Scientia Canadensis
Canadian Journal of the History of Science, Technology and Medicine
Revue canadienne d'histoire des sciences, des techniques et de la médecine

"The Assistance of Science and Capital": The Role of Technology in Establishing B.C.'s Hard Rock Mining Industry, 1876-1906

Jeremy Mouat

Volume 16, numéro 2 (43), 1992

URI : https://id.erudit.org/iderudit/800353ar
DOI : https://doi.org/10.7202/800353ar

Aller au sommaire du numéro

Éditeur(s)

CSTHA/AHSTC

ISSN

0829-2507 (imprimé)
1918-7750 (numérique)

Découvrir la revue

Citer cet article

Mouat, J. (1992). "The Assistance of Science and Capital": The Role of Technology in Establishing B.C.'s Hard Rock Mining Industry, 1876-1906. *Scientia Canadensis*, *16*(2), 165–192. https://doi.org/10.7202/800353ar

Résumé de l'article

Cet article analyse le rôle des sciences et des technologies appliquées à l'industrie minière en Colombie-Britannique, au cours de la période de transition qui va du milieu du 19e siècle jusqu'à l'émergence, en 1906, de Cominco, complexe industriel intégré de la mine aux fonderies, typique des grandes compagnies minières du 20e siècle. Bien que maints observateurs de l'époque étaient persuadés que le développement scientifique et technologique constituait un facteur de progrès, cette étude suggère que le passage des méthodes traditionnelles aux techniques « modernes » a été plus difficile que prévu et que les résultats obtenus sont plutôt ambivalents.

"The Assistance of Science and Capital": The Role of Technology in Establishing B.C.'s Hard Rock Mining Industry, 1876-1906*

JEREMY MOUAT

RÉSUMÉ

Cet article analyse le rôle des sciences et des technologies appliquées à l'industrie minière en Colombie-Britannique, au cours de la période de transition qui va du milieu du 19e siècle jusqu'à l'émergence, en 1906, de Cominco, complexe industriel intégré de la mine aux fonderies, typique des grandes compagnies minières du 20e siècle. Bien que maints observateurs de l'époque étaient persuadés que le développement scientifique et technologique constituait un facteur de progrès, cette étude suggère que le passage des méthodes traditionnelles aux techniques "modernes" a été plus difficile que prévu et que les résultats obtenus sont plutôt ambivalents.

ABSTRACT

This article examines the role of technology and applied science in British Columbia's hard rock mining industry. It focuses on a transitional period, from the decline following the gold rushes of the mid century through to the emergence in 1906 of Cominco, a vertically-integrated mining and smelting complex typical of the large mining companies of the twentieth century. Although many contemporary observers held a naive faith in the possibilities of science and technology, the article argues that the transition to "modern mining" was more difficult and more complex than they had anticipated and its outcome a good deal more ambivalent.

THE EXPORT of natural resources has been the central feature of the Western Canadian economy since settlement by Europeans in the mid nineteenth century (and much earlier in those parts touched by the fur trade). Dependent upon distant markets for the sale of its varied products of the forest, ocean, mine and prairie, the region was quickly incorporated into the expanding network of world trade. It was also a "region of recent settlement," one of those areas which John Fogarty argues "must be defined by the facts of their absorption of European migrants and capital and their involvement in the expanding international economy of the

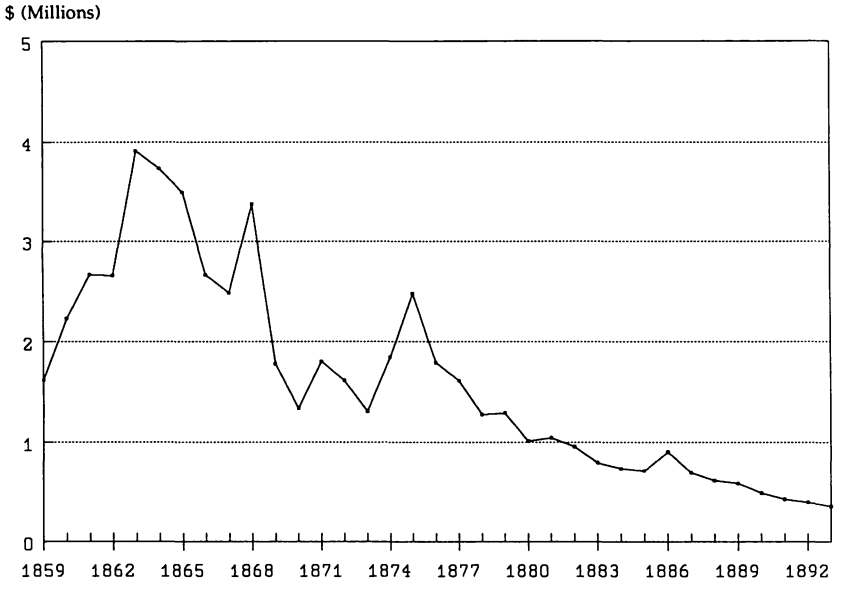
late nineteenth and early twentieth century."[1] Without question, Western Canada participated in and relied upon "the unique growth of the nineteenth century economy and the interdependent set of linkages and transfers of resources which it evoked."[2]

The resource industries of Western Canada developed in the context of this exchange or dialogue between the various partners in the emerging international economy. At first the methods of exploiting the region's natural resources reflected the prior experience of immigrants, people who had brought their own (often rudimentary) skills and techniques. The bounty of available resources – notably the alluvial gold deposits that sparked a series of rushes beginning in 1859 – returned windfall profits to some. However, by the early 1900s market pressures forced mining and other extractive industries to rely heavily on science and technology in order to achieve economies of scale.[3] The following pages examine this transition. The central focus is on the ways in which applied science and improved technology facilitated the profitable extraction of minerals in British Columbia. Contemporaries saw these as sure panaceas for the economic difficulties of the post-rush era, although typically there was little appreciation of the complexities involved in the wholesale transfer of new equipment or the implementation of new processes. This point is developed in the following discussion of the abortive efforts to establish lode mining in the Cariboo in the 1870s and the 1880s; the contribution of both railways and smelters to the mining industry of the 1880s and 1890s; and finally, the rise of Rossland/Trail, the centre of the province's mining industry by the turn of the century and birthplace of the mining and smelting conglomerate, Cominco.

* * *

By the middle years of the nineteenth century, Europeans had some knowledge of the mineral wealth of British Columbia. Vancouver Island's coal resources and the placer gold deposits of the mainland promised that the region would prosper in the coming decades. In both cases, however, mining was beset by considerable initial difficulties. Efforts by the Hudson's Bay Company to develop a coal mine at Fort Rupert after 1848 proved fruitless and the company's second attempt at mining on Vancouver Island, at Nanaimo, was only marginally successful. (However, the Nanaimo mine did return handsome profits after its sale to private interests in 1862.[4]) The Fraser River gold rush was also marked by initial difficulties. Bonanza discoveries typical of other nineteenth century gold excitements did not occur until two years after the first

Figure 1
B.C. Placer Gold Production 1859-1893
Annual Value (Current Dollars)



stampede and the departure of many disgruntled miners.[5] Although undeniably a rich one, the Cariboo gold field centred around Barkerville did not lead to extensive and long-lasting mining operations. After the first flush of activity – and the completion of the Cariboo Road, to encourage economic linkages with the coastal population centres – gold revenues declined sharply. Figure 1 ("B.C. Placer Gold Production 1859-1893") suggests the trend by the 1880s, with the exhaustion of the richest deposits.[6] Production was inevitably falling; revival could only come with the adoption of new and more efficient methods of mining.

Conscious of the dwindling returns from placer mining, the Annual Reports of British Columbia's Minister of Mines frequently advocated moving beyond working such alluvial deposits (the water-borne gold found along creeks or ancient water-courses) to

mining gold *in situ*, in the gold-bearing quartz found around Barkerville. However, hard rock or lode mining was very different from placer mining. After all, placer gold was pure gold – no secondary treatment was required once it had been found – and its recovery called for relatively simple techniques, utilising gravity and water. This accounted for the appeal of placer mining, as a 1907 booklet on B.C.'s mines argued:

> the placer is the "poor man's mine"; he needs little or no capital to work it; its product is cash, to all intents and purposes, and he is his own master – all attractions too great for the sturdy independence of the prospector to allow him to think of searching for lode mines, which, when found, require so much capital to work them as to leave but very small interest in the property with the original owner.[7]

As the passage hints, hard rock mining could only be carried out successfully with considerable capital outlay and such concomitants as sophisticated geological knowledge, engineering expertise, and a skilled workforce. Applied science was a critical ingredient in this package, as residents of the Cariboo were to discover.

The complexities of hard rock mining were not readily comprehended by the enthusiastic boosters of the Cariboo's quartz mines, people anxious only to reverse the slump in gold revenues. The region's miners had acquired the skills of shaft sinking and tunnelling by the 1870s, in order to follow placer deposits underground along ancient riverbeds, but more was involved in lode mining than simply locating a quartz deposit and then bringing the ore to the surface. This became clear when Barkerville experienced a "quartz excitement" in the late 1870s, a flurry of feverish activity which ended in total failure. In 1876 a company was formed to work the quartz deposits of the Cariboo; it sent ore samples to San Francisco for assay and readied machinery for "a new era in the mining annals of this Province."[8] Residents of the area lobbied the provincial government in the spring of 1877 for the appointment of a mining engineer, arguing that "the assistance of science and capital" was necessary to develop quartz mining. The government agreed to the request and enlisted the help of the British Consul in California to hire a Cornishman ("a thoroughly practical quartz miner") who arrived in Barkerville in July 1877.[9] The Cariboo's Government Agent for 1877 predicted that "an era of prosperity is about to dawn on Cariboo, surpassing the palmy days of 1863." In the three months since the arrival of the new mining engineer, he

reported, prospectors staked thirty-six quartz claims. Another eighty-two claims were staked in the last two months of the year.[10]

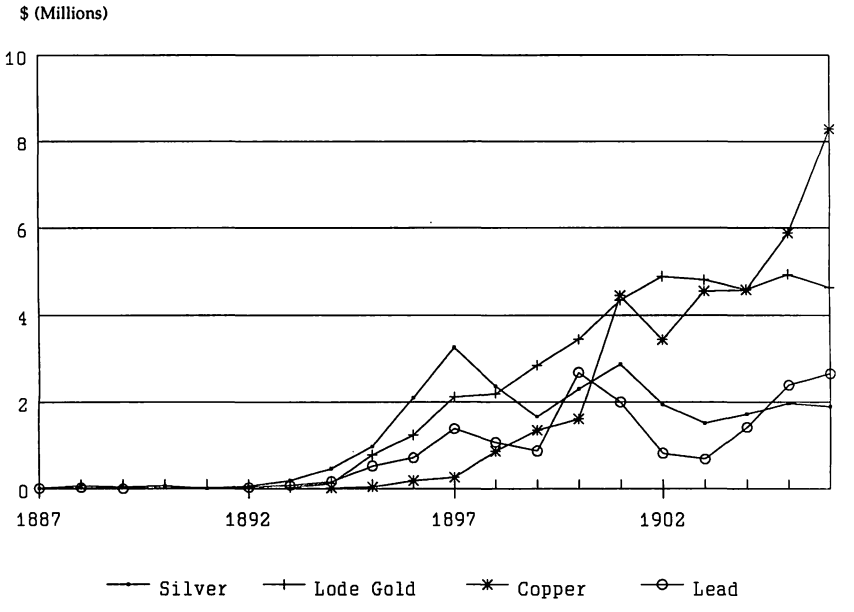
Despite this enthusiasm and effort, the new age did not dawn. More restrained reports from the Cariboo in 1878 and 1879 regretfully acknowledged that hard rock mining had yet to be established on a paying basis, despite the expenditure of considerable amounts of money. (The British Columbia Milling and Mining Company, for example, invested some $100,000 before suspending operations.) Although no one could question the existence of gold-bearing quartz, nor the significant assay values that the ore carried, the trick was to learn how to treat the quartz successfully and recover a significant percentage of the gold within it.[11]

By the mid 1880s Cariboo's quartz was once more attracting interest. In 1886 a typical passage in the Annual Report of the Minister of Mines foresaw a new era:

> the most sanguine hopes are entertained with regard to the profitable working of gold quartz. In fact, information from every source irresistibly leads to the conclusion that the era of quartz mining is at hand.[12]

Similar optimism had been expressed the year before, when the Geological Survey of Canada had sent a team to Barkerville to map the area. At the same time, representatives of the provincial government solicited the opinion of a number of people on the prospects for quartz mining in the Cariboo. "Mr Koch, mining expert" was commissioned to write a report on the gold quartz deposits; Wm. Craib, like Koch, an expert from California, submitted a letter in response to a series of thorny questions, such as "the best method to introduce our quartz interests to capitalists in order that they might be induced to advance the means to prospect and open up the same."[13] During the following year Barkerville's government assay office was re-opened by a "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] Efforts to treat Cariboo ore continued: in 1890,

Figure 2
Production of B.C.'s Lode Mines 1887-1906
Annual Value (Current Dollars)



samples were sent to Scotland to be treated by the newly-discovered cyanide process; two years later the Scottish company sent a representative to Barkerville to promote the process.[16]

Although none of these initiatives ended in success, they indicate the energy (and perhaps, the misplaced optimism) of those within the mining industry. Revival was always just around the corner, and would come with more generous government help, greater investment, and/or more sophisticated technology. Few doubted that all that was needed to treat the refractory ore of Barkerville was the application of appropriate technology, such as that in use in Nevada and California, places where the transition from placer to quartz mining had already taken place. As the Cariboo's gold commissioner confidently explained, "science has demonstrated the fact that the infinitesimally fine gold locked up in sulphuret ore can be nearly all extracted and saved without the unsatisfactory and expensive aid of arastra wheels and quicksilver."[17] Despite such optimism, the introduction of the latest processes to treat gold ore (such as

chlorination and cyanidation) did not bring the anticipated success. The emergence of the lode mining industry after 1893 was not due to the exploitation of the Barkerville deposits but a result of developments elsewhere. The most significant factor was the establishment of a new transportation system, a network which did not include the Cariboo. Hard rock mining's requirements for substantial equipment, as well as the need to ship ore to smelters for treatment, meant that access to reliable and inexpensive transportation was critical if the industry was to prosper. As figure 2 ("Production of B.C.'s Lode Mines 1887-1906") indicates, by the early years of this century the industry was well-established.[18]

The bulk of this mineral production came from southern British Columbia. Europeans had identified minerals in this area of the province as early as the 1840s. (Chief Factor John McLoughlin of the Hudson's Bay Company, for example, sent samples of lead deposits from around Kootenay Lake to England in 1844, and fifteen years later H. Bauerman reported the existence of rich galena in the same locality.[19]) Despite this knowledge, geographical barriers meant that the formal staking of such mineral wealth did not take place until 1882. Six years later George Mercer Dawson, the well-known Canadian geologist, reflected on the reasons why "development of metalliferous mining in its more permanent forms has been slow," despite British Columbia's early career as gold producer. "[O]ne of the chief drawbacks [he concluded] has always been the want of proper means of transport for heavy machinery and for ores."[20] Substantial development of the mineral resources of the Kootenays became possible only after the construction of the transcontinental railways in the 1880s.

The first of these transcontinentals, the Northern Pacific Railway, started running in 1883, passing south of the border from Minnesota to Portland, Oregon, via Sandpoint in Idaho, and Spokane, Washington.[21] In 1885 the Canadian Pacific Railway [CPR] was completed, connecting Montreal to Port Moody via Golden and Revelstoke. In addition to the two railways, by the late 1880s steamboats operated on a regular basis on the three north-south water routes of the Kootenays (the Purcell, Selkirk and Rocky Mountain Trenches), providing limited connections with both the CPR and the Northern Pacific. The improved transportation network encouraged prospectors to fan out across the Interior, and most of the famous Kootenay mines were first staked during the 1880s and early 1890s. Ironically, the Canadian Pacific Railway was ultimately to control much of the province's mining industry, but

during the closing decades of the nineteenth century the most pressing concern was how to establish and then extend the rail network, rather than speculation on its possible consequences.[22]

Almost as soon as the railway reached the Pacific coast a second issue arose, the need for local smelters to treat the province's ore. People argued that smelters were needed so that the mining industry would provide the greatest possible benefit to the regional economy, and this demand quickly became part of the public discourse on mining.[23] The provincial government responded to this pressure in the spring of 1886, passing "An Act to encourage the erection of Smelting Works." A front page article in the *Victoria Daily Times* welcomed this gesture, claiming that the act

> will meet with the approval of every man in the province.... We have the mines and they ought to be developed.... The successful operation of one quartz mill would be worth more than two or three large woollen mills to the province.[24]

The legislature passed a related bill in 1887 ("An Act to aid the Development of Quartz Mines"); in a similar vein Vancouver's ratepayers approved a bylaw in the autumn of that year, giving both direct financial assistance as well as a ten year tax holiday to any business constructing a smelter within city limits. Although a smelter was subsequently built in Vancouver, operating briefly in the spring of 1889, the venture ended disastrously.[25] This failure does not seem to have dampened the enthusiasm of local interests for smelters: in 1893, at least some business people were welcoming a proposal to build a steel smelter in Vancouver.[26] In 1896, another smelter proposal was creating headlines ("It Is Vancouver: The Future Site of an Immense Busy Smelter"), encouraging journalists to conclude that this was "bound to become one of the greatest smelting works on the whole globe."[27]

By this time, even the federal government had entered the field, bringing in legislation in the summer of 1895 to encourage the construction of smelters in the province. Defending this initiative, George Foster (Minister of Finance in Mackenzie Bowell's Conservative ministry) reiterated the common rationale for smelters:

> The object the Government have in view is to give an impetus to the mining and smelting industry.... It is believed that a very great benefit will result. A mining population is particularly a consuming population. It makes nothing for its own wear, and for its own food, but it calls

lavishly and constantly for the products of the manufacturer, and more especially for the products of the agriculturist. ... The object is to give a stimulus to the development [of a smelting industry in Canada] at once, to get capital to go in and set up establishments there, and commence operations, so as to give the benefits that are derived from a large industry.[28]

Despite a number of false starts, smelters were soon being built throughout the province's interior, as well as several on the coast.[29] The most successful of these was built in 1896 at Trail, to treat the copper gold ores from nearby Rossland.

Rossland was the province's premier hard rock mining community in the late nineteenth century – "as well known in London as Johannesburg"[30] – and its career highlights the various issues raised thus far. Here the new age of lode mining began, that transition so eagerly anticipated by the residents of the Cariboo. The critical preconditions for success, railways and smelters, were quickly in place, once the mines had proved their value. No simple equation explains Rossland's growth, however; railways plus smelters plus ore deposits did not automatically result in an established lode mining industry.

Several contemporaries noted that Rossland's rise to prominence was partly the result of generally depressed mining conditions elsewhere. As a consequence the town and its mines attracted the attention of wealthy developers seeking new outlets for their energy and capital. For example, in his 1895 pamphlet on the Kootenay mines Charles St. Barbe explained how "mining matters in the Western States and throughout British Columbia being flat[,] the wave of public attention rolled towards Trail Creek."[31] In early 1896, in an article in a Toronto newspaper, Harold Kingsmill offered a more detailed explanation of what he called "The Awakening":

The closing of the Indian mints to the coinage of silver, the repeal of the silver purchasing clause of the Sherman act by the United States Congress, and the consequent slump in the price of the white metal, had rendered silver mining so unprofitable and hazardous an investment that it actually compelled money usually used in this industry to seek the only other alternative – gold mining for ores, from which it could be profitably extracted, no matter how small the margin. These were the indirect causes of Trail Creek's present prosperity and fame. Patsy Clark bonding and making a mine of the War Eagle claim is the direct cause.[32]

F. Augustus Heinze, a young copper magnate from Butte, Montana, was among those turning their attention to Rossland. In the summer of 1895 he sent two men up to Rossland to check on the area's prospects. Impressed by the men's account, he signed a deal in the autumn with the owners of the LeRoi mine, guaranteeing to supply him with 5,000 tons of ore. With an ore contract in hand (an agreement later described as "without a doubt the greatest and most important event of the year"[33]), Heinze quickly built a smelter at Trail Landing, on a terrace above the Columbia River. Trail's first smelter was blown in on 1 February 1896. To facilitate the supply of ore from Rossland to his smelter, Heinze built a narrow gauge railway, which was running by June. For his smelter to function at capacity, Heinze had to treat virtually the entire output of the Rossland mines. Although no other smelters were built in the vicinity, Heinze's monopoly of Rossland ore soon came to an end.

In December 1896, Daniel Corbin completed his Columbia and Red Mountain Railway, which ran from Rossland to Northport, Washington, where it linked up with his other railway, the Spokane Falls and Northern. Thus the new railway provided Rossland with a direct connection to the two American transcontinentals running through Spokane, the Northern Pacific and (from 1892) the Great Northern.[34] As a Spokane newspaper proclaimed, "The construction of the Red Mountain railroad ... has made Spokane the virtual headquarters of Rossland's mining men, and the acknowledged trade center of the entire Trail Creek region."[35] This was particularly bad news for Heinze: soon Rossland ore was among the freight going south on the Columbia and Red Mountain Railway, calling into question the viability of his smelter at Trail.

The LeRoi was Rossland's major producing mine and its ore had to go to Heinze's smelter if it was to function economically. The Spokane businessmen who owned the LeRoi, however, decided to utilise Corbin's railway to ship their ore across the border. They built their own smelter in Northport, Washington during 1897, which was finished and blown in on 1 January 1898.[36] Heinze attempted to rally public opinion in British Columbia around him and lobbied hard in Victoria and Ottawa for further railway grants and a duty on exported ore, hoping somehow to regain his monopoly of Rossland ore. However, when he received word that the manager of his Butte properties had gone over to his competitors, he decided to give up the struggle. On 11 February 1898 he sold his smelter and railway to the Canadian Pacific Railway and returned to Butte.[37]

The CPR's interest in the Kootenay mining region had begun almost as soon as regular transcontinental traffic was under way. In 1889, for example, company shareholders were notified that the *CPR* had control of the Columbia and Kootenay Railway.[38] Throughout the 1890s the railway continued to improve and expand its Kootenay connections. Major acquisitions came in the period 1896 - 1898, beginning with the purchase of the Columbia and Kootenay Steam Navigation Company, the major group of river boats providing the vital connections between various rail lines of the area. Then came the construction of a railway into the Kootenays from Alberta through the Crow's Nest Pass route. And in early 1898, the company bought Heinze's railway, the Columbia and Western, as well as his smelter at Trail. *CPR* shareholders were told that all this would stimulate further mining development in southern British Columbia "and is certain to add largely to the earnings of the Company."[39] If anything threatened this anticipated prosperity, it was competition from the rail lines south of the border. The *CPR* soon learned that Corbin too had sold his railway into Rossland. By 1 July 1898, J. J. Hill's Great Northern Railway controlled the line which connected Rossland's mines to the smelter in Northport, Washington as well as linking the city to the American transcontinentals which ran through Spokane.[40] Ore shipments offered railways regular and lucrative business, and intense competition began between Hill's Great Northern group and the *CPR*.[41]

Railway competition in southeastern British Columbia was more wide-ranging than simply rivalry for ore traffic or supplying the province's smelters with coal and coke. At stake was which rail network would assume the dominant position in the Canadian west, especially in the area between the *CPR*'s main line and the U.S. border. Both the Great Northern and the *CPR* went to considerable efforts to ensure victory. The construction of two separate and distinct transportation systems within the Kootenays was one consequence of this battle.[42] Another was the *CPR*'s commitment to vertical integration: it decided to re-furbish and extend Heinze's smelter. The company re-organized the Trail plant as the Canadian Smelting Works, and placed it in the hands of an energetic and ambitious American, W. H. Aldridge.

Like Kootenay railways, the region's smelters needed considerable quantities of ore to achieve profitable operations. The LeRoi's Northport smelter was a serious threat to the Canadian Smelting Works, since it siphoned off a substantial percentage of Rossland's

production. Aldridge's response was to diversify the Trail smelter. After he took over the works on 1 March 1898, it closed for improvements and expansion. The changes that Aldridge initiated allowed the smelter to treat the silver lead ores of the Slocan and East Kootenay, in addition to Rossland's copper gold ores. Despite the capital outlay required to construct the lead furnaces and roasters, the capacity to treat silver lead ores provided the smelter's owners with a greater range of potential customers. The *CPR* had several connections between Trail and the Slocan mines, while the CPR's Crow's Nest Pass railway and its Kootenay Lake steamers between them could bring the Moyie area's silver lead ore to Trail.[43] Despite these advantages, however, the new smelter was not an immediate success.

In 1901, Aldridge faced two difficulties. A miners' strike brought a prolonged shutdown of his main Rossland producers, while a steep drop in the price of lead closed a number of the province's silver lead mines.[44] Sir Thomas Shaughnessy, *CPR* president, called him to Montreal to discuss the problems and then outlined the company's difficulties in a long and candid letter to Sir Richard Cartwright, the federal Minister of Trade and Commerce. Shaughnessy admitted to Cartwright that

> With the large investment that we have made in railways to serve these mining districts, amounting to about $15,000,000, in the last four years, we are, of course, very much disturbed by the conditions that prevail [in British Columbia]. Practically, all of the ore now produced in the Rossland camp goes to the Northport Smelter, because the Le Roi and Josie Mines have their own smelter at that point. We ... made them a proposition to do the work at Trail at much lower figures. They declined, because, no doubt, the abandonment of their Northport smelter might injuriously affect some of their stock operations in London.
>
> We have left no stone unturned to encourage the opening and operation of mines, because, of course, we must depend upon them for the support of our railway lines in the mining districts.[45]

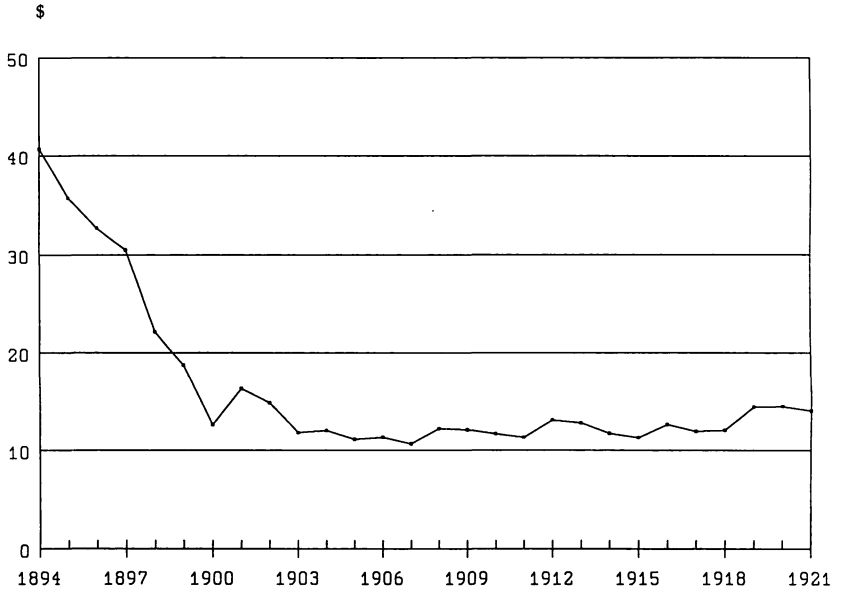
Shaughnessy was irritated that so many B.C. mining companies publicly blamed railway and smelting charges for their financial problems which, as he pointed out to Cartwright, stemmed from low metal prices and high capitalization.

While Shaughnessy resented such attacks on the *CPR*, the company and Kootenay mine owners plainly shared an over-riding concern in the health of the province's mining industry. Thus,

when a serious and unexpected threat arose in 1901, the two responded in unison. The American smelter conglomerate, American Smelting and Refining Company [Asarco], was establishing monopoly control over the ore treatment industry in the United States.[46] Asarco's success was such that by 1901 Canadian ores were no longer in demand south of the border. With the lucrative U.S. lead market in the hands of Asarco, B.C.'s silver lead mines had nowhere to ship their ores for treatment. The province's mine owners responded by initiating "a very active agitation for Government assistance in the development of lead mining and smelting."[47] During the spring of 1901, meetings were held throughout the Kootenays, often under the auspices of local Boards of Trade. As a consequence, "on April 15 a large deputation from the Kootenay district, generally, waited upon the members of the Government at Ottawa with the object of securing a bounty towards establishing the lead refining industry in Canada."[48] Within six weeks the government responded to the pressure by introducing the called-for lead bounty.[49]

The *CPR* had earlier contemplated selling the smelter, but with the lead bounty now in place the company apparently renewed its commitment to Trail's expansion.[50] A lead refinery was added to the Trail complex in 1902, utilising the new "Betts process" of electrolytic refining. This, the first ever commercial application of the new technology, proved to be a resounding success.[51] The capacity of the original refinery was a modest eight tons a day but by 1904 this had doubled and in 1906 had reached 70 tons a day.[52] The Huntington-Heberlein roasting process, a recent advance in lead smelting, was also incorporated into the Trail plant in 1906. This was an important innovation for the plant's lead smelting, since it not only "resulted in a great reduction in smelting costs"[53] but also allowed the plant to operate much more efficiently with the locally available silver lead ores. As an earlier researcher has pointed out, the process provided significant advantages, "advantages [which] were particularly important in areas where the lead industry depended on only a few mines producing the same type of ore, and where mix-smelting was unprofitable."[54] Mix smelting involved blending a wide range of ores in order to maintain self-fluxing or neutral charges for the furnaces; such a process was well suited to the American "valley smelters" of Colorado and Montana, since they could tap a diverse group of mines (and ores). The Huntington-Heberlein process freed the Trail smelter from its competitive disadvantage as a mix smelter, allowing it to develop a

Figure 3
Rossland Ore Production 1894-1921
Value Per Ton(Current Dollars)



custom process closely tailored to the East Kootenay ores.[55] Under Aldridge's management, and with the active encouragement of both the federal government and senior *CPR* management, the Trail smelter adopted the latest technological advances and diversified its capacity, no longer a somewhat primitive copper smelter almost totally reliant on the Rossland ores but a modern plant able to treat virtually all the ores then mined in south-eastern British Columbia.

The construction of the lead refinery and the adoption of the Huntington-Heberlein process established the Trail smelter as one of the most advanced on the continent; "probably the largest and most complete of its kind in America," pronounced R. W. Brock, the director of the Geological Survey of Canada.[56] When the Canadian Mining Institute organised an international "excursion to the mineral districts of Canada" in the late summer of 1908, the visiting experts were much impressed by the Trail smelter and indeed with the Kootenay region generally. Describing the experience later, a member of the British contingent confessed that "the

visitors, who had been referred to by the local press in such flattering terms as 'eminent experts,' 'big fellows,' and the 'top notchers' of their profession, were all very ready to admit they had learnt a great deal from their genial professional Canadian brethren."[57] These overseas mining men were particularly struck by "the courage exhibited in attacking low grade ores, and the technical and administrative skill which have established sound industrial concerns upon low grade ore bodies."[58] For Rossland managers, this was a case of necessity being the mother of invention.

New technology was brought to Rossland in order to meet a growing crisis. This predicament had its roots in a speculative frenzy during 1896-97, when literally hundreds of mining companies were floated.[59] As the boom in company formation and flotation died away and the Klondike gold rush diverted attention from Rossland, the leading mines of Rossland – all American owned – began to sell out to British and Canadian syndicates. In late 1897, for example, the War Eagle was sold to the Gooderham-Blackstock liquor interests of Toronto; in late 1898, they added the Centre Star to their group. The London-based British America Corporation was the other purchaser of leading Rossland properties. Throughout 1898 it bought up claims, culminating in December with the purchase of the LeRoi.[60] Ironically, while the "repatriation" of the mines to British and Canadian interests was frequently applauded, its impact was detrimental. Regardless of the nationality of either vendor or purchaser, the mines were changing hands at ludicrously inflated prices and the only way that such over-valued properties could operate successfully would be by making drastic efforts to reduce costs.

By this time Rossland's mines were places of considerable sophistication, already having gone through "the transition period from the slow, old-fashioned method of hand-drilling, manual windlass work, and mule-packing, to compressed air-drills, concentrators, steam hoists and elevated rope tramways."[61] The LeRoi is a good example: at the end of 1898 its plant included a 40-drill air compressor and a 300 horse power steam hoist. On average the mine employed two hundred and fifty men, working at depths underground of up to eight hundred and fifty feet.[62] To oversee its complexities, the mine's new owners employed a Mining Engineer-in-charge, William Carlyle. He had come to the job after serving as B.C.'s inaugural Provincial Mineralogist (appointed in 1895), in which capacity he wrote the first full-length report on Rossland. Earlier he had lectured in mining and metallurgy at McGill University

and worked in silver-lead mines in the western United States.[63] The appointment of Carlyle to the LeRoi indicates the ways in which Rossland was maturing, the prospector's and developer's lucky strikes and gambles giving way to board-room decision-making based on the professional advice of engineers and other experts. But this was not the only transformation to affect Rossland during the period: as Figure 3 suggests, the ore itself was also changing.[64] That change, a drop in value per ton produced as the ore's mineral content declined, was to have a profound impact on the province's leading lode mining community.

By the early 1900s the challenge confronting mine managers was to discover some way to treat the mines' increasingly low-grade copper gold ores at a profit. As the manager of the Centre Star mine told shareholders in his 1903 Annual Report, the mines had to find some way to adjust to "the transition from the occurrence of high grade bonanza ore bodies ... to masses of lower grade."[65] It was becoming obvious that if some means was not soon found to process these latter ores, Rossland's future would be in jeopardy.

Although the need to treat low grade ore had been discussed for some time, by 1903 the problem was receiving widespread attention.[66] For example, at the end of the year Rossland's Gold Commissioner reported that

> some experiments ... have been conducted for the better reduction of Rossland's ores. ... In consequence of this, several plants, of varying nature, have been completed, or are under way, and the years to come will probably see a revolution in the treatment of ores of this camp, the initial stages of which have been witnessed in 1903.[67]

Five concentrating mills were built in the vicinity of the mines in order to reduce smelter costs.[68] If the ore underwent an initial stage of treatment at these mills, it would then be economical to ship the product, material of substantially higher grade, to the smelter. (For example, ore worth $8 a ton could not be mined and shipped to the smelter if the freight and treatment charges were $7.50; on the other hand, concentrates carrying values of $16 a ton might well return a profit to mine owners.) The most innovative of these experiments involved what was known as the "Elmore Oil Process." A fore-runner of the flotation process, it was installed at two Rossland mines (the LeRoi No. 2 and the White Bear) in 1903-1904, but ultimately proved to be a failure.[69] The other mills around Rossland were no more successful than those using the Elmore process; these

failures suggested the need for other approaches to achieve "the chief end and object of mining, viz: – the earning of a profit."[70]

In January 1905, the *British Columbia Mining Record* reflected on the past year's progress at Rossland, and regretfully acknowledged that "operations ... have not proved as satisfactory as was earlier anticipated."[71] The failed attempts to concentrate Rossland's ore were central to the journal's account; it was clear that the mines had yet to be placed on a secure and profitable basis. The same month, a headline in a Vancouver newspaper proclaimed that "Rossland Depends on Concentration" "Its Future Now In The Balance."[72] Like the former piece, this article concluded that the various efforts at concentration had not been notably successful. And it noted that a new solution to Rossland's difficulties was now being advanced: amalgamation of the various mines into one large concern.

By the spring of 1905, local and national journals as well as the international mining press were discussing the efforts then underway to consolidate the leading Rossland properties.[73] The key players met in Rossland to consider the mechanics of the proposed merger and made optimistic public statements: the War Eagle/Centre Star's new manager was hopeful; the LeRoi's managing director saw no obstacles ahead; George Waterlow, a LeRoi director, "stated with considerable emphasis that the proposed merger of the big mines and smelters of the Trail Creek district is practically an assured fact."[74] Despite such optimism, the LeRoi did not end up as part of the new "consolidated" company that was formally created in January 1906. The critical event that cleared the way for this new company came on 1 June 1905, when the "Aldridge Syndicate" (that is, the CPR) secured an option on the Gooderham-Blackstock group's majority holdings in the War Eagle/Centre Star, the Rossland Power Company and the St. Eugene Consolidated. Despite Blackstock's reluctance, the purchase went through in late June, for $825,000.[75]

Aldridge, the CPR's key player in the amalgamation proposal, tried hard to persuade those in charge of the LeRoi mine to join in the scheme. In late 1905 he travelled to London to attend a shareholders' meeting considering the proposal, hoping to persuade them to support it. The LeRoi's English shareholders made their objections to amalgamation clear, however, so Aldridge returned to eastern Canada, where he orchestrated the formal creation of the Consolidated Mining and Smelting Company of Canada [Cominco] from the heretofore separate properties controlled by the

CPR.[76] In February 1906 Cominco issued its first report to shareholders and Aldridge, its managing director, declared that

> The Consolidated Mining & Smelting Co. of Canada, Ltd., is not dependent upon any single mine, nor upon any single mining district; but its interests and business, besides being to an extent industrial, will also be so diversified as to minimise, so far as possible, the speculative element.[77]

Contemporary observers agreed with Aldridge, and saw Cominco's birth as reflecting a new maturity, a sign of the shift from an earlier form of mining venture – often marked by recklessness and stock market manipulation – to modern industrial organizations structured much like any other business.[78] Although some years passed before Cominco became profitable, by 1941 virtually one-half of all dividends ever paid by B.C. mining companies (including coal) had gone to its shareholders. Twenty-five years later, a government publication credited the company with having produced "nearly one half the metal wealth of British Columbia."[79]

* * *

The period examined in these pages, from the early efforts to establish lode mining in the Cariboo during the 1870s and 1880s through to the trials and tribulations of Rossland's mines in the first years of this century, was a transitional one. It was clear by the late 1870s that the rich placer gold deposits were rapidly depleting yet the establishment of a modern precious and base metals industry in British Columbia did not occur until the 1900s. Technology played a central role in this latter process, as innovations in milling and refining techniques – notably selective flotation and electrolytic refining – facilitated the bulk treatment necessary to treat low grade ores profitably.[80] Companies such as Cominco devoted much time and money to metallurgical research, recognising the key role that applied science was assuming in the industry.

Although technology was to become critical to the success of the mining industry, during the years examined here it was regarded in a much less sophisticated way, essentially as a "quick fix" solution to the twin problems of depletion and decline. From the calls for expert advice and government help in the Cariboo in the late 1870s through to the experiments with new concentrating techniques in Rossland in 1903 and 1904, people were concerned with little more than overcoming immediate economic difficulties. But technology can not be invoked in isolation; it comes as part of a larger package. The necessary capital expenditures lead to economies

of scale and vertical integration, and the unity of conception and execution at the workplace is dissolved, replaced by the university-trained engineer and a de-skilled group of workers.

The changes which occurred in the hard rock mining industry went much further than simply the introduction of new machines or processes: they occurred as part of a larger transformation of the region. Mining, however, initiated this transformation. Mineral extraction created underground areas that required elaborate systems of timber supports to minimise the danger of cave-ins. Machinery was essential to ventilate and drain these subterranean spaces, as well as to operate the winding gear which gave underground access. Once on the surface, the ore went to veritable factories where the mineral content was separated out by a variety of complex processes. Sophisticated transportation facilities were needed to ship the final product. All this led to nearly identical industrial conditions in the communities of the western Cordillera and by the 1900s their landscapes were dominated by the same features: shafts capped by headframes; the insistent noise and pollution of surface workings with their machinery, their slag heaps and their smoke stacks; and everywhere work rhythms orchestrated by "boss whistle." These were among the most industrialized environments of their day.

Cole Harris has observed that "in this corner of the New World [the Interior of British Columbia] abstractions become realities, and the long story of emerging modernity, extending back through European millennia, is compressed into a hundred years or so."[81] At Rossland, this compression is even more dramatic: from the first staking of the mines in 1890, scarcely fifty years passed before researchers in the nearby smelting and refining complex were conducting experiments with heavy water for the Manhattan project.

NOTES

* An earlier version of this paper was presented to the 7th Kingston Conference in Ottawa, 20 October 1991. I was assisted in my research by a generous grant from Athabasca University's Academic Research Committee. I am also grateful to my friends Keith Ralston (of the University of British Columbia) and Logan Hovis (of the National Parks Service, Anchorage, Alaska); both helped to sharpen my own thinking about mining and the history of British Columbia.

1 John P. Fogarty, "The Comparative Method and the Nineteenth Century Regions of Recent Settlement," **Historical Studies**, 19 (1981): 415.

2 Fogarty, ibid.

3 Good discussions of technology and the various resource industries include Richard Rajala, "Managerial Crisis: The Emergence and Role of the West Coast Logging Engineer, 1900-1930," in Peter Baskerville, ed., **Canadian Papers in Business History**, Volume I (Victoria, 1989), pp. 101-27; Duncan A. Stacey, **Sockeye & Tinplate: Technological Change in the Fraser River Canning Industry 1871-1912** (Victoria, 1982); 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 [UBC hereafter], 1986; Paul Voisey, **Vulcan: The Making of a Prairie Community** (Toronto, 1988), esp. pp. 77-154.

4 The best published accounts of early coal operations in B.C. are H. Keith Ralston, "Miners and Managers: The Organization of Coal Production on Vancouver Island by the Hudson's Bay Company, 1848-1862," in E. Blanche Norcross, ed., **The Company on the Coast** (Nanaimo, 1983) pp. 42-55, and Eric Newsome, **The Coal Coast: The History of Coal Mining in B.C. – 1835-1900** (Victoria, 1989). See also Richard Somerset Mackie, "Colonial Land, Indian Labour and Company Capital: The Economy of Vancouver Island, 1849-1858," MA thesis, University of Victoria, 1984; D. T. Gallacher, "Men, Money, Machines: Studies Comparing Colliery Operations and Factors of Production in British Columbia's Coal Industry to 1891," PhD thesis, UBC, 1979; and Lynne Bowen, **Three Dollar Dreams** (Lantzville, 1987).

5 Scholars have yet to explore the depth of disappointment felt by many of the participants in the 1859 Fraser River gold rush, but for a revealing contemporary account see J. Ross Browne, **A Peep at Washoe and Washoe Revisited**, (Balboa Island, California, 1959), pp. 6-11; this first appeared as part of a series in **Harper's Monthly Magazine**, 1860-1861. Useful detail on the gold rush in B.C. can be found in Sylvia Van Kirk, "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, 1992) pp. 21-37; "John Cameron," **Dictionary of Canadian Biography**, Vol. XI (Toronto, 1982), pp. 142-43; "William Barker," **Dictionary of Canadian Biography**, Vol. XII (Toronto, 1990), pp. 55-57; Morley Arthur Underwood, "Governor Douglas and the Miners, 1858-1859," BA essay, UBC, 1974;

Patricia Elizabeth Vaughan, "Cooperation and Resistance: Indian-European Relations on the Mining Frontier in British Columbia, 1835-1858," MA thesis, UBC, 1978; William J. Trimble, **The Mining Advance into the Inland Empire** (New York, 1972, reprint edition); and Gordon R. Elliott, **Barkerville Quesnel & the Cariboo Gold Rush**, second edition (Vancouver, 1978).

6 The graph is based on data from the **Annual Report of the Minister of Mines of British Columbia**, passim. Paul Phillips discusses the consequences of declining gold production in "Confederation and the Economy of British Columbia," in W. George Shelton, ed., **British Columbia & Confederation** (Victoria, 1967), pp. 43-65, esp. 47-49.

7 **British Columbia, The Mineral Province of Canada, being a Short History of Mining in the Province, a Synopsis of the Mining Laws in force, Statistics of Mineral Production to Date, and a Brief Summary of the Progress of Mining during 1906** (Victoria, 1907), p. 7.

8 **Annual Report of the Minister of Mines of British Columbia**, 1876, p. 419.

9 See "Return ... relative to the appointment of a Mining Engineer ...," British Columbia **Sessional Papers**, 1878, pp. 431-38.

10 **Annual Report of the Minister of Mines of British Columbia**, 1877, pp. 397 & 398.

11 Koch's "Report on the Cariboo Quartz Ledges," referred to in the following paragraph, includes a useful analysis of the failure of the quartz excitement. The figure of $100,000 is given in **Annual Report of the Minister of Mines**, 1878, p. 374.

12 **Annual Report of the Minister of Mines of British Columbia**, 1886, p. 195. The following year a similar hope is expressed: "it is confidently expected that substantial progress will be made during the coming season in the development and successful working of our quartz mines." (op. cit., 1887, p. 255.)

13 Mr. Koch, Mining Expert, "Report on the Cariboo Quartz Ledges," **Annual Report of the Minister of Mines**, 1886, pp. 215-24; "Report of Mr. Wm. Craib," ibid., p. 199; Amos Bowman, "Preliminary Report on Ores Collected and Quartz Localities Examined During Field Work of 1886, in Cariboo District," ibid., pp. 225-39.

14 "Cariboo," **Annual Report of the Minister of Mines**, 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**, 1888, pp. 293-94, and op. cit., 1889, pp. 275-76. The reference to its destruction by fire is in the **Report** for 1890, p. 361.

16 See **Annual Report of the Minister of Mines**, 1890, p. 361, and op. cit., 1892, p. 528; also, Mouat, "Early Cyanide Plants in British Columbia" (Technical Note), **CIM Bulletin**, Vol. 85, No. 959 (April 1992): 97.

17 **Annual Report of the Minister of Mines of British Columbia**, 1886, p. 209.

18 This graph is based on data from **British Columbia, The Mineral Province of Canada ...**, p. 18.

19 On the Hudson's Bay Company's interest in Kootenay minerals, see McLoughlin to Archibald Barclay (London secretary of the Hudson's Bay Company), 23 November 1844, **The Letters of John McLoughlin From Fort Vancouver to the Governor and Committee, Third Series, 1844-46**, edited by E. E. Rich (London, 1944), p. 62, & Jean Murray Cole, **Exile in the Wilderness: The Biography of Chief Factor Archibald McDonald** (Don Mills, 1979), p. 218. For Bauerman's comments, see his **Report on the Geology of the Country near the Forty-Ninth Parallel of North Latitude West of the Rocky Mountains. From Observations Made 1859 - 1861** (Montreal, 1884), p. 38 B (published with the **Report of Progress 1882-83-84** of the Geological Survey, Montreal, 1885).

20 G. M. Dawson, **Summary Reports of the Operations of the Geological Survey For the Years 1887 and 1888** (Montreal, 1889), p. 65 A. In a monograph written the following year, Dawson repeated this analysis: see George M. Dawson, **The Mineral Wealth of British Columbia** (Montreal, 1889), published with the **Annual Report**, (New Series) Vol. 3, Part 2, 1887-88, of the Geological Survey, especially pp. 14-15, 55, 59.

21 The impact of railway development on the Kootenays is described by Ronald Howard Meyer, "The Evolution of Railways in the Kootenays," MA thesis, UBC, 1970, and George A. Tripp, "Transportation and Lead Smelters in the Kootenays; A Reconsideration," BA essay, UBC, 1970. Tripp also discusses the role of water transportation, an important adjunct to the Kootenay railways; see also Edward Lloyd Affleck, **Sternwheelers, Sandbars and Switchbacks: A Chronicle of Steam Transportation in the British Columbia Waterways of the Columbia River System 1865 to 1965**, 2nd edition (Vancouver, 1973). Cole Harris provides a succinct overview of the province's transportation networks in his article "Moving Amid the Mountains, 1870-1930," **B.C. Studies**, 58 (Summer 1983): 3-39.

22 I have explored the issue of CPR control of B.C.'s mining industry in Mouat, "Creating a New Staple: Capital, Technology and Monopoly in B.C.'s Resource Sector, 1905-1925," **Journal of the Canadian Historical Association**, New Series, Vol. 1 (1990): 215-37.

23 A similar argument lay behind the agitation for a direct rail connection between the Kootenays and the Pacific coast, and lobbying efforts continued throughout the 1890s and early 1900s; see Patricia E. Roy, "Railways, Politicians, and the Development of Vancouver as a Metropolitan Centre, 1886-1929," MA thesis, University of Toronto, 1963, and Barrie Sanford, **McCulloch's Wonder: The Story of the Kettle Valley Railway** (West Vancouver, 1977).

24 "Reduction Works," **Victoria Daily Times**, 2 April 1886, p. 1; for the text of the act, see **Statutes of the Province of British Columbia ... 1886**, Ch. 18, p. 59.

25 For a full description see S. S. Fowler, "Early Smelters in British Columbia," **British Columbia Historical Quarterly**, Vol. 3 (1939): 183-201; also, Jay Morrison, "Vancouver's Pioneer Smelter," **British Columbia Historical News**, Vol. 20, No. 3 (Summer, 1987): 6-9.

26 For example, CPR president Van Horne wrote that "Referring to yours of the 9th October about Mr. Witherow's scheme [for the construction of a steel smelter in Vancouver], ... I understand that there is a good deal of local feeling at Vancouver in favour of this absurd enterprise. Can you not get the Vancouver newspapers to give it a kick in time? These things once fairly started with the people are sometimes difficult to head off." (Van Horne to Abbott, 18 October 1894, p. 713, M.G. 28, III, 20, microfilm reel 38, Van Horne Letterbook 47, CPR Records, National Archives of Canada [NAC].)

27 "It Is Vancouver: The Future Site of an Immense Busy Smelter," **Daily World**, 22 August 1896, p. 2. This article noted that the city of Vancouver "has a smelter committee composed of members of the Board of Trade and the City Council."

28 For the debate on the bill, see Canada **Debates**, Vol. II, 5 July 1895, pp. 3925-28, and 18 July 1895, pp. 4763-67; for the quotation, see Foster, 5 July 1895, pp. 3926-27. Laurier questioned Foster's sunny assessment of the consequences of the bill's passage but offered no opposition (ibid., p. 3928).

29 The best overview of this development is Fowler's "Early Smelters in British Columbia."

30 **The Canadian Mining Review**, Vol. 17, No. 6, June 1898, 169.

31 Charles St. Barbe, **The Kootenay Mines: A Sketch of the Their Progress and Condition Today** (Nelson, 1895), p. 11. Trail Creek was an early synonym for Rossland.

32 Harold Kingsmill, "Gold Regions of the West," **The Saturday Globe**, Toronto, 8 February 1896. J. W. McCarty's "British Investment in Overseas Mining, 1890-1914" (PhD thesis, Cambridge, 1961) discusses the relationship between the collapse of silver in the early 1890s and the subsequent stimulus to gold mining; see especially pp. 31-32.

33 Harold Kingsmill, **First History of Rossland With Sketches of Some of its Prominent Citizens, Firms and Corporations** (Rossland, 1897), p. 2.

34 The Columbia River, however, was not bridged until October 1897. Earlier, trains had crossed the river at Northport by ferry. Corbin extended his Spokane Falls and Northern Railway to Nelson in December 1893, as the Nelson and Fort Sheppard Railway; see John Fahey, Inland Empire: D. C. Corbin and Spokane (Seattle, 1965), pp. 161-165 & 123-141.

35 The **Spokesman-Review** (no date given), quoted in John R. Fahey, "The Retirement of Daniel Corbin," **The Pacific Northwesterner**, Vol. 7, #4 (Fall 1963), pp. 50-51.

36 For details of the Northport smelter, see **Annual Report of the Minister of Mines of British Columbia**, 1897, p. 539; **Canadian Mining Journal**, 16(1897): 28; British Columbia **Sessional Papers**, 1902; and Russell D. Bowers, "The LeRoi Mine and Smelter," **The Pacific Northwesterner**, 7(1963): 43-48.

37 For details of the struggle between Heinze and Corbin, see Fahey, **Inland Empire**, pp. 157-83, and Sarah McNelis, **Copper King At War: The Biography of F. Augustus Heinze** (Montana, 1968), pp. 23-28.
38 Tripp, "Transportation and Lead Smelters in the Kootenays," pp. 27-28, and Meyer, "The Evolution of Railways," pp. 109-10.
39 **Annual Report of the Canadian Pacific Railway Company, For the Fiscal Year Ending December 31st, 1897**, p. 6. For an excellent discussion of the corporate policies of the CPR during this period, see John A. Eagle, **The Canadian Pacific Railway and the Development of Western Canada, 1896-1914** (Kingston, Montreal, London, 1989), passim.
40 See Fahey, **Inland Empire**, pp. 188-89.
41 Meyer's thesis, "The Evolution of Railways," provides an excellent account of this competition; indeed his central argument is that intercompany rivalry rather than the international boundary was responsible for railway development in the Kootenays (pp. 115-120). As he points out, the rivalry between the two lines was an historical one, dating from the CPR's decision to build north of Lake Superior instead of opting for a southern route through the U.S., using Hill's railway (p. 105). Sanford's **McCulloch's Wonder** also chronicles the rivalry in British Columbia between the two companies.
42 Meyer, in "The Evolution of Railways," points out that "the railnet of the Kootenays should not be considered a single network, but rather two separate treelike networks each with its own system of flows ... [with] a minimum of overlap" (pp. 70-71).
43 The CPR controlled the Nakusp and Slocan Railway which linked Sandon to the Upper Arrow Lake and the CPR's steamers. The CPR's Columbia and Kootenay and Heinze's Columbia and Western between them connected Slocan City with Trail. For details of these connections, see Tripp, "Transportation and Lead Smelters in the Kootenays," passim. Turnbull's **Topping's Trail** gives a description of the inaugural run of the Crows Nest Pass line, pp. 42-43; this line did not become an all-rail route until the 1930s.
44 On Rossland's labour relations, see Mouat, "The Genesis of Western Exceptionalism: British Columbia's Hard Rock Miners, 1895-1903," **Canadian Historical Review**, Vol. 71, No. 3 (September 1990), esp. pp. 329-37. The **Annual Report of the Minister of Mines of British Columbia**, 1901, describes the inactivity at Trail: "The copper furnaces ... were only operated to any extent during the first six months of the year.... Only one lead furnace was run (there are three) during most of the year" (p. 1049).
45 Shaughnessy to Sir Richard Cartwright, 12 December 1901, pp. 2-3 (#353-54), MG 28, III, 20, microfilm reel M-3042, CPR Records, NAC.
46 For a description of the rise of Asarco, see James E. Fell, Jr., **Ores to Metals: The Rocky Mountain Smelting Industry** (Lincoln, 1979), pp. 221-54, and Isaac F. Marcosson, **Metal Magic: The Story of the American Smelting & Refining Company** (New York, 1949), passim. Christopher Schmitz's "The Rise of Big Business in the World Copper Industry 1870-1930" (**Economic History Review**, 2nd Series, XXXIX, 3

(1986): 392-410) provides an excellent analysis of the consolidations within the mining and metallurgical industries.

47 **Morang's Annual Register of Canadian Affairs**, 1901, p. 55. Years later, Aldridge claimed that he was responsible for the bounty: see the typescript interview of Aldridge by Howard Bayley (Cominco's Supervisor of Publicity), May 1954, p. 5 (copy of interview held in Cominco files, Rossland Historical Museum, Rossland).

48 **Ibid.**, p. 56. See also **British Columbia Mining Record**, Vol. VIII, June 1901, p. 175, and T. G. Blackstock to Laurier, 11 April 1901, Toronto, #55277, MG 26, G, Vol. 193, Laurier Papers, NAC.

49 Canada **Debates**, 1901, Vol. II, 21 May 1901, pp. 5716-5729.

50 Rumours of the smelter's sale to the Gooderham/Blackstock group were occasionally reported: see, for example, **Grand Forks Miner**, 19 August 1899, and **British Columbia Mining Record**, Vol. VIII, May 1901, pp. 169-70; also Eagle, **The Canadian Pacific Railway and the Development of Western Canada**, p. 240. As late as 1903, however, Aldridge was writing to Shaughnessy on the "Advantages of Trail Smelter to Railway" (Aldridge to Shaughnessy, 6 December 1903, Cominco Historical Files, Microfilm #8, BC Archives and Records Service [BCARS]).

51 The process is explained by its inventor, Anson G. Betts, in "Electrolytic Lead-Refining," **Transactions of the American Institute of Mining Engineers**, Vol. XXXIV, (1904): 175-184; and A. G. Wolf, "The Betts Process at Trail, B. C.," **Mines and Minerals**, August 1907, pp. 11-15. It is described in the context of traditional lead refining by Henry F. Collins, **The Metallurgy of Lead** (London, 1910), pp. 452-56, second edition. Both smelter and refinery processes are described by A. J. McNab, "Lead Smelting and Refining Practice at Trail, B.C.," **Journal of the Canadian Mining Institute**, Vol. XII (1909): 424-436, and in a form more intelligible to the non-expert, with pictures, by J. M. Turnbull, in "Trail Smelter and Lead Refinery," **Mines and Minerals**, September 1910, pp. 121-125. Turnbull, McNab and Betts all worked for the Canadian Smelting Works, although Betts' tenure was brief. He supervised the installation and early operation of the refinery. As Alexander Dow has pointed out, few historians or economists have appreciated the extent of innovation undertaken by Cominco and its antecedent company ("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), p. 215).

52 Wolf, "The Betts Process," p. 11; McNab, "Lead Smelting and Refining Practice at Trail," p. 424.

53 **Quarterly Bulletin of the Canadian Mining Institute** (Souvenir Number, Summer Excursion) January 1909, p. 172.

54 Tripp, "Transportation and Lead Smelters in the Kootenays," p. 84.

55 Tripp (op. cit., pp. 51-58) provides a good description of mix smelting as well as an excellent account of the Huntington-Heberlein process (pp. 82-85). Victoria's **Daily Colonist** published an eye witness account of the first application of the "Heberlein Process of Ore Roasting," 3

June 1905. (This was at the Marysville smelter.) See also W. H. Dennis, **A Hundred Years of Metallurgy** (Chicago, 1964), pp. 59-61.

56 Geological Survey of Canada, **Summary Report**, 1909, p. 29.

57 R. E. Commans, "Notes on Plant in the Mining Districts of Canada," **Transactions of the Institution of Mining and Metallurgy** (London), Vol. XVIII, 1908-1909, p. 190. See also William Frecheville and Hugh F. Marriott, "A Visit to the Mineral Districts of Canada," op. cit., pp. 158-78.

58 Sam Mavor, **Quarterly Bulletin of the Canadian Mining Institute** (Souvenir Number, Summer Excursion) January 1909, p. 306.

59 See John Spencer Church, "Mining Companies in the West Kootenay and Boundary Regions of British Columbia, 1890-1900, - Capital Formation and Financial Operations," MA thesis, UBC, 1961.

60 The purchase of the LeRoi by the British America Corporation has been described by a number of historians; the most accurate and detailed account is by Gordon T. German, "A Million Dollar Cheque," a nine page typescript, n.d., Add. Mss. 465, BCARS. See also Elsie G. Turnbull's "Rossland Camp," in **The Pacific Northwesterner**, 6(1962): 9-14 (reprinted in Dickson M. Falconer (ed.), **British Columbia: Patterns in Economic, Political and Cultural Development** (Victoria, 1982), pp. 96-104.) On the buy out generally, see Church, "Mining Companies in the West Kootenay," pp. 116-153 & 441-445.

61 **Annual Report of the Minister of Mines of British Columbia**, 1898, p. 1080. The reference here is to the Ainsworth mines, but Rossland's transition was identical.

62 **Ibid.**, p. 1092.

63 The B.C. Minister of Mines reported Carlyle's appointment as Provincial Mineralogist in a letter dated 10 March 1896 (**Annual Report of the Minister of Mines of British Columbia**, 1895, p. 643), although it had been discussed publicly for almost a year (see, for example, the **Canadian Mining Review**, Vol. XIV, June 1895, p. 100. Carlyle left Rossland to take charge of the Rio Tinto mines in Spain (**The Journal of the Canadian Mining Institute**, Vol III, 1900: 164) and later occupied the Chair of Metallurgy at the Royal School of Mines in London (**Transactions of the Institution of Mining and Metallurgy**, Vol. XVIII, 1908-09: 323). Carlyle had briefly returned to Rossland in the first months of 1908, to prepare a report on the LeRoi mine (Directors' Report, LeRoi Mining Co., dated 8 January 1909, copy in Mining Reports, 1907-8, K-M, Guildhall Library, London).

64 This graph is based on data from the **Annual Reports of the Minister of Mines of British Columbia**, passim.

65 Edmund Kirby, quoted in **Annual Report of the Minister of Mines of British Columbia**, 1903, p. 16.

66 For example, an article in 1898 described "the low grade ore problem" in Rossland: "The poor ore which is sorted out and thrown over the tip is a rapidly augmenting quantity, having a certain value, say from $7 to $10 per ton, and it will be a strange thing if some system is not one day devised that will treat all this refuse profitably." ("British Columbia

Mining" "A Review of the Present Condition of the Industry, Its Prospects and Possibilities," **Daily Colonist**, 28 July 1898, p. 7.)

67 **Annual Report of the Minister of Mines of British Columbia**, 1903, p. 151. See also the **Annual Report** for 1902, p. 166.

68 For descriptions of the various mills, see the **Annual Report of the Minister of Mines of British Columbia**, 1903, pp. 151-55, and R. W. Brock's comments, "Preliminary Report on the Rossland Mining District," **British Columbia Mining Record**, Vol. 13, June 1906, pp. 234-37.

69 In a report dated 22 November 1904, consulting engineers for the LeRoi No. 2 described the trial with the Elmore, or bulk oil, process. Although the process was technically successful, the low grade of the mine tailings being treated, as well as the cost of the oil, rendered it uneconomical and forced the mine's management to abandon it. (A copy of the report can be found in the LeRoi No 2 corporate records, in the Guildhall Library (London), Mining Reports, 1903-4, J-L; it is also discussed in **Engineering and Mining Journal**, 19 January 1905, Vol. 79, p. 160.) For additional detail, see H. H. Claudet, "A Pioneer Flotation Process," **Western Miner and Oil Review**, Vol. 27 (May 1954): 35-37; **Annual Report of the Minister of Mines of British Columbia**, 1903, pp. 151-53; and **British Columbia Mining Record**, Vol. 10-11, 1903-04, passim. The latter journal reported the discontinuing of the process, Vol. 12, January 1905, p. 25.

70 **Annual Report of the Minister of Mines of British Columbia**, 1903, p. 15.

71 **British Columbia Mining Record**, January 1905, p. 24. The year-end review was followed by an article on "Milling and Concentration in Rossland Camp," ibid., pp. 26-27.

72 "Rossland Depends on Concentration," **Daily Province**, 21 January 1905, p. 15.

73 For example: **The Daily Colonist**, 21 & 28 April & 7, 10 & 18 May 1905; **British Columbia Mining Record**, April, (pp. 128-30), May (p. 165) & June (pp. 208-09) 1905; **The Gazette** (Montreal), 22 May 1905, p. 5; **The Monetary Times** (Toronto), 30 June 1905, p. 1758; **The Engineering and Mining Journal** (New York) 23 March 1905, pp. 571-72, & 25 May 1905, p. 1017; & **Mining and Scientific Press** (San Francisco), 13 May 1905, pp. 309-10.

74 **The Daily Colonist**, 10 May 1905, p. 2; cf. 21 & 28 April & 7, 18 & 19 May. **The Engineering and Mining Journal** (25 May 1905, p. 1017) described the proposed amalgamation as "his [i.e., Waterlow's] amalgamation scheme."

75 Blackstock's "largest interest was mining," according to his obituary, and he was probably loath to abandon it. Details on his disinclination to sell, and the purchase generally, are from the 9 August 1906 memorandum by Hal Osler, the lawyer who negotiated the sale on behalf of the CPR interests (a copy of this document is preserved in the Cominco Historical Files, Microfilm Reel #8, BCARS). The War Eagle/Centre Star had been run as one property, with identical managers and directors,

since 1898; the two mines were formally consolidated into one company in November 1905. The Rossland Power Company was the unsuccessful concentrator intended to treat War Eagle/Centre Star ore. The St. Eugene was a silver lead property in Moyie, East Kootenay, on the Crows Nest Pass rail line. The collective paper capitalization of the three companies was some nine million dollars, considerably higher than the $825,000 purchase price. (**The Engineering and Mining Journal**, 15 July 1905, p. 84.)

76 For details see St. Eugene Consolidated Mining Co., Ltd., Directors' Minutebook, p. 72, held in French's Complex Ore Reduction Co. Papers, BCARS; also **British Columbia Mining Record**, January 1906, p. 5.

77 **British Columbia Mining Record**, March 1906, p. 119.

78 See, for ex., **British Columbia Mining Record**, November 1907, pp. 428-29; **The Canadian Mining Journal**, Vol. 28, 1907, p. 117. The latter journal noted that "one laudable feature" accomplished by the creation of Cominco was "the straining off of a considerable quantity of 'water' from the capital of the combined interests." (Cominco's initial capitalization was just under five million, whereas the value of the companies which formed Cominco had been over ten million.)

79 For statistics on Cominco's share of the dividends produced by B.C. mining companies, see the table compiled by the Department of Mines in 1941: "Table XVII. – Dividends Paid By Mining Companies, 1897-1941," **Annual Report of the Minister of Mines of British Columbia**, 1941, pp. 18-20. The quotation is from R. J. W. Douglas, ed., **Geology and Economic Minerals of Canada** (Ottawa: Department of Energy, Mines and Resources, 1970), p. 504. There is no thorough history of the company, but see Mouat, "Mining in the Settler Dominions: A Comparative Study of the Industry in Three Communities from the 1880s to the First World War," PhD thesis, UBC, 1988, especially Chapter 4, "The Emergence and Growth of Cominco."

80 For a description of these developments, see Logan W. Hovis, "The Origins of 'Modern Mining' in the Western Cordillera, 1880-1930," unpublished paper, presented to BC Studies Conference, Victoria, 1986, and Mouat, "Creating a New Staple."

81 Cole Harris, "The Fraser Canyon Encountered," **BC Studies**, No. 94 (Summer 1992): 6.