene M. Spry* (Ottawa, 1985); and Mouat, "Creating a New Staple: Capital, Technology and Monopoly in B.C.'s Resource Sector, 1901-1925," *Journal of the Canadian Historical Association*, n.s. 1 (1990).

The increasing mechanization of underground mining came at a price—one paid by miners. The clouds of dust created by machine drills had a severe impact on their lungs, and resulted in high levels of silicosis in some regions. South Africa was among the first places to recognize and attempt to treat this debilitating disease: see Elaine N. Katz, "Silicosis of the Witwatersand Gold Mines: Incidence and Prevalence; Compensation; 1902-1978," *South African Labour Bulletin* 4 (1979), and her subsequent book, *The White Death: Silicosis on the Witwatersrand Gold Mines, 1886-1910* (Johannesburg, 1994). For a discussion of the efforts to deal with silicosis in Ontario, see Dieter Grant Hogaboam, "Compensation and Control: Silicosis in the Ontario Hardrock Mining Industry, 1921-1975," MA thesis (Queen's University, 1997), and the more general comments by Nancy M. Forestell, "'You Never Give Up Worrying': The Consequences of a Hazardous Mine Environment for Working-Class Families in Timmins, 1915-1950," in Margaret Kechnie and Marge Reitsma-Street, eds., *Changing Lives: Women in Northern Ontario* (Toronto, 1996).

There is a notable American historiography on silicosis: see Alan Derickson, *Workers' Health, Workers' Democracy: The Western Miners' Struggle, 1891-1925* (Ithaca and London, 1988) esp. pp. 162-69 & 180-88; Alan Derickson, "Federal Intervention in the Joplin Silicosis Epidemic, 1911-1916," *Bulletin of the History of Medicine* 62 (1988); David Rosner and Gerald Markowitz, *Deadly Dust: Silicosis and the Politics of Occupational Disease in Twentieth-Century America* (Princeton, NJ, 1991); James C. Foster, "The Western Dilemma: Miners, Silicosis, and Compensation," *Labor History* 26, no. 2 (Spring, 1985); Foster, "Western Miners and Silicosis: 'The Scourge of the Underground Toiler,' 1890-1943," *Industrial and Labor Relations Review* 37, no. 3 (April 1984); and David M. Emmons, "Immigrant Workers and Industrial Hazards: The Irish Miners of Butte, 1880-1919," *Journal of American Ethnic History* 5, no. 1 (Fall 1985). For comparative studies of the treatment of silicosis in different jurisdictions, see Brian Kennedy's "The Conquest of Phthisis," in his book, *A Tale of Two Mining Cities: Johannesburg and Broken Hill 1885-1925* (Melbourne, 1984); Alan Derickson, "Industrial Refugees: The Migration of Silicotics from the Mines of North America and South Africa in the Early 20th Century," *Labor History* 29 (1988); and Gillian Burke and Peter Richardson, "The Profits of Death: A Comparative Study of Miners' Phthisis in Cornwall and the Transvaal, 1876-1918," *Journal of Southern Africa Studies* 4 (1978).

Miners were well known for their loyalty to unions, which tended to migrate into Canada from the United States. Standard works describing American mining labour and labour relations include Vernon H. Jensen, *Heritage of Conflict: Labor Relations in the Nonferrous Metals Industry up to 1930* (Ithaca, NY, 1950); Richard E. Lingenfelter, *The Hardrock Miners: A History of the Mining Labor Movement in the American West, 1863-1893* (Berkeley, 1974); Ronald C. Brown, *Hard Rock Miners: The Intermountain West, 1860-1920* (College Station, Texas, 1979); Mark Wyman, *Hard Rock Epic: Western Miners and the Industrial Revolution, 1860-1910* (Berkeley, 1979); and Melvyn Dubofsky, "The Origins of Western Working-Class Radicalism, 1890-1905," *Labor History* 7 (1966). Only recently has new scholarship moved beyond the assumptions of this earlier work; see especially the exemplary book by Elizabeth Jameson, *All That Glitters: Class, Conflict, and Community in Cripple Creek* (Urbana and Chicago, 1998).

There is a reasonably extensive literature that deals with miners and mining unionism in western Canada; see A. Ross McCormack, *Reformers, Rebels, and Revolutionaries: The Western Canadian Radical Movement 1899-1919* (Toronto, 1977); David Jay Bercuson, "Labour Radicalism and the Western Industrial Frontier: 1897-1919," *Canadian Historical Review* 58, no. 2 (June, 1977); Bercuson, *Fools and Wise Men: The Rise and Fall of the One Big Union* (Toronto, 1978); Stuart Jamieson, "Regional Factors in Industrial

Conflict: the Case of British Columbia," *Canadian Journal of Economics and Political Science* 28, no. 3 (1962); Mouat, "The Genesis of Western Exceptionalism: British Columbia's Hard Rock Miners, 1895-1903," *Canadian Historical Review* 71, no. 3 (September 1990); Mouat, *Roaring Days: Rossland's Mines and the History of British Columbia* (Vancouver, 1995), esp. chapters four and five; H. Clare Pentland, "The Western Canadian Labour Movement, 1897-1919," *Canadian Journal of Political and Social Theory* 3 (1979); Paul Phillips, "The National Policy and the Development of the Western Canadian Labour Movement," in A. W. Rasporich and H. C. Klassen, eds., *Prairie Perspectives* 2 (Toronto, 1973); Phillips, *No Power Greater: A Century of Labour in B.C.* (Vancouver, 1967); Martin Robin, *Radical Politics and Canadian Labour, 1880-1930* (Kingston, 1968); Allen Seager, "Miners' Struggles in Western Canada, 1890-1930," in Deian R. Hopkin and Gergory S. Kealey, eds., *Class, Community, and the Labour Movement: Wales and Canada, 1850-1930* (Aberystwyth, Wales, 1989); Allen Seager and David Roth, "British Columbia and the Mining West: A Ghost of a Chance," in Craig Heron, ed., *The Workers' Revolt in Canada, 1917-1925* (Toronto, 1998); and Mike Solski and John Smaller, *Mine Mill: The History of the International Union of Mine, Mill and Smelter Workers in Canada Since 1895* (Ottawa, 1984).

For mining unionism in Ontario, see Thomas Henry Nicholson, "A Sordid Boon: The Business of State and the State of Labour at the Canadian Copper Company, 1890 to 1918," MA thesis (Queen's University, 1991); Brian F. Hogan, *Cobalt: Year of the Strike 1919* (Cobalt, Ontario, 1978); Wayne Roberts, ed., *Miner's Life: Bob Miner and Union Organizing in Timmins, Kirkland Lake and Sudbury* (Hamilton, 1979); Laurel Sefton MacDowell, *"Remember Kirkland Lake": The History and Effects of the Kirkland Lake Gold Miners' Strike, 1941-42* (Toronto, 1983); John B. Lang, "A Lion in a Den of Daniels: A History of the International Union of Mine Mill and Smelter Workers in Sudbury, Ontario, 1942-1962," MA thesis (University of Guelph, 1970); Solski and Smaller, *Mine Mill*; and Mercedes Steedman, Peter Suschnigg, and Dieter K. Buse, eds., *Hard Lessons: The Mine Mill Union in the Canadian Labour Movement* (Toronto and Oxford, 1995). For an introduction to mining unionism in Quebec, see Benoit-Beaudry Gourd's *Mines et syndicats en Abitibi-Témiscamingue*, 1910-1950 (Rouyn, 1981).

Discussions of miners and ethnicity also contain much valuable information on labour organization and other aspects of mining. See Guy Gaudreau, "Ethnicité et division du travail dans la modernisation d'une enterprise minière: la Canadian Copper Company, 1886-1928," in Guy Gaudreau, ed., *La mobilité des ouvriers-mineurs du Nord ontarien et québécois 1900-1939* (Sudbury, 1998); Paul de la Riva and Guy Gaudreau, "Les ouvriers-mineurs de la région de Sudbury (1912-1930): le cas de l'International Nickel Co.," *Revue du Nouvel Ontario* 17 (1995); Gabriele P. Scardellato, "Beyond the Frozen Wastes: Italian Sojourners in the Canadian North, 1885-1920," in Roberto Perin and Franc Sturino, eds., *Arrangiarsi: The Italian Immigration Experience in Canada* (Montreal, 1989); Allen Seager, "Finnish Canadians and the Ontario Miners' Movement," *Polyphony* 3 (Fall 1981); and Peter Vasiliadis, *Dangerous Truth: Interethnic Competition in a Northeastern Ontario Goldmining Center* (New York, 1989). More generally, see Donald Avery's two books, *"Dangerous Foreigners": European Immigrant Workers and Labour Radicalism in Canada, 1896-1932 (Toronto, 1979),* and *Reluctant Host: Canada's Response to Immigrant Workers, 1896-1994* (Toronto, 1995).

An important topic deserving scholarly attention is the part played by Native people in prospecting and locating mines. The following works hint at their important role. For B.C., see Alex P. McInnes, *Chronicles of the Cariboo, Number One; Being a True Story of the First Discovery of Gold in the Cariboo District on the Horsefly River by Peter C. Dunlevey* (Lillooet, 1938); Patricia Elizabeth Vaughan, "Cooperation and Resistance: Indian-European Relations on the Mining Frontier in British Columbia, 1835-1858," MA thesis (University of British Columbia, 1978); Daniel P. Marshall, "Rickard Revisited: Native 'Participation' in the Gold Discoveries of British Columbia," *Native Studies Review* 11, no. 1 (1997); Margaret Whitehead, ed., *They Call Me Father: Memoirs of Father Nicolas Coccola* (Vancouver, 1988); and Helen Lee, *The Silver King* (Nelson, 1986). For Manitoba, see B. F. Townsley, *Mine-Finders: The History and Romance of Canadian Mineral Discoveries* (Toronto, 1935); LeBourdais, *Metals and Men: The Story of Canadian Mining* (Toronto, 1957); R. G. Zahalan, *Mining in Manitoba* (Winnipeg, 1980); George E. Cole, "Mining in Manitoba," *Transactions, Historical and Scientific Society of Manitoba*, ser. 3, no. 5 (1950); and James David Mochoruk, "The Political Economy of Northern Development: Governments and Capital along Manitoba's Resource Frontier, 1870-1930," PhD thesis (University of Manitoba, 1992). For Ontario, see Thomas W. Gibson, *Mining In Ontario* (Toronto, 1937); L. Carson Brown, "The Golden Porcupine," *Canadian Geographical Journal* 74, no. 1 (January 1967); and W. Robert and Nancy M. Wightman. *The Land Between: Northwestern Ontario Resource Development, 1800 to the 1990s* (Toronto, 1997). For Quebec, see Gourd, *La mine Lamaque et le village minier Bourlamaque: Une histoire de mine* (Rouyn, 1983). For the Klondike, see Julie Cruikshank, "Images of Society in Klondike Gold Rush Narratives: Skookum Jim and the Discovery of Gold," *Ethnohistory* 39, no. 1 (Winter 1992).

Mining technology in Canada did not develop in a vacuum. Local conditions and international trends

influenced what was practical and/or acceptable. Generally, western culture has tended to privilege technological developments. Some of the consequences of this *Weltanschauung* are traced in Michael Adas, *Machines as the Measure of Men: Science, Technology, and Ideologies of Western Dominance* (Ithaca, 1989); Daniel R. Headrick, *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century* (New York, 1981); and the several books of Arnold Pacey. Scholarly reflections on the western fetish for technology include John M. Staudenmaier, *Technology's Storytellers: Reweaving the Human Fabric* (Cambridge, Mass., 1985); Cecelia Tichi, *Shifting Gears: Technology, Literature, Culture in Modernist America* (Chapel Hill, 1987); Ursula Franklin, *The Real World of Technology* (Toronto, 1990); and the two edited collections, Stephen H. Cutcliffe and Robert C. Post, eds., *In Context: History and the History of Technology* (Bethlehem, 1989), and Merritt Roe Smith and Leo Marx, eds., *Does Technology Drive History? The Dilemma of Technological Determinism* (Cambridge, Mass., 1994).

The preceding paragraph lists books that offer broad perspectives on the history of technology. Those more interested in finding specific answers or detail on individual mines should turn to provincial indices, bibliographies and other compilations. Useful works that fall into this category include Janet Gillespie-Wood, *Gold in Nova Scotia: A Bibliography of the Geology, and Exploration and Mining Histories from 1832-1986* (Halifax, 1987); Arnold Roos, comp., *A Bibliography of the History of Canadian Science and Technology/Une bibliographie de l'histoire de la science et de la technologie au Canada* (Ottawa, 1995); H. T. Nation, comp., *Index to Annual Reports of the Minister of Mines of the Province of British Columbia For the Years 1874 to 1936, inclusive* (Victoria, 1938); Hovis and Mouat, comps., *Mining in British Columbia: A Guide to Sources*, typescript (Vancouver, 1987); A. G. Johnston, comp., *Index of Publications of the Geological Survey of Canada 1845-1958* (Ottawa, 1961); Ontario, Ministry of Northern Development and Mines, *Geographic Index to Published Reports and Maps, Mines and Minerals Division 1891 to 1993* (Ontario Geological Survey Miscellaneous Paper, No. 178, 1994); David Neufeld, *An Annotated Bibliography of Placer Gold Mining 1896–1966* (Ottawa, 1994), which is particularly strong on the Yukon.

The above is merely a rough guide to the most useful and relevant work that charts the history of mining technology in Canada. The following bibliography attempts a more complete listing but readers should note that it too remains a selective compilation.

Bibliography Of Works On Mining Technology And Related Topics

1. Contemporary Periodicals

The following list is heavily weighted in favour of technology and business. Local newspapers of particular mining communities provide a far broader coverage of social issues, but are far too numerous to be included here.

The Canadian Annual Review of Public Affairs, Toronto.
Canadian Mines Handbook, Don Mills, Ontario.
The Canadian Mining Journal, Ottawa, Montreal. (Title varies: until 1907, *Canadian Mining Review.*)
CIM Bulletin, Montreal. (Title varies: until 1967, *Canadian Mining and Metallurgical Bulletin.*)
The Economist, London.
Engineering and Mining Journal, New York.
The Mineral Industry, New York.
The Miners' Magazine, Denver, Colorado.
Mining and Industrial Record, Vancouver. (Title varies: until 1908, *British Columbia Mining Record.*)
Mines & Minerals, Scranton, Pa.
Mining and Scientific Press, San Francisco.
Mining Journal, London.
Mining Magazine, London.
The Monetary Times, Toronto.
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Transactions of the American Institute of Mining Engineers, New York.
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A Glossary of Common Canadian Mining Terms

The following Glossary is reproduced from the 1955 publication of *The Northern Miner, Mining Explained in Simple Terms.* A handful of other terms—related to gold mining—have been included, taken from Albert H. Fay's *A Glossary of the Mining and Mineral Industry,* Washington: Government Printing Office, 1920 (Bulletin 95 of the U.S. Bureau of Mines); where this has been done, it is acknowledged in the text. Fay's exhaustive glossary—over 750 pages in length—includes etymological information as well as a valuable bibliography of other glossaries (on pp. 5–8). Also of interest is the brief article, "The Standardisation of Mining Terms," *The Mining Journal,* Vol. 98, No. 4019 (31 August 1912), pp. 853–55.

ADIT – A passageway or opening driven horizontally into the side of a hill generally for the purpose of exploring or otherwise opening a mineral deposit. Strictly, an adit is open to the atmosphere at one end, a tunnel at both ends.

AERIAL SURVEY – A survey made from a flying aircraft, such as photographic, magnetometer, radioactivity, etc.

AERIAL TRAMWAY – A system for the transporting of ore or rock in buckets which are suspended from a cable.

AGITATION – In metallurgy, the act or state of being stirred or shaken mechanically, sometimes assisted by the introduction of compressed air.

ALLOY – A compound of two or more metals, usually produced by fusion.

ALTERATION – Any physical or chemical change in a rock or mineral subsequent to its formation.

AMALGAMATION – A process by which gold and silver are extracted from an ore by dissolving them in mercury.

AMORPHOUS – A term applied to rocks or minerals that possess no definite crystal structure or form.

ANOMALY – A term used in geophysics to describe any change in sub-surface conditions as detected by geophysical instruments. In other words, it is any change from the normal and may be caused by such factors as mineralization, change in rock types, structural conditions or even depths of over-burden.

ANTICLINE – An arch or fold in the layers of rock shaped like the crest of a wave, as opposed to a syncline which is similar to the trough of a wave.

ASSAY – To test ores or minerals by chemical or other methods for the purpose of determining the amount of valuable metals contained.

ASSESSMENT WORK – The amount of work specified by law, which must be done each year to retain legal control of mining lands. Generally, five year's work requirements must be done before the holder of the mining lands can acquire title to the property.

BACK – The ceiling of a drift, crosscut or stope.

BACK STOPE – The initial lift or slice when commencing to stope or mine from a drift.

BALL MILL – A piece of milling equipment used to grind ore into small particles. It is a cylindrical shaped steel container filled with steel balls into which crushed ore is fed. The ball mill is rotated, causing the balls themselves to rotate, which in turn grind the ore.

BASEMENT ROCKS – The underlying or main rock mass. This term came into common use with the discovery of Ontario's Blind River uranium camp. Here, the favourable ore-bearing sedimentary rock formations lie on top of a granite "basement". The hunt for ore, therefore, is restricted to the over-lying rocks in this particular case.

BATHOLITH – A large mass of igneous rock extending to great depth and with its upper portion dome-like in shape. It has crystallized below surface, but may be exposed due to erosion of the overlying rock. Smaller masses of igneous rocks are known as bosses or plugs.

BEDROCK – Solid rock forming the earth's crust, frequently covered by overburden or water.

BENEFICIATE – To concentrate or enrich. The term is generally applied to the preparation of iron ore for smelting, through such processes as sintering, magnetic concentration, washing, etc.

BIT – The cutting end of a boring instrument. In rock drilling, it is frequently made with ultra-hard material such as diamonds or tungsten carbide.

BONANZA – Very rich ore.

BOX HOLE – A short raise or opening driven above a drift for the purpose of drawing ore from a stope, or to permit access.

BREAST – A working face, usually restricted to a stope.

BRECCIA – A fragmental type rock whose components are angular in shape, as distinguished from a conglomerate whose components are water worn into a rounded shape.

BULLION – Precious metal in bars, ingots or other uncoined form.

BULK SAMPLE – A large sample, frequently involving many tons, selected in such a manner as to be representative of the material being sampled.

BY-PRODUCT – A secondary or additional mineral or mineral product.

CAGE – The conveyance used to transport men and equipment in a shaft.

CHALCOPYRITE – A sulphide mineral of copper and iron, being a common ore of copper.

CHANGE HOUSE – A special building constructed at a mine where the miner changes to his working clothes. It is also known as a "dry house."

CHANNEL SAMPLE – A sample composed of pieces of vein or mineral deposit that have been cut out of a small trench or channel, usually about four inches wide and an inch or so deep. By taking channel samples at regular and close intervals, an accurate estimate of the grade of a deposit can be obtained.

CHUTE – An inclined opening, usually constructed of timber and equipped with a gate, through which ore is drawn from a stope into mine cars.

CINNABAR – A vermilion-coloured ore of mercury.

CLAIM – A portion of mining land held under federal or provincial law. The common size is 1,320 ft. square, containing 40 acres.

COLLAR – The term applied to the timbering or concrete around the mouth of a shaft. The term is also used to describe the top of a drill hole.

COMPASS – An instrument for determining directions, by use of a magnetic needle.

COMPLEX ORE – An ore containing a number of minerals of economic value, usually implying difficult metallurgy to extract them.

COMPRESSOR – A machine for compressing air to a pressure sufficient to actuate mine machinery.

CONCENTRATE – A product containing the valuable metal and from which most of the waste material in the ore has been eliminated.

CONCENTRATOR – A particular type of milling plant that produces a concentrate of the valuable minerals or metals. The concentrate must then be treated in some other type of plant such as a smelter to effect recovery of the pure metal.

CONGLOMERATE – A sedimentary rock consisting of rounded, water-worn pebbles or boulders cemented together into a solid mass.

CONTACT – The line or plane along which two different rocks come together.

CORE – The long cylinder of rock, about one inch in diameter, that is recovered by the diamond drill.

COUNTRY ROCK – A loose term to describe the general mass of rock adjacent to an ore body, as distinguished from the vein or ore deposit itself.

CRADLE – A wooden box longer than wide, provided with a movable slide and hopper, and mounted on two rockers. It is used for washing gold-bearing earths. Cf. ROCKER. (Fay.)

CROSSCUT – A horizontal opening driven across the course of a vein or structure, or in general across the strike of the rock formations. A connection from a shaft to an ore structure.

CRUSHER – A machine for crushing rock, such as a gyratory crusher, jaw crusher, stamp mill, etc.

CUT-AND-FILL – A method of stoping in which ore is removed in slices or "lifts," following which the excavation is filled with rock or other waste material before the subsequent slice is mined. The backfill supports the walls of the stope.

CUT VALUE – Applies to assays that have been reduced to some arbitrary maximum figure. Thus high erratic values would not appreciably increase the over-all average.

CYANIDATION – A method of extracting gold or silver by dissolving it in a weak solution of sodium cyanide.

DEVELOPMENT – Is the underground work carried out for the purpose of reaching and opening up a mineral deposit. It includes shaft sinking, cross-cutting, drifting and raising.

DIABASE – A common basic igneous rock usually occurring in dikes or sills.

DIAMOND DRILL – A rotary type of rock drill in which the cutting is done by abrasion rather than percussion. The cutting bit is set with diamonds and is attached to the end of long hollow rods through which water is pumped to the cutting face. The drill cuts a "core" of rock which is recovered in long cylindrical sections, about an inch in diameter.

DIFFERENTIAL FLOTATION – A milling process using the flotation process, by which concentrates are made of each of the various valuable minerals in an ore.

DIKE – A long and relatively thin body of igneous rock that, while in the molten state, has intruded a fissure in older rocks and solidified.

DIP – The angle at which a vein, structure or rock bed is inclined from the horizontal, measured at right angles to the strike.

DIP NEEDLE – A compass whose needle is mounted so as to swing in a vertical plane, used for determining the magnetic attraction of rocks.

DISSEMINATED ORE – Ore carrying small particles of valuable minerals, spread more or less uniformly through the gangue matter. Opposed to massive ore wherein the valuable minerals occur in almost solid form with very little waste material included.

DRAG FOLD – Where rock has been folded or bent back on itself.

DREDGE – A scoop or suction apparatus, operated by power, and usually mounted on a flat-bottomed boat, for clearing out or deepening channels, harbours, etc., by taking up and removing mud or gravel from their bottoms. Extensively used in mining gold-bearing sand and gravel. For this purpose it is equipped with screening apparatus and gold-saving devices. Also called Dredging machine. (Fay.)

DRIFT – A horizontal passage underground. A drift usually follows the vein or ore structure, as distinguished from a crosscut which intersects it.

DRIFT MINING – A method of mining gold-bearing gravel, or cement, by means of drifts and shafts, as distinguished from the process of hydraulic mining. (Fay.)

DRIFTER – A rock drill used for boring horizontal holes for blasting.

DRY HOUSE –A building where the miner changes to his working clothes.

DUMP – A pile or heap of rock or ore on surface.

En ECHELON – A term used to describe a formation in which the occurrences are found in roughly parallel but staggered fashion.

EROSION – The breaking down and subsequent removal of either rock or earthy surface material through the forces of nature.

ESCROW – As applied to mining shares, is stock that cannot be released to the owner until certain conditions are fulfilled.

FACE – As applied to a drift, crosscut or stope, is the end in which work is progressing.

FAULT – A break in the earth's crust caused by forces which have moved the rock on one side with respect to the other. Faults may extend for miles, or be only a few inches in length. Similarly, the movement or displacement along the fault may vary widely. Ore deposits are commonly associated with faults, as the movement frequently provides a channel for the passage of ore-bearing solutions.

FISSURE – An extensive crack, break or fracture in rocks.

FLOAT – Pieces of rock that have been broken off and moved from their original location by natural forces such as frost action or glaciers.

FLOTATION – A milling process by which some mineral particles are induced to float and others to sink. In this way the valuable minerals are concentrated and separated from the worthless gangue.

FLOWSHEET – The sequence of operations, step by step, by which ore is treated in a milling or concentration process.

FLUX – A salt or other mineral added in smelting to assist fusion.

FOLD – Any bending or wrinkling of a rock strata.

FOOTWALL – The wall or rock on the underside of a vein or ore structure.

GALENA – A sulphide mineral of lead, being a common lead ore.

GANGUE – The worthless minerals associated with valuable minerals in an ore deposit.

GEIGER COUNTER – An instrument used in the search for radioactive minerals, particularly uranium, as it is capable of detecting—by means of a Geiger-Mueller tube—the rays emanating from such minerals. It registers the frequency or intensity of these rays either visually (by dial or flashing light), audibly (by earphones) or both.

GEOPHYSICS – A scientific method of prospecting that utilizes the physical properties of minerals to detect their presence. Common properties include magnetism, specific gravity, electrical conductivity and radioactivity.

GLORY HOLE – A large open pit from which ore is extracted.

GNEISS – A layered or banded crystalline metamorphic rock whose grains are aligned or elongated into a roughly parallel arrangement.

GOSSAN – The rust coloured oxidized capping or staining of a mineral deposit, generally formed by the oxidation or alteration of iron sulphides.

GOUGE – Fine, putty-like material composed of ground up rock found along a fault.

GRAB SAMPLE – A sample taken at random; it is assayed to determine if valuable elements are contained in the rock. A grab sample is not intended to be representative of the deposit. In fact, the best looking material is customarily selected. Thus assays of grab samples almost invariably run higher than the average.

GREENSTONE – A convenient field term used to describe any fine-grained green volcanic rock, most often applied to andesite.

GRIZZLY – A grating (usually steel rails) placed over the top of a chute or ore pass for the purpose of stopping the larger pieces of rock or ore.

GROSS VALUE – The theoretical total value of the ore, without consideration as to what percentage of the valuable minerals that can be extracted. It is invariably higher than the recoverable value.

GROUTING – The process of sealing off a water flow in rocks by forcing thin cement solution into the crevices. This is usually done through a diamond drill hole.

GRUB STAKE – Finances or supplies of food, etc., furnished a prospector on promise of some share in any discoveries he makes.

GUIDES – The timbers along the sides of a shaft for the purpose of steadying or "guiding" the cage or conveyance.

HANGING WALL – The wall or rock on the upper or top side of a vein or ore deposit.

HEMATITE – An iron oxide mineral, one of the commonest ores of iron. When pure, it contains about 70% metallic iron.

HOIST – The machine used for raising and lowering the cage or other conveyance in a shaft.

HORSE – A mass of waste rock lying within a vein or ore body.

HYDRAULICKING – Washing down a bank of earth or gravel by the use of pipes, conveying water under high pressure. (Fay.)

HYDRAULIC MINING – A method of mining in which a bank of gold-bearing earth or gravel is washed away by a powerful jet of water and carried into sluices, where the gold separates from the earth by its specific gravity. (Fay.)

IGNEOUS ROCKS – Rocks formed by the solidification of molten material that originated within the earth.

ILMENITE – An ore of titanium, being an iron-titanium oxide. It contains 36.8% iron, 31.6% titanium.

INTRUSIVE – A body of igneous rock formed by the consolidation of magma intruded into other rocks. In contrast, lavas are extruded upon the surface.

JAW CRUSHER – A machine in which the rock is broken by the action of moving steel jaws.

JIG – An apparatus used in milling to concentrate ore on a screen submerged in water, either by a reciprocating motion of the screen or by the pulsation of water through it.

LAGGING – Planks or small timbers placed along the roof of a stope or drift to prevent rocks from falling, rather than to support the main weight of the overlying rocks.

LAVA – A general name for the molten rock ejected by volcanoes.

LEACHING – A chemical process used in milling for the extraction of valuable minerals from ore. Also, the natural process by which ground waters dissolve minerals, thus leaving the rock with a smaller proportion of some of the minerals than it contained originally.

LENS – Generally used to describe a body of ore that is thick in the middle and tapers towards the ends.

LENTICULAR – A lens-shaped deposit having roughly the form of a double convex lens.

LEVEL – The horizontal passages on a working horizon in a mine. It is customary to work mines from a shaft, establishing levels at regular intervals, generally 100–150 ft. apart. They are numbered in sequence below surface, or named by the depth at which they lie below surface, e.g., 250–ft. level.

LODE – A mineral deposit in solid rock.

LONG TOM – An inclined trough in which gold-bearing earth or gravel is crudely washed. It is longer than a rocker. (Fay.)

MAGMA – The molten material deep in the earth from which rocks are formed.

MAGNETITE – Magnetic iron ore, being a black iron oxide containing 72.4% metallic iron when pure.

MAGNETOMETER – A sensitive instrument used to measure the magnetic attraction of underlying rocks.

MARGINAL ORE DEPOSITS – Ore bodies approaching the lowest limits of commercial workability.

MATTE – The product of a smelter, being metal with some contained sulphur. It must be further refined to obtain the pure metal.

MATRIX – The rock or gangue material containing ore minerals.

METAMORPHISM – In geology, any change in the texture or composition of a rock.

METAMORPHIC ROCKS – Rocks that have undergone a change in texture or composition subsequent to their first solidification, through such factors as heat, pressure, etc.

MILL – A plant in which ore is ground and treated for the recovery of the valuable metals contained.

MILL HEADS – The average grade of ore fed into a mill.

MINERAL – A naturally occurring homogeneous substance having definite physical properties and chemical composition and, if formed under favourable conditions, a definite crystal form.

MUCK – Ore or rock that has been broken by blasting.

MUSKEG – Decayed vegetable matter and black soil forming swampy areas.

NET PROFIT – The profit that remains after deducting ALL charges, including taxes and depreciation.

NUGGET – A water-worn piece of precious metal, usually implying some size.

OPEN CUT – A surface working, open to daylight.

ORE – A mixture of ore minerals and gangue from which at least one of the metals can be extracted at a profit.

OUTCROP – An exposure of rock or a mineral deposit that can be seen on surface, i.e., it is not covered by overburden or water.

OVERBURDEN – Worthless unconsolidated surface material, such as earth, sand and boulders, covering the rock surface.

OXIDATION – A chemical reaction caused by natural forces that results in a change in the composition of a mineral.

PAN – To wash gravel or ground rock in a pan in the search for gold or other valuable metals.

PARTY LINE – Refers to the underground boundary between two properties. Under most mining laws, an underground heading can not be carried within seven feet of a boundary without permission of the owners of the adjoining ground.

PEGMATITE – A coarse grained igneous rock usually irregular in texture and composition, similar to a granite in composition. It usually occurs in dikes or veins and sometimes contains valuable minerals.

PICKET LINE – A reference line, marked by pickets or stakes, established on a property for mapping and survey purposes.

PIG IRON – The crude cast iron from a blast furnace.

PILLAR – A block of solid ore or rock left in place for the purpose of supporting the walls or roof in a mine.

PITCH – See "PLUNGE" below.

PITCHBLENDE – An important uranium ore mineral, containing a high percentage of uranium oxide. It is black in colour, possesses a characteristic pitch-like or greasy lustre, and is highly radioactive.

PLACER – A place where gold is obtained by washing; an alluvial or glacial deposit, as of sand or gravel, containing particles of gold or other valuable mineral. (Fay.)

PLACER MINING – That form of mining in which the surficial detritus is washed for gold or other valuable minerals. When water under pressure is employed to break down the gravel, the term hydraulic mining is generally employed. There are deposits of detrital material containing gold which lie too deep to be profitably extracted by surface mining, and which must be worked by drifting beneath the overlying barren material. To the operations necessary to extract such auriferous material the term drift mining is applied. (Fay.)

PLUNGE – Similar to pitch or rake, being the vertical angle an ore body makes between the horizontal plane and the direction along which it extends to depth.

PLUTONIC – Referring to rocks of igneous origin that have come from great depth.

PORPHYRY – Any igneous rock in which relatively large, conspicuous crystals (called phenocrysts) are set in a fine-grained groundmass.

POSITIVE ORE – Ore which is exposed and properly sampled on four sides, in blocks of reasonable size.

POSSIBLE ORE – Ore which has been opened on one side only and which may exist below the lowest workings or laterally beyond the limits of the mine workings. Also, ore indicated by diamond drilling.

PROBABLE ORE – Ore that is exposed on either two or three sides, but not blocked out to the point where it can be classified as "positive."
ce entrance to a tunnel or adit.

PROSPECT – A mining property, the value of which has not been proved by exploration.

PROVEN ORE – Ore that has been blocked out by mine workings on at least three sides in such a manner as to leave practically no risk of failure of continuity.

PYRITE – A hard, heavy, shiny, yellow mineral, being a sulphide of iron. It is a common sulphide, sometimes known as "fool's gold."

PYRRHOTITE – A less common iron sulphide than pyrite, being a peculiar bronze in colour and magnetic. It sometimes is associated with nickel, in which case it may be mined as a nickel ore.

RADIOACTIVITY – The property of spontaneously emitting alpha, beta or gamma rays by the disintegration of the nuclei of atoms.

RAISE – A vertical or inclined underground working that has been excavated from the bottom upward.

RAKE – Similar to plunge, being the trend of an ore body along the direction of its strike. Technically, it is the vertical angle an ore body makes between the horizontal plane and the direction along which it extends to depth.

RECONNAISSANCE – A preliminary examination or survey of ground.

REFRACTORY ORE – One that resists the action of chemical reagents in the normal treatment processes, and which generally requires roasting to effect the full recovery of the valuable minerals.

REPLACEMENT ORE BODY – An ore body formed by a process during which certain minerals have passed into solution and have been carried away, while valuable minerals from the solution have been deposited in the place of those removed.

RESERVES – Ore reserves fall into four general categories – proven, probable, possible and indicated. Proven is ore that has been blocked out on four sides, probable is ore that has been opened on two or three sides, while possible ore has been opened on one side only. Indicated ore is ore that has been outlined by diamond drilling but which has not been opened by underground work.

RESUING – A method of stoping wherein the wall rock on one side of the vein has been blasted before the ore itself is broken. It is employed on narrow veins (say

less than 30 inches) and permits a recovery with a minimum of dilution.

ROASTING – The treatment of ore by heat in order to remove sulphur and arsenic.

ROCK – Any naturally formed combination of minerals forming an appreciable part of the earth's crust.

ROCKER – A short trough in which auriferous sands are agitated by oscillation, in water, to collect their gold. (Fay.)

ROCK BURST – The sudden failure of walls or pillars in a mine caused by the weight or pressure of the surrounding rocks.

ROYALTY – The amount paid by the lessee or operator to the owner of the mineral land, generally based on a certain amount per ton or a percentage of the total production or profits.

RUN-OF-MINE – A loose term sometimes used to describe ore of average grade.

SALTING – Introducing particles of metal or mineral into a deposit or samples, thus making the assays run higher than they actually should be. Done either accidentally or with intent to defraud.

SAMPLE – A small portion of rock or mineral deposit, usually taken for the purpose of being assayed to determine possible content of valuable elements.

SAMPLING – Selecting a fractional but representative part of a deposit for analysis.

SCARP – An escarpment, cliff or steep slope along the margin of a plateau, mesa or terrace.

SCHIST – A foliated metamorphic rock whose grains have a roughly parallel arrangement. It is generally developed by shearing.

SCINTILLATION COUNTER – An instrument used for detecting and measuring radioactivity, more sensitive than the geiger counter.

SECONDARY ENRICHMENT – An enrichment of a vein or ore body by minerals which have been taken into solution from one part of the vein or adjacent rocks and redeposited in another.

SEDIMENTARY ROCKS – Secondary rocks formed from rock particles which are laid down under water, e.g., limestone, shale, sandstone. A characteristic feature of sedimentary deposits is a layered structure known as bedding or stratification.

SEISMIC PROSPECTING – A geophysical method of prospecting utilizing the knowledge of the speed and reflection of sound waves in rock.

SHALE – Sedimentary rock formed by the consolidation of mud or silt.

SHAFT – A vertical or inclined excavation for the purpose of opening and servicing a mine. It is usually equipped with a hoist at the top, which lowers and raises a conveyance for handling men and material.

SHEAR OR SHEARING – The deformation of rocks by lateral movement along innumerable parallel planes, generally resulting from pressure, and producing such metamorphic structures as cleavage and schistosity.

SHEAR ZONE – A zone in which shearing has occurred on a large scale.

SHEAVE WHEEL – A large grooved wheel placed in the top of a headframe, over which the hoisting rope passes.

SHOOT – A concentration of mineral values. That part of a vein or zone carrying values of ore grade.

SHRINKAGE STOPE – A method of stoping which utilizes part of the broken ore as a working platform, as well as support for the walls.

SIDERITE – Iron carbonate, being an iron ore that contains 48.2% iron when pure. Before it can be utilized in the blast furnace, it must be roasted to drive off the contained carbon dioxide, the resulting product being called sinter cake.

SINTER – See above.

SILICA – An oxide of silicon, of which quartz is a common example.

SILICEOUS – Containing an abundance of quartz.

SILL – An intrusive sheet of igneous rock of approximately uniform thickness and generally extending over a considerable lateral extent. It has been forced between level or gently inclined beds.

SILT – A general name for the muddy deposits of fine sediment usually found on the bottom of lakes.

SKIP – A self-dumping type of bucket used in a shaft for hoisting ore or rock.

SLAG – The vitreous mass separated from the fused metals in a smelting process.

SLASH – Rock blasted from the side of a drift, resulting in the widening of the opening. It is generally done to ascertain the width of the ore, or merely to make more working room.

SLICKENSIDE – The striated polished surface of a fault caused by one wall rubbing against the other.

SLUICE – A long, inclined trough, launder, or flume, usually on the ground, for washing auriferous earth, floating down logs, etc. In gold mining such a contrivance is paved with riffles, etc., to hold the quicksilver for catching the gold. (Fay.)

SLUICE BOX – A wooden trough in which alluvial beds are washed for the recovery of gold or tinstone. (Fay.)

SLUICING – Washing auriferous earth through long races or boxes, provided with riffles and other gold saving appliances, and so-called sluices. (Fay.)

SPHALERITE – A sulphide mineral of zinc, being a common zinc ore.

SQUARE SET – A set of timbers used for support in underground mining, consisting of cap, girt and post.

STAMP DUTY – The amount of ore (tons) that one stamp will crush in 24 hours. (Fay.)

STAMP MILL – An apparatus (also the building containing the apparatus) in which rock is crushed by descending pestles (stamps), operated by water or steam-power. (Fay.)

STATION – An enlargement of a shaft made at the level horizon used primarily for the storage and handling of equipment.

STOCK PILE – Broken ore accumulated in a heap on surface, pending treatment or shipment.

STOPE – An excavation in a mine from which ore is being or has been extracted.

STRIKE – The direction, that is the course or bearing, of a vein or rock formation measured on a level surface.

STRINGER – A narrow vein or irregular filament of mineral traversing a rock mass.

STRIP – To remove the overburden or barren rock overlying an ore body.

SUB-LEVEL – An intermediate level or working horizon in a mine, opened between main working levels.

SUBSIDIARY COMPANY – A company in which the majority of the shares of stock are held by another company, giving the control to the latter.

SULPHIDE – A compound of sulphur and another element to form minerals.

SUMP – An excavation underground for the purpose of catching or storing water. The bottom of a shaft is commonly used for this purpose.

SYNCLINE – A downarched fold in bedded or stratified rocks.

TACONITE – A term common on the Mesabi iron range for a siliceous iron formation, containing magnetite and hematite, that has to be concentrated to make it into a useable iron ore.

TAILINGS – Material rejected from a mill after the recoverable valuable minerals have been extracted.

TALUS – A heap of broken coarse rock found at the foot of a cliff or mountain.

TONS-PER-VERTICAL-FOOT – A common expression to describe the measure of a mine or ore body. It is arrived at by multiplying the ore length by its width and dividing by the appropriate weight-volume factor, usually 12. It is the amount of ore for each foot of depth. Thus an ore body that shows 1,000 tons per vertical foot would, if it carried down for 100 ft., contain 100,000 tons.

TRAM – To haul or push ore cars in a mine.

TUBE MILL – A piece of milling equipment consisting of a revolving cylinder about half filled with steel rods or balls and into which crushed ore is fed for fine grinding. The material to be ground is mixed with water or other solution and comes out as a slime.

TUFF – A sedimentary rock composed of fine material such as ash that has been explosively ejected from a volcano.

TUNDRA – Level or undulating treeless plains characteristic of the arctic regions.

TUNNEL – A horizontal underground passage that is open to the atmosphere at both ends. The term is loosely applied in many cases to an adit, which is open to the atmosphere at only one end.

UNDERWRITE – A firm commitment whereby a broker or other financing interest agrees to purchase a block of stock at a fixed price.

URANINITE – A uranium mineral carrying a high percentage of uranium oxide, frequently found in pegmatite dikes.

VEIN – A fissure, fault or crack in a rock filled by minerals that have travelled upwards from some deep source.

VUG – A small cavity occurring in the midst of a vein or ore deposit. It is frequently lined with well formed crystals, such as amethyst.

WAGON DRILL – A reciprocating type of drill that is mounted on a truck and which usually employs long steel, thus not requiring frequent changes.

WALL ROCK – The rock forming the walls of a vein or ore deposit. Sometimes referred to as country rock.

WASTE – Barren rock in a mine, or at least material that is too low in grade to be of economic value.

WEATHERING – The chemical and mechanical breakdown of rocks and minerals under the action of atmospheric agencies. Eventually, surface rocks crumble into soil.

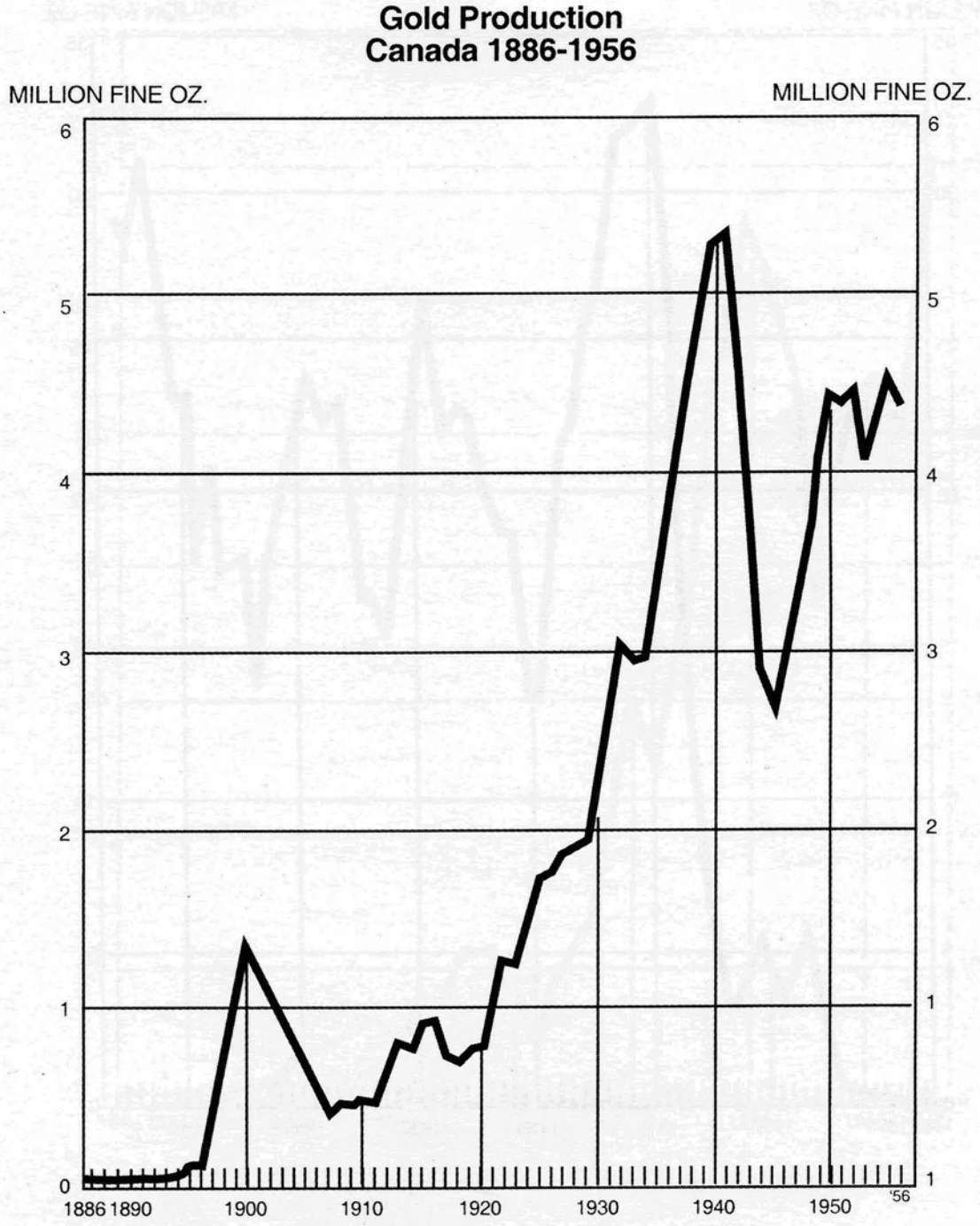
WEDGE – As used in diamond drilling, refers to the placing of a wedge at some point in the hole for the purpose of deflecting the bit in another direction.

WINZE – A vertical or inclined opening sunk from a point inside a mine. Similar to a shaft, but the latter starts at surface.

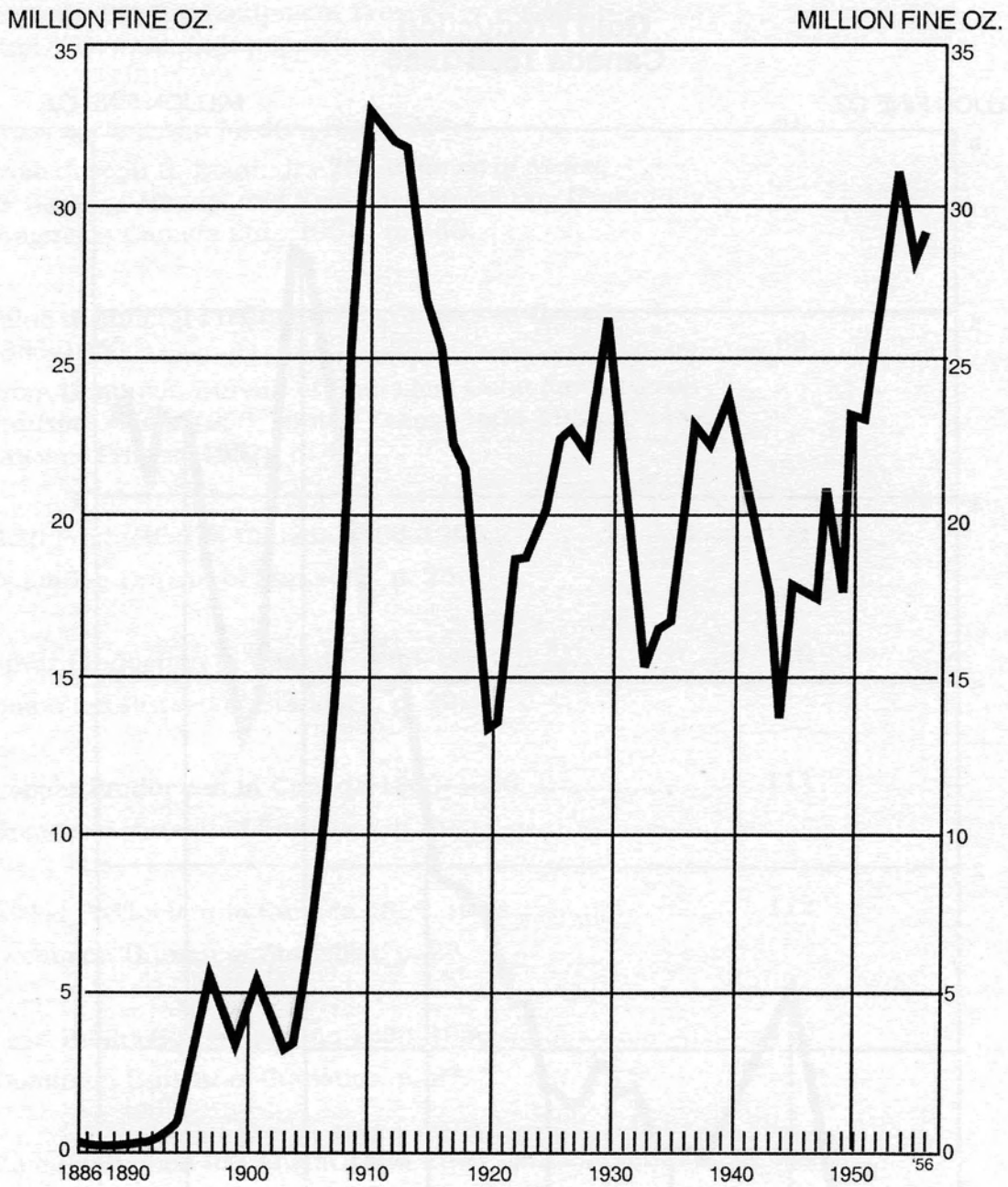
ZONE OF OXIDATION – The upper part of a mineral deposit that has become oxidized.

Illustrations in the Text

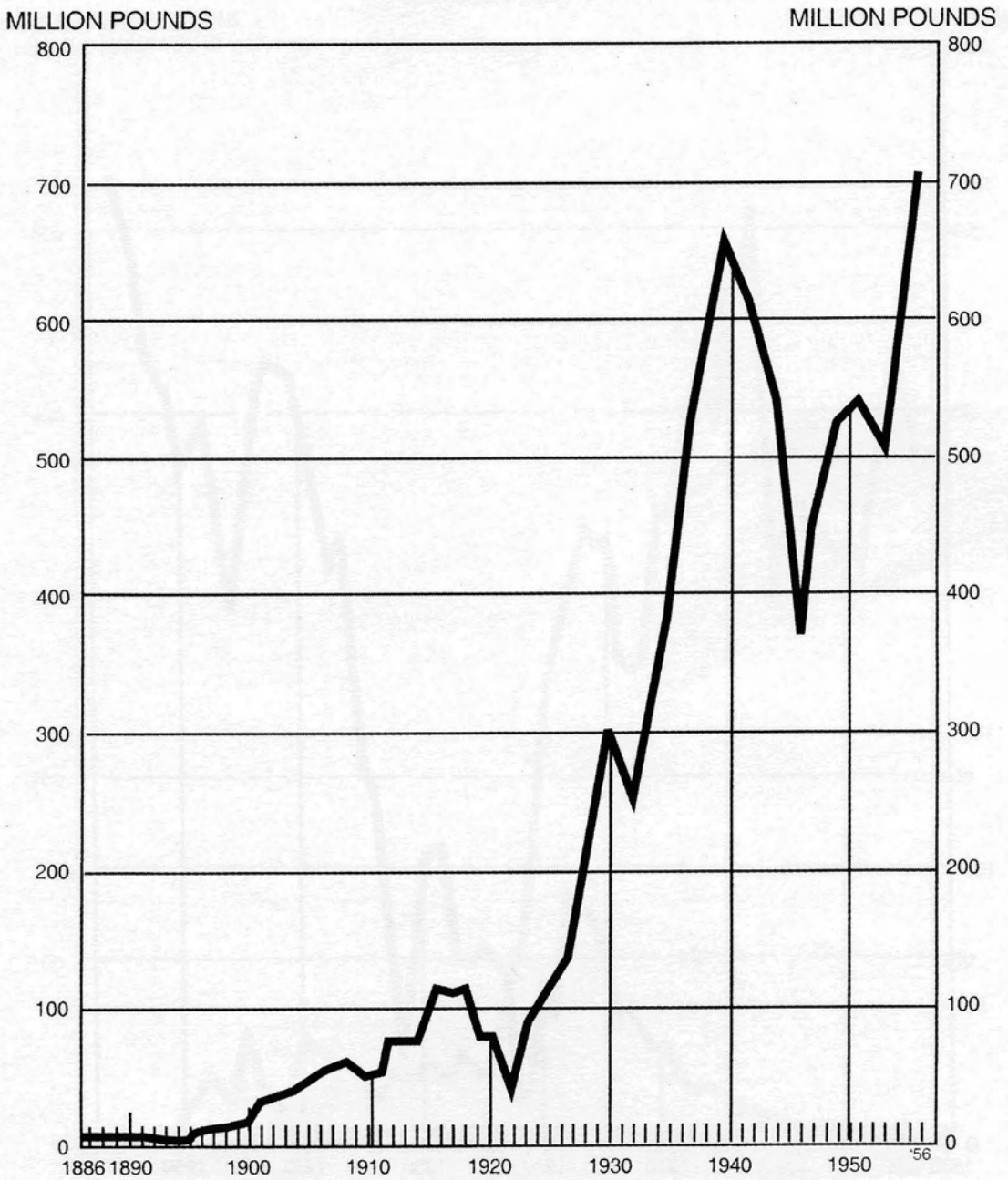
Appendix A


Gold Production
Canada 1886-1956
MILLION FINE OZ.
MILLION FINE OZ.
6
5
4
3
2
1
0
1886 1890
1900
1910
1920
1930
1940
1950
'56

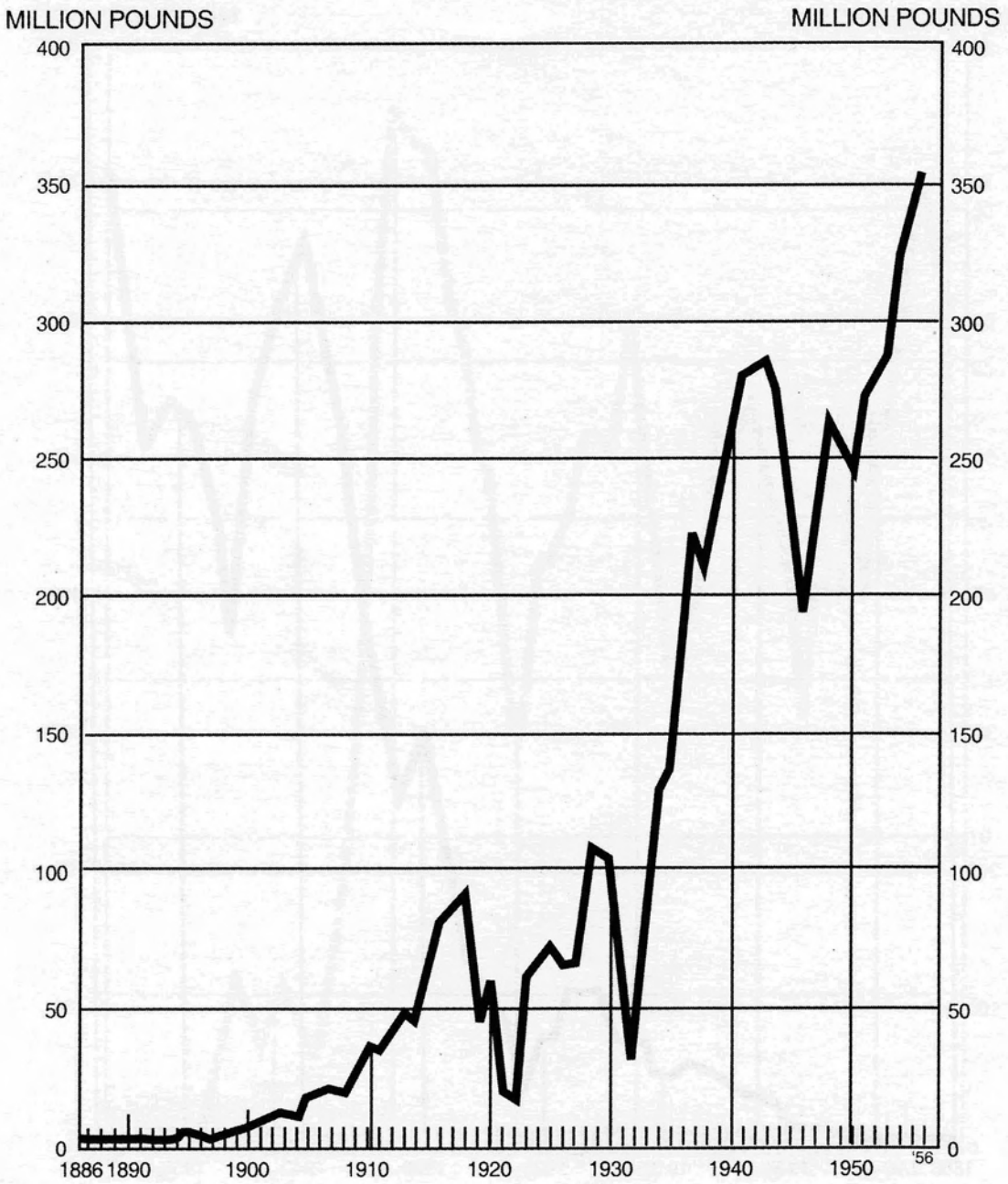
Silver Production
Canada 1886-1956



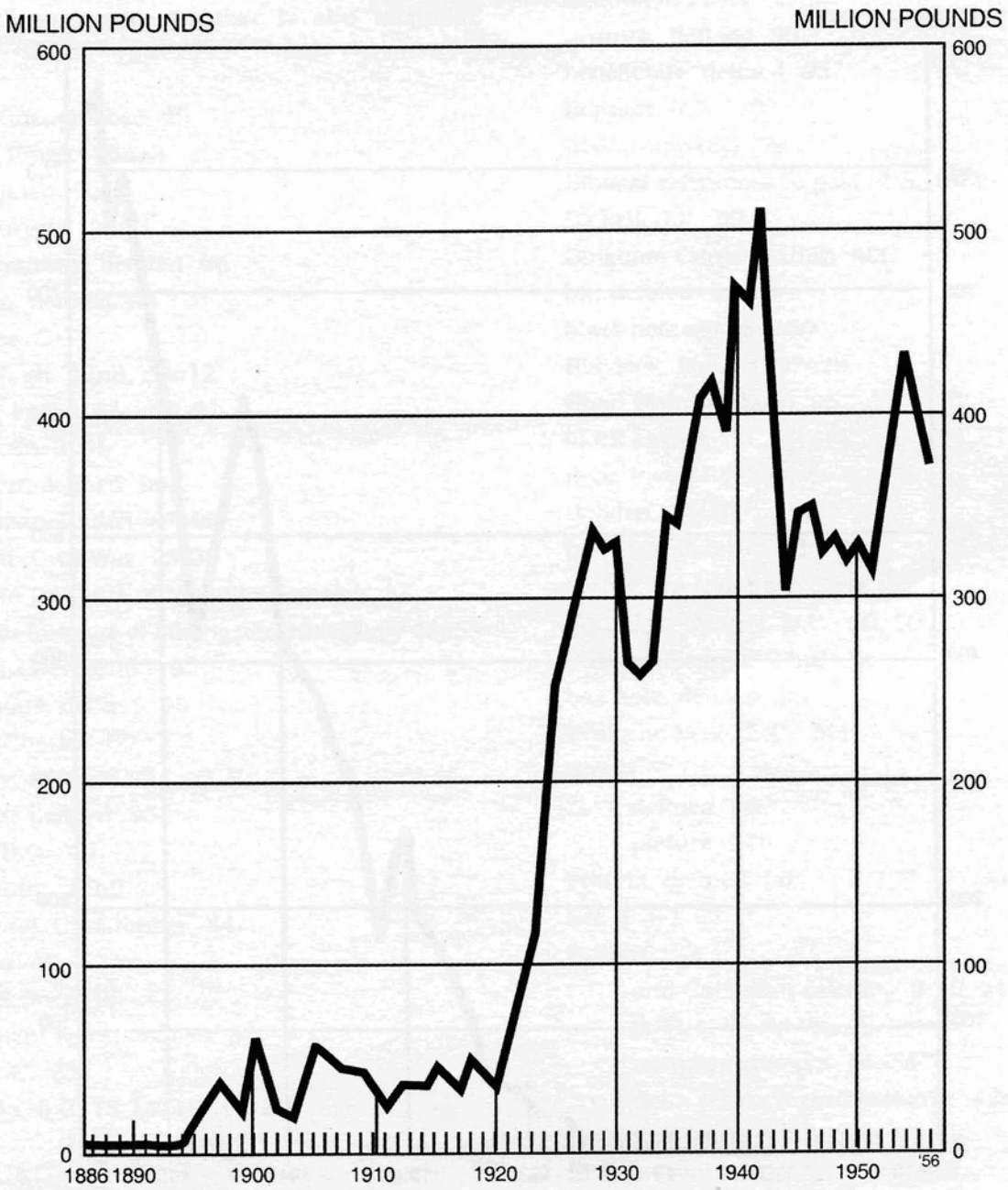
Copper Production
Canada 1886-1956



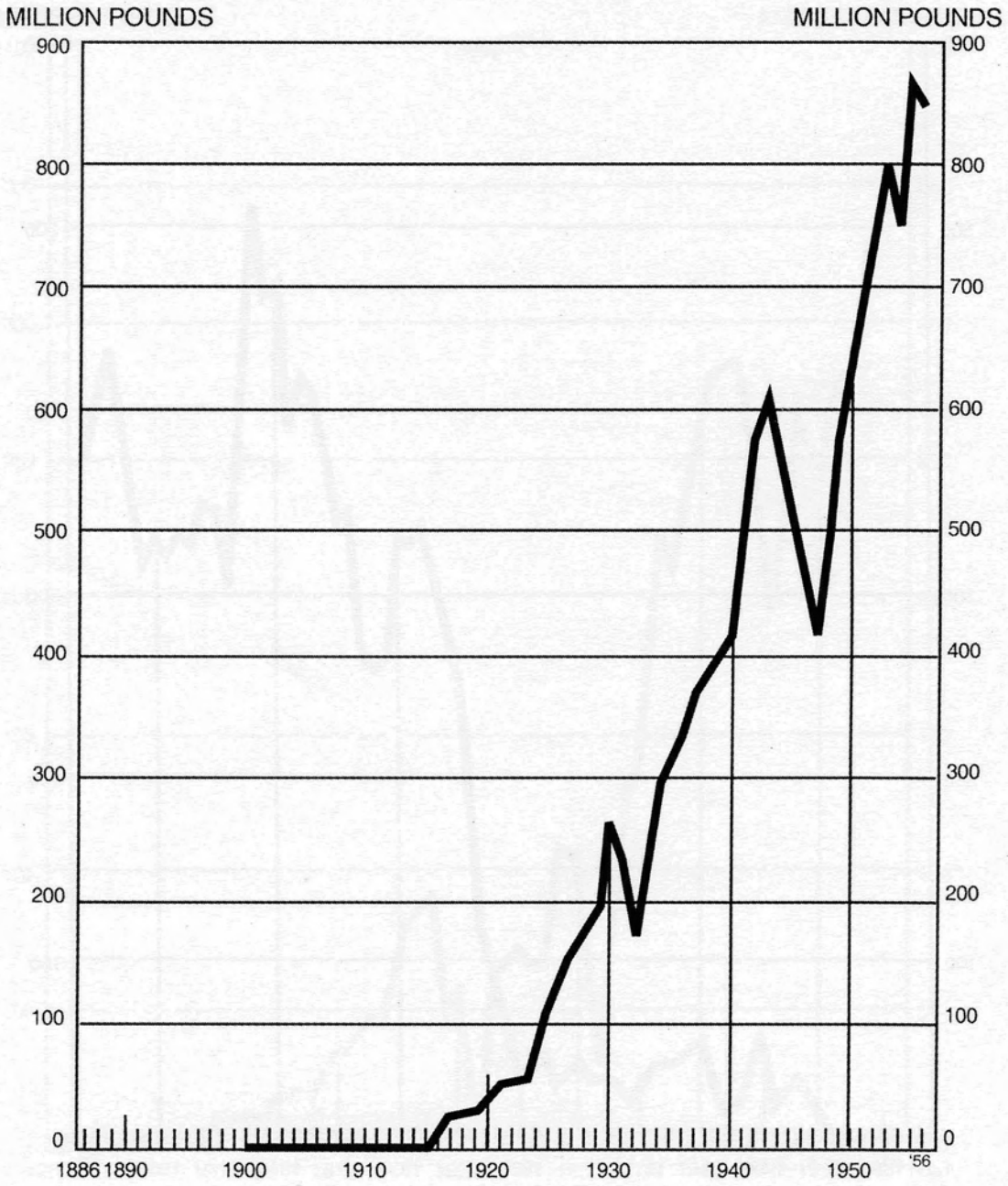
Nickel Production
Canada 1886-1956



Lead Production
Canada 1886-1956



Zinc Production
Canada 1886-1956



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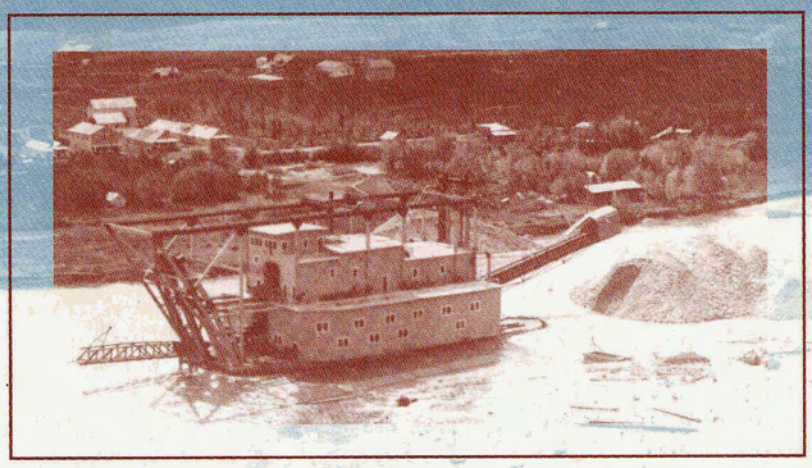

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