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TRANSFER AND DEVELOPMENT OF COAL-MINE TECHNOLOGY IN HOKKAIDO

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This paper is being circulated in a pre-publication form to elicit comments from readers and generate dialogue on the subject at this stage of the research.

CONTENTS

INTRODUCTION

The development of coal mining in underdeveloped Hokkaido started at the end of the Tokugawa period. From the Meiji Restoration (1868) onward, the new government, under its policy of nurturing capitalism, pursued full-scale development and promoted the introduction of foreign technology. The development of coal mining in Hokkaido — unlike in other parts of Japan such as at Miike and Chikuhō in Kyushu — presented considerable problems. Firstly, while there was an accumulation of endogenous coal-mining technology at Miike and Chikuhō, it was totally nonexistent in the Hokkaido mines. Secondly, in view of the fact that Hokkaido was underdeveloped, transport facilities for coal were so poor that transportation means such as railways and harbours had to be specially built before coal mining could be developed. Thirdly, because there was no industry other than the fishing industry when coal mining began in Hokkaido, a market for coal did not yet exist there. Thus most of the coal had to be shipped out to distant places outside Hokkaido at high cost. Fourthly, it was difficult to recruit coal miners in Hokkaido because there was virtually no surplus agricultural labour due to a scarce farming population working on vast uncultivated land. Thus, the scarcity of labour presented a serious problem not met in other areas.

The objective of this paper is to examine Hokkaido coal mining from two aspects, first, the introduction, implantation, and development of technology, and second, the labour force and the transformation of labour organizations.

I. THE INTRODUCTION OF FOREIGN TECHNOLOGY

1. Early Hokkaido Coal Mining and Its Pioneers

Owing to the development of coastal fishing in Hokkaido in the latter half of the eighteenth century, the existence of coal in the Kushiro and Shiranuka areas was known to fishermen. However, the development of coal mining in Hokkaido was not initiated until the 1850s, the late Tokugawa period. The development was triggered as a result of the opening of Hakodate port to foreigners, which necessitated a supply of fuel for foreign steamships. Therefore, the circumstances of the development of Hokkaido coal mining undertaken by the Tokugawa shogunate will be touched upon first.

The shogunate established the Hakodate magistrate's Office in 1854 and assigned it the task of surveying the coal deposits in Hokkaido. (This survey was limited to the coastal areas due to the difficulty of investigating the interior.) Based upon the results of this survey, the shogunate decided upon government control and the excavation of the Shiranuka coal mine in 1856 (see figure 1). In the following year, Zempachi Kurihara, an official in charge of coal at the Hakodate Magistrate's Office, ordered four coal miners whom he had sent from Edo, modern Tokyo, (originally they were from Yanagawa, Kyushu) to begin extracting coal. Hakodate prison labour and Ainu (native people of Hokkaido) labourers were also used.

This early excavation and coal extraction work had the following features. There were two portals, each of which led to an adit with a height and width of approximately 1.8 metres that was excavated horizontally from the side of the mountain with the use of mandrils, gravers, and crowbars. Each adit had galleries to the right and left at a depth of about 18 metres from one portal and about 15 metres from the other portal. Pit wood was used to prop

up the ceiling in order to prevent cave-ins. Metal hand lamps were used in the adits, and it is believed that a safety lamp was used in some sections.

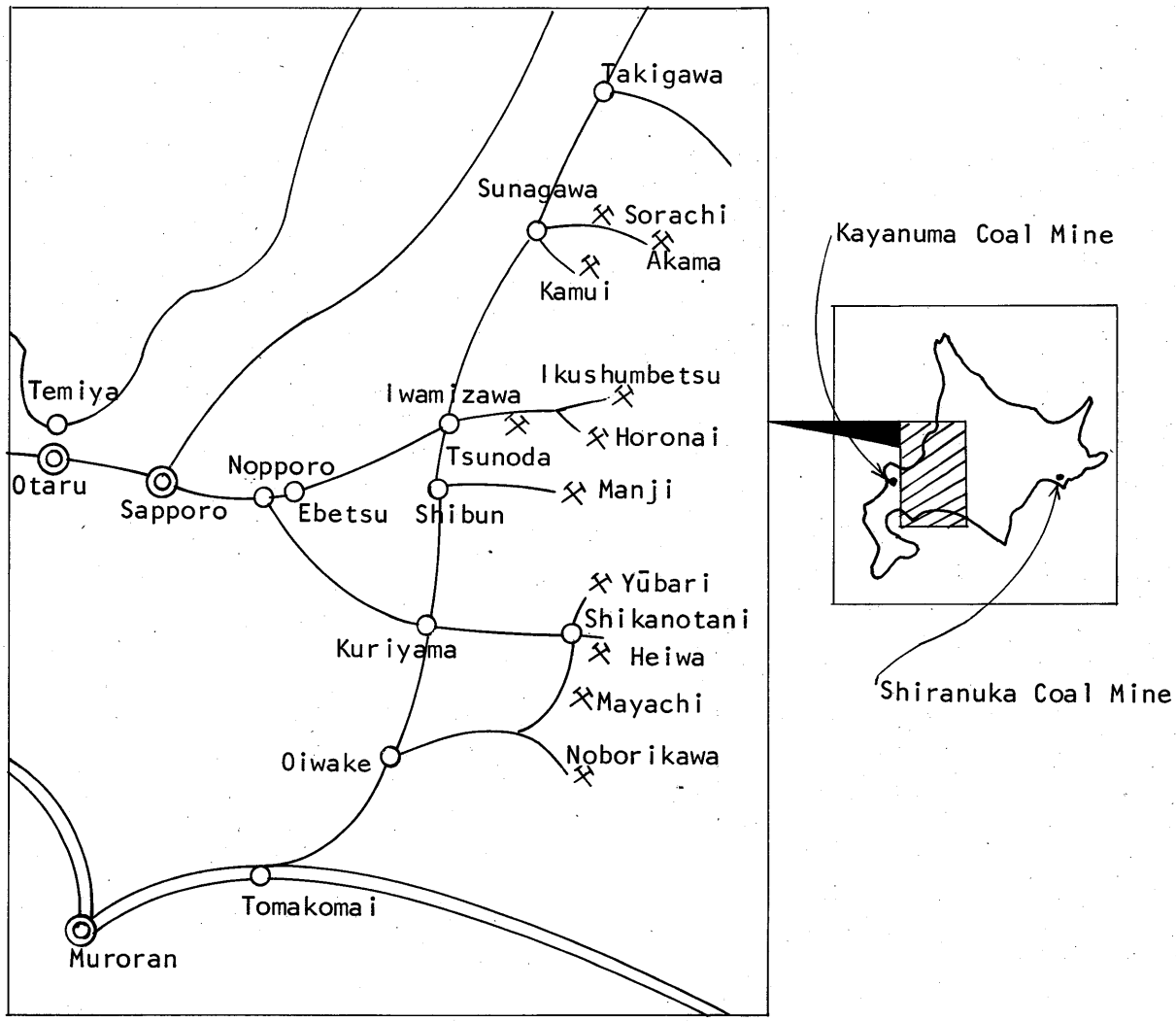

FIG. 1. The Location of Coal Mines in Hokkaido

As can be seen from this, there was more to extraction technology at this mine than primitive badger burrowing methods. It can be assumed that the coal extraction technology of the Kyushu region was fully utilized here too. The amount of coal extracted in a period of eleven months was about 865 tons, all of which was sent to Hakodate as fuel for foreign ships. This coal was not only inferior in quality, but also turned into coal dust during long-distance shipment. When the coal was selected according to grade, the cost was so expensive that it resulted in a loss. Consequently, when the full-

scale development of the Kayanuma coal mine started in 1864, coal extraction at the Shiranuka coal mine was stopped and all the miners were transferred to Kayanuma.

Instead of Shiranuka, the Hakodate Magistrate's Office came to concentrate on the development of the Kayanuma coal mine, which was discovered by a fisherman in 1856. The reasons for the switch were that Kayanuma was close to Hakodate and the quality of its coal was good. The year after the discovery, the Hakodate Magistrate's Office sent officials to begin extraction. It is said that subsequently this coal mine had an annual output of about one hundred straw bags full of coal. But after the cave-in of an adit in 1860, when coal extraction was stopped temporarily, the mine functioned only sporadically. This situation lasted until the Meiji Restoration, when it became clear that the mine was unprofitable due to expensive costs entailed in such items as coal transport. In the interim, however, attempts were made to develop this mine into the first Western-style coal mine in Japan with the successive introduction of government-employed foreign engineers. First of all, R. Pumpelly, an American geologist and mine engineer, and W.P. Blake, a mining scientist and mine engineer, undertook a geological survey of the Kayanuma coal mine in 1862, at a time when operations had been suspended. In July of the same year, they established a miners' school in Hakodate and taught mining science to the Japanese.[1] Among the students were such people as Takatō Ōshima, Yōzō Yamao and Hisaburō Takeda, who became the pioneers of the modernization of mining in Japan. In 1867, E.H.M. Gower, a government-employed British engineer, was sent to the Kayanuma coalmine and made an attempt to restore its operation. (In view of the fact that the geological survey conducted by Blake had revealed that the quality of Kayanuma coal was good, full-scale extraction had been started in 1864 under the leadership of Takatō Ōshima, who employed eight miners and fifteen labourers transferred from the Shiranuka coal mine. Nevertheless the operation proved to be unprofitable as Kayanuma coal was 50 per cent more expensive than the average market price of coal in Nagasaki. Thus extraction had been again discontinued.) In order to restore the mine, Gower first of all built a road from the mine to the coast (for horse-cart transport) and increased the number of pitmen. (Initially five pitmen and later seven pitmen were added from the Shiwatari mine.) At this stage,

however, mechanization both inside and outside the mine remained untouched, and the output for that year was again no more than 100 tons.

As seen above, coal mining in Hokkaido was initiated at the end of the Tokugawa period. Despite the fact that not only advanced endogenous technology but also foreign technology was introduced to Hokkaido coal mining at an early stage, the pace of development was not smooth. The difficulties were caused by the lack of a neighbouring market and an insufficient transportation system due to the underdeveloped state of Hokkaido. The new Meiji government set itself the task of overcoming these difficulties in order to establish the foundation of Hokkaido coal mining through a comprehensive development plan.

The Meiji government, which was established after the overthrow of the Tokugawa regime, was intent on developing Hokkaido, which had an abundance of resources but was as yet underdeveloped, in order to promote capitalism "from the top." One of its major tasks was mine development. The methods employed by the government (in the form of the Land Development Bureau) can be summarized by the following four points: firstly, to employ and utilize positively Japanese engineers who had acquired a knowledge of coal-mine technology; secondly, to introduce foreign engineers; thirdly, to acquire modern technology and knowledge by sending students abroad; fourthly, to spread mining technology through school education. A typical example of an experienced Japanese engineer was Takeaki Enomoto. He had studied chemistry as well as steam-engine technology at the Tokugawa government's naval school in Nagasaki (between 1856 and 1858). He also studied in Holland (from 1862 to 1867), his subjects being artillery, steam engines, navigation, and, more especially, the subjects required for mine development such as chemistry and mining science. It is said that the reason the new Meiji government appointed Enomoto, who was one of the Tokugawa vassals, as an official of the Hokkaido Development Bureau was because of his technological knowledge. After the Meiji Restoration, Enomoto contributed greatly to the development of Hokkaido coal mining as he was able to put to use his mine development technology. He was not only the first person to survey the interior of the Horonai coalfield, but he was also the first to formulate a full-scale analysis chart of coal.[2] Besides Enomoto, such former Tokugawa officials

as Ikunosuke Arai, who became the principal of the Provisional School of the Development Bureau, and the aforementioned Takatō Ōshima and Hisaburō Takeda were all positively employed by the new Meiji government and played various roles in the development of Hokkaido coal mining.

The foreign engineers who were introduced by the government comprised the second group; they were the principal pioneers in the development of Hokkaido coal mining. The foundations of coal mining in Hokkaido were established through them. Horace Capron, in particular, was the first of these foreign engineers. At the request of the Meiji government, Capron, who was the former Secretary of Agriculture in the United States, came to Japan in 1871 with Thomas Antisell, a chemical engineer, A.G. Warfield, a civil engineering surveyer, and Stuart Eldridge, a medical doctor. In the following year, he began the development of Hokkaido under the title of adviser and chairman of the Hokkaido Land Development Bureau (post relinquished in 1875). A report concerning the geological survey submitted by Blake was an important reference for Capron when he carried out mine development. He had two assistants, A.G. Warfield, who conducted a land survey, and Thomas Antisell, who conducted a geological survey. In the following year, 1873, Benjamin S. Lyman (whose work had considerable impact) and a student of his, Henry S. Munroe, conducted a geological survey of all Hokkaido. Lyman came to Japan to take up the position occupied by Antisell who was dismissed as a result of a conflict with Capron. He conducted a survey beginning in 1873 which covered all of Hokkaido in two years. The Horonai area, in particular, was surveyed sev eral times. There is no doubt that this survey activity and its results laid the basis of Hokkaido coal mining. (This will be discussed later.)

Following Lyman, such foreign engineers as L.C.E. Goujot and Joseph U. Crawford, American mining engineers; Edward Parry, a British chief mine excavator; and Joseph H. Dauss, an American mining foreman, were employed in succession. The development of the Horonai coal mine and the improvement of the Kayanuma coal mine were pursued under their leadership. (See table 1 for a list of government-employed foreign engineers who either directly or indirectly helped in the development of coal mining.) As can be seen, the foundation of Hokkaido coal mining can be said to have been established

TABLE 1. Government-employed Foreign Engineers Involved in the Development of Hokkaido Coal Mining

Name	Work undertaken in Japan	Appointed Year
W.P. Blake	Geological survey of the Kayanuma coalfield.	1862
R. Pumpelly	- ditto -	1862
E.H.M. Gower	Re-excavation of the Kayanuma coal mine and railway installation.	1867
James Scott	- ditto -	1869
Thomas Antisell	Extraction at the Kayanuma coal mine and technical instruction.	1871
A.G. Warfield	Surveying instruction.	1871
Horace Capron	Adviser and chairman of the Hokkaido Development Bureau.	1871
B.S. Lyman	Geological survey of coalfields in Hokkaido.	1873
H.S. Munroe	- ditto -	1873
L.C.E. Goujot	Improvement and excavation guidance at Kayanuma and Horonai mines.	1879
J.U. Crawford	Railway installation.	1879
Edward Parry	Excavation and extraction guidance at the Horonai coal-mine.	1879
Ghent	Survey of Kayanuma pier, and survey and map-making of the Ishikari River area.	1879
Joseph H. Dauss	Excavation guidance at the Horonai coal mine.	1879
J.R. Wasson	Survey instruction.	1872
M.S. Day	- ditto -	1873
D.P. Penhallow	Chemical analysis of coal at Sapporo Agricultural School.	1876
F.A. Potter	Inspected Kayanuma and Horonai mines and gave instruction in excavation methods.	(1881)*
John Chambers	Inspected Kayanuma and Horonai mines.	(1881)

* Years within parentheses indicate the year of inspection.

by means of foreign engineers, especially American engineers. This does not imply that their contribution was simply directed toward mine development; what was more important was technological diffusion. In other words, Japanese assistants to these foreign engineers acquired a knowledge of modern technology through experience. The most representative example is

the case of thirteen assistants who accompanied Lyman's geological survey. Most of them were students at the Provisional School of the Development Bureau (this will be discussed later). They studied theory at the school, and then they acquired actual geological surveying skills while accompanying Lyman on his Hokkaido survey. It is said that Lyman himself tried to make his assistants acquire there skills. In 1878, they formed the Geological Society and held study meetings every other Saturday. They not only studied Western books and translated books on geology, but also published a monthly entitled *Chigaku zasshi* (Geological magazine) (nos. 1 - 16) from January 1879. The magazine contained translations of Western books and reports of geological surveys. Even though Lyman's guidance existed, the above activities prove that the assistants had absorbed the theories thereby acquiring enough competence to conduct their own surveys. Upon Lyman's return to his own country, they became the central personnel in the development of Hokkaido coal mining. In addition, such people as Jun'ichi Shimada and Tetsunosuke Inagaki subsequently played key roles in the development of coal mining in Kyushu. Shimada became director of Mitsui Miike coal mine and, after that, director of Mitsui Yamano coal mine. Inagaki was appointed to an executive of Meiji Mining Co. (See table 2 for a resume of Lyman's thirteen assistants.) Regarding the triangular survey method, Ikunosuke Arai and other Japanese acquired the method and related skills from Warfield and his successor, James R. Wasson, as well as from Murry S. Day, Wasson's assistant. The introduction of foreign engineers thus meant the acquisition of modern technology for the Japanese assistants. In addition, these students became the leading pioneers of the development of Hokkaido coal mining.

Kiyotaka Kuroda, Director of the Development Bureau, was one of the first to study abroad. Six engineers accompanied Kuroda's mission to inspect conditions in Europe and the United States in January 1871 and stayed on to study abroad. (One of them six was Keisuke Ōtori, who later taught at the Development Bureau School and played an important role in the final decision making of the development of the Horonai coal mine.) These six were the first Japanese to study in various fields abroad including agriculture, mining science, and engineering. Subsequently thirty-three more students were sent by the Development Bureau, twenty-four to the United States, six to Russia, and three to France. That the Development Bureau

TABLE 2. A Brief Resumè of Lyman's Pupils

Name	Background	Year of birth	A Brief resumé of Later Years
Tokusaburō Yamauchi	Former Tokugawa government official	1846	Official in charge of mine opening at the Development Bureau, Coal-mine section chief of the Ministry of Agriculture and Commerce. Manager of Horonai branch office of Hokkaido Prefectural Government. Acting director of the mining bureau of the Ministry of Agriculture and Commerce.
Tetsunosuke Inagaki	Samurai from the Toba fief	1852	Executive of Meiji Mining Co., Ltd.
Teiichi Kada	Samurai from the Toyoura fief, Nagoto Province	1850	
Tomoaki Kuwata	Samurai from the Shibata fief, Echigo Province	1847	Surveyed Ikushunbetsu coalfield. Managed the Akiyama pit at Jōban coalfield.
Jun'ichi Shimada	Samurai from the Yamaguchi fief	1852	Surveyed Ikushunbetsu coalfield. Drew up a geological map of Chikuhō coalfield. Director of the Miike coal-mine and then the Yamano coal mine of Mitsui Mining.
Jōzō Takahashi	Former Tokugawa government official	1853	The mining bureau of the Ministry of Agriculture and Commerce. Vice-manager of Sumitomo's Besshi mining office. Director of Sumitomo's Tadakuma coal mine.
Shōgo Nishiyama	Samurai from the Ueda fief	1852	Opened the Nishiyama pit, which was made part of Mitsui's Sunagawa mining district. Director of Sapporo Mining Supervisory Office.
Ichitaro Ban	Samurai from the Ōgaki fief	1854	Discovered Yūbari coalfield. Opened the pit of the Kami Utashinai coal mine. Founded Ban Coal Mining Co. Ltd., and then joined Hokutan.
Masaaki Maeda	Samurai from the Matsushiro fief	1854	Joined Hokutan.
Eigo Yamagiwa	Samurai from the Aizu fief	1853	Surveyed Ikushunbetsu coalfield with Shimada. Executive of Iriyama Coal Extraction Co., Ltd.
Shijō Misawa	Unknown	Unknown	Retired from government office in 1877 due to illness at a young age.
Yoshimaru Akiyama	Unknown	Unknown	Died in 1886.
Takeji Saitō	Unknown	Unknown	Retired in 1876 due to illness.

was keen not only on agriculture but also on mine development can be seen from the fact that fourteen students were sent to study agriculture, eight to study mining, and two to study engineering.[3] The outcome is clearly pointed out in the report written by Keisuke Otori contained in *Sekitan hen*, a work on coal mining published in 1874. Ōtori described the methods of modern coal-mine development technology (pit excavation, coal extraction, transport, drainage, ventilation, etc.) in simple language in his report, indicating that he had acquired the relevant technological knowledge.

The first school for the education of engineers was the Provisional School of the Development Bureau, which was founded in April 1872 at the request of Kuroda in the compound of the Zōjō-ji temple, Shiba, Tokyo (50 students). Although this school was closed down for a while, it was started again in Hokkaido in September 1876 and was renamed the Sapporo Agricultural School. The initial aim of the school was to train engineers in such fields as analytics, mining science, architecture, and agriculture. The lecturers consisted of government-employed foreigners such as Capron and Lyman, Japanese who had acquired a knowledge of modern technology by studying abroad such as Keisuke Ōtori, and those ex-retainers of the Tokugawa regime who possessed relevant technological knowledge, for example, Ikunosuke Arai. They taught fundamental principles, and the students also acquired practical skills through actual surveying.

Owing to the several effecs of the above-mentioned various methods, it can be said that by the latter half of the 1880s modern Western coal-mine development technology had been implanted among the assistants of government-employed foreigners, students who studied abroad, and the graduates of the Development Bureau School. To put it differently, there was no foreign mining engineer who was employed by the Development Bureau for more than five years. At the time of the sale of the Horonai coal mine to a civilian concern (1889) there was not a single foreign mining engineer. This fact reveals that the Japanese had already acquired the necessary knowledge and technology while the foreign engineers were in Japan.

The actual conditions of the development of coal mining in Hokkaido after the Meiji Restoration will be examined in the following section.

2. The Kayanuma Coal Mine

(1) Foreign Technology

The Meiji government, which acquired the Kayanuma coal mine from the Tokugawa regime, began coal extraction at this mine in 1869 once the civil war had subsided. Gower and his assistant, James Scott, who were employed by the shogunate, remained to continue working at the mine. They first concentrated on the implementation of transportation facilities. They introduced the manual wheelbarrow to be used in the mine. As for coal transport outside the mine, tracks with a width of 80 centimetres were installed from the portal to the coast, an approximate distance of two kilometres. A four-ton coal cart pulled by oxen was used. The parts for the train were initially purchased from the West. However, it was reported that "now that blacksmiths are capable of newly manufacturing as well as repairing the coal cart, it can be managed without relying upon foreigners." As can be seen from this passage, Japanese craftsmen soon learned how to produce the coal cart and began supplying the product. In contrast to the transportation system, the structure in the mine still remained the same as ever. Although blast powder was used for the excavation of pits, the height and width were 1.8 metres each and the condition was such that it was described as being "similar to a honeycomb with many pits going up and down as well as to the right and left." This must have happened because improvements to the mine were delayed because of the emphasis placed upon the means of transport. The fact that improvements in the mine were later steadily introduced becomes apparent when conditions in the Kayanuma coal mine at that time are compared to those described in a report compiled by Takeaki Enomoto, when he inspected the mine is 1872. (Enomoto's report provided excellent material on the conditions of the Kayanuma coal mine at that time.) Let us thus see in more detail the conditions prevailing at this mine based upon his report.

As far as the pits are concerned, it is explained in the report that most of the old pits had been abandoned and new pits were excavated in accordance with the plan drawn up by Scott. The newly excavated portals consisted of a "main pit," an "annexed pit," and a "drainage pit." The portal of the main pit was located about 110 metres above sea level and the main gallery, with a height of 3.6 metres and a width of 2.7 metres, was dug horizontally towards

the coal vein in the mountain and was about 168 metres in length. Adits to the right and left were dug from the main gallery (to the right at a spot about 9 metres from the portal and to the left at a spot about 67 metres from the portal), and the coal-faces were set there. The ceiling and both sides of the pit were solidified with the use of square timber, and cave-ins at the extraction points were prevented by "stacking up stone plates." The annexed pit was excavated in order to extract coal from the upper part of the same coal vein, while the drainage pit was excavated for water drainage from the main pit. (The latter was being revived as an extraction pit due to the discovery of a coal vein.)

According to Enomoto, there were three types of extraction tools, namely, powder, the mandril, and the Chinese hoe, of which powder was the most often used. The use of powder at this period was a distinctive characteristic of this mine and was related to the transfer of foreign technology by government-employed foreigners as well as to the miners of the Kayanuma coal mine, who had had previous experience working at metal mines in Sado, the Nambu region, and Akita. Powder was used not only for the excavation of the pit, but also as the main method for coal extraction. The use of powder at this period, however, was different from the blasting coal-extraction method. The powder caused the mine to deteriorate, as it was set without making slits at the top and bottom or to the right and left. Enomoto criticized this kind of powder usage by the miners:

> Believing that coal extraction is the same as copper extraction, and, in addition, without paying attention to the largeness or smallness of the coal lumps or to the sections mixed with dirt and rocks, the miners set the powder and blast it at random, irrespective of the coal bed, so that they can simply compete for the greatest output. Thus a weak section disintegrates into powder while the section mixed with dirt and rocks remains in large lumps.

As for lighting in the mine, "striped bamboo," a native plant growing in the vicinity, was used. The bamboo was dried and then cut into sticks 70 to 80 centimetres long. Three to four sticks were bundled together and lit. Enomoto also pointed out the danger of such a method.

With regard to the method of coal transportation in the mine, a tunnel was

dug from the coal face to an adit (or to the main gallery). Coal was shoved down through the tunnel to the adit and then it was transported outside with the use of a manual wheelbarrow. Coal transportation outside the mine was on a sharp incline and was effected by a one-ton train on a single track. A descending train which was loaded was made to pull up an empty train. A four-ton train was used on flat land, which was not too different from previous times. Drainage was entirely dependent upon natural flow and there was no device specifically designed for ventilation.

As seen above, although the Kayanuma coal mine was in the process of being transformed into a modern coal mine under the leadership of government-employed foreigners, it can be said that the mine at this stage was in a condition where old and new facilities coexisted.[4] A massive amount of initial investment was required in order to transform these conditions and bring about a fundamental improvement of the mine. Furthermore, a comprehensive survey regarding the quality of coal and the deposits available was indispensible in order to ascertain whether or not such improvement should be pursued. Consequently, the mine was actively inspected and surveyed by Antisell, Lyman, Keisuke Ōtori, etc., from around the time of Enomoto's inspection tour, and opinions for improvement were submitted (see table 3). On the basis of Keisuke Ōtori's inspection report written in 1875, the government planned a development plan for the Horonai coal mine as well as an improvement plan for the Kayanuma coal mine. The government decided to allocate an expenditure of ¥170,000 in 1877 for the improvement of the transport and port facilities of the Kayanuma coal mine.

In 1879, an American engineer, L.C.E. Goujot, and a British foreman, Edward Parry, were invited to lead the improvement of the Kayanuma coal-mine, and thus Western coal extraction technology came to be introduce on a large scale. Having surveyed the Kayanuma coal mine, Goujot submitted a proposal for improvement under seven headings: (a) coal bed, (b) coal vein, (c) coal mine, (d) repairing the old pits, (e) new projects, (f) coal quality, and (g) coal transport. In his proposal, he first of all pointed out that it was necessary to excavate the pits both vertically and horizontally due to a complex and sharply inclined coal bed. He also stated that "although several pits are excavated along the outcrop or above the natural drainage level, it is

TABLE 3. A Brief Chronology of the Kayanuma Coal Mine

Date		Item
	1867	The shogunate reopens the mine.
	1868	Comes under the jurisdiction of the Hakodate Court, Production Office.
Aug.	1869	Comes under the jurisdiction of the Development Bureau.
Aug.	1871	Thomas Antisell, a government-employed American, submits his opinions on the improvement of excavation and extraction.
Aug.	1872	Comes under the jurisdiction of the Sapporo Municipal Office, Accounting Office. Coal transport comes under the jurisdiction of the Hakodate Produce Office.
Apr.	1873	Two Americans, Lyman and Munroe, his assistant, arrive in Hokkaido.
Dec.	1873	Lyman and Munroe submit a proposal for improvement.
Apr.	1874	Lyman writes a report on the coalfields in Hokkaido.
May	1875	Keisuke Ōtori submits an inspection report on Horonai and Kayanuma.
May	1875	The Mine Office changed to the Iwanai Extension Office.*
July	1875	Lyman presents proposals for improvement.
Apr.	1876	The Iwanai Extension Office renamed the Iwanai Branch Office.
July	1876	Comes under the jurisdiction of the Development Bureau, Produce Office.
Sept.	1876	Lyman submits a report on coal quality and the available deposits.
Dec.	1877	An estimate of the improvement cost compiled.
Mar.	1878	Improvement cost approved.
Mar.	1879	Goujot, a government-employed American miner, and Parry, a government-employed British miner, sent to the mine.
Sept.	1879	The Coal Mining Office changed to the Coal Extraction Office.
June	1881	Potter, a government-employed British engineer inspects the mine and gives instructions.
July	1881	Yōzō Yamao and J. Chambers inspect the mine.

* The Kayanuma coalfield was called for a time the Iwanai coalfield.

not possible to transport the extracted coal to a distant place with the use of a wheelbarrow, and in addition because there is no means of ventilation into the pit they cannot excavate in depth and thus [must] abandon the pit halfway." This statement reveals that the technology of coal extraction

at depth had not yet been acquired. In order to improve this situation, he insisted that the facilities of the main gallery be improved so that adits along each coal bed with a ventilation pit piercing through them could be excavated. Furthermore, he stated that it was necessary to install rails in the main gallery and in the adits along the coal bed for carts pulled by horses. He also called for the installation outside the mine of selecting machines ("shifters" and "screeners"), and he proposed that a railway between Kayanuma and Shibui port be installed. According to his plan, all these improvements were to be completed in three years' time, and, as a result it was estimated that 75,000 to 100,000 tons of coal could be produced annually at a cost of less than one yen per ton. Moreover, he suggested that an embankment be built in Shibui Bay so that the safety of Chazunai Bay could be secured.

Goujot pursued the improvement of the Kayanuma coal mine in accordance with this plan. (Refer to table 4 for the subsequent conditions of excavation.) As a result, vertical pits were excavated for the first time in Hokkaido coal mines and "manual fans," "wooden fans," and "ventilators" were installed. Miners' huts and an iron factory for the production of coal carts were built. Furthermore, the safety lamp was introduced in 1879. In the following year, a cylinder was installed in the ventilation pit which brought about the use of a steam engine. In addition, a simple selector was installed in 1881. In spite of the modernization of various facilities in the pit, a massive amount of gas was produced in the pit. Additionally, there were many jumps in the coal bed, and the deposits were much less than estimated. In consequence, output did not reach the planned amount (see table 5). The states control of the mine was discontinued in 1882, and the mine was sold to a civilian concern.

(2) The Procurement and Organization of Labour

In general, labour shortage becomes a problem in the germinating stage of capitalism. The procurement of labour was an even more difficult task in Hokkaido, which was underdeveloped. Thus it is said that the Kayanuma coal mine at the end of the Tokugawa period had to rely upon the Ainu people and prison labour. Together with the progress in development subsequently made, the labour demand increased. However, only little of the situation surround-

TABLE 4. Excavation Conditions of the Kayanuma Coal Mine

Name of the pit	Name of gallery or adit	Length of the excavated pit		Remarks (1 *shaku* = approx. 30.3 cm)
		Length of the pit (*Shaku*)	Length of adits (*Shaku*)	
Iriho Main Pit	Main Gallery	757.5	360.0	A length of 102 *shaku* excavated in 1879
	New East Large Gallery	138.0	43.0	Excavation started in 1880
	New West Large Gallery	122.0	119.0	A length of 38 *shaku* excavated in 1879
	East No.1 Adit	537.0	2,301.0	A length of 42 *shaku* excavated in 1879
	West No.1 Adit	294.0	3,799.5	A length of 136 *shaku* excavated in 1879
	East No.2 Adit	28.0	92.0	A length of 28 *shaku* excavated in 1879
	West No.2 Adit	301.0	876.0	A length of 92 *shaku* excavated in 1879
	East No.3 Adit	391.5	1,291.6	A length of 88 *shaku* excavated in 1879
	West No.3 Adit	240.0	1,857.0	A length of 83 *shaku* excavated in 1879
	East No.4 Adit	197.0	356.5	Excavation started in 1881
	West No.4 Adit	14.0	0.0	Excavation started in 1881
	West No.4 Frontal Adit	73.0	0.0	Excavation started in 1881
	East No.5 Adit	9.0	0.0	Excavation started in 1881
	West No.5 Adit	177.0	682.5	Excavation started in 1881
	East No.3 Upper Adit	12.0	0.0	A length of 12 *shaku* excavated in 1879
	East No.6 Adit	47.0	24.0	Excavation started in 1881
Ōsawa Pit	Provisional Pit	127.0	0.0	A length of 127 *shaku* excavated in 1879
	No.2 Shaft	129.0	110.0	Excavation started in 1880
	No.3 Shaft	68.0	113.7	Various excavations started in 1879
	No.4 Shaft	0.0	44.0	Only for 1880
	No.5 Shaft	396.0	208.0	Excavation started in 1880
	No.6 Shaft	114.0	0.0	Excavation started in 1881
	East No.3 Shaft	19.0	0.0	Excavation started in 1881
Nakanosawa Pit	Tateiri	170.0	84.0	Started in 1880
	Shinguchi	143.0	65.0	Started in 1881
	No.3	64.0	0.0	Started in 1881
Honnsawa Pit	Honsawa	372.0	0.0	A length of 100 *shaku* excavated in 1879
	No.4 Ventilation Pit	71.0	0.0	Started in 1880
	No.3 Drainage Pit	127.0	39.0	Started in 1880
Taryō Pit		22.0	0.0	Started in 1881

Note: This table shows excavation in the three years between 1879 and 1881.

TABLE 5. Output and Expenditure at the Kayanuma Coal Mine

Year	Output	Expenditure
	(tons)	(¥)
1869	410	1,105
1870	1,423	4,701
1871	2,652	5,908
1872	2,985	14,349
1873	7,730	12,458
1874	1,641	10,014
1878	284	562
1879	534	21,809
1880	3,196	83,133
1881	4,014	43,360

Note: Figures for output and expenditure are rounded to the nearest unit.

ing labour procurement and organization of the mine is known. As far as the number of workers is concerned, there were 17 miners and 80 labourers in 1871. The number fluctuated, as there were 387 workers (see table 6) in the following year but there was a total of 338 in 1873 (139 miners, 139 navvies, 24 porters, and 36 various operatives). In 1875, however, the number of miners decreased to 12. The improvement plan of this mine was submitted in 1877, and in addition there was a request made by Mitsubishi Co. to buy up 20,000 tons in the same year. Thus, as a result of recruitment carried out by the Development Bureau, it is said that the number of miners came up to about 150. It is probably the case that these increases and decreases in the number of workers reveal that the management of the Kayanuma coal mine was as yet unstable. Subsequently, in 1879, when Goujot began improvements, an average of 70 miners were recruited. Men from the Tōhoku region predominated among newly recruited miners.

The coal-extraction workers also came mostly from the metal mines of the Tōhoku region. As pointed out earlier (Enomoto's report), the following case also verifies the use of metal miners. When 16 miners were transferred from the Horonai coal mine to the Kayanuma coal mine in September 1879, the leader of the miners (Kumagorō Kimura) was a metal miner from the Osarizawa mine in Akita Prefecture, and there was another miner from the same mine as well as

TABLE 6. Composition of Labour at the Kayanuma Coal Mine

	Type of Work	Number
Government Officials	Inspector	1
	General affairs	1
	Accounting	1
	Supplies	1
Miners, various operatives and others	Various operatives	238
	Merks	2
	Janitors	2
	Assistant janitors	1
	Foreman of the miners	1
	Pit co-ordinator	1
	Miners	87
	Blacksmiths	5
	Carpenters	18
	Sawyers	12
	Foreman of the labourers	1
	Cowherd	1
	Operator of the 4-ton cart	1
	Charcoal makers	6
	Mountain workers	11
	Total	391

one from the Ani mine. Thus it can be said that, in the initial stage of the development of Hokkaido coal mining, former metal mine workers from the Tōhoku region played in important role and their metal extraction technology was brought into play in coal-extraction technology in Hokkaido.[5] The introduction of modern coal-extraction technology by government-employed foreigners made it possible not only to raise the technological standard of the leading miners from metal mines who were directly involved in the production process, but also to reorganize them as middle-ranked managerial staff who possessed appropriate technology required for coal mining.

Although some miners volunteered to work at the Kayanuma coal mine, most of them were recruited either by the officials of the Development Bureau who

went on scouting trips or by the miners of the Kayanuma coal mine who brought with them their relatives and acquaintances from their home towns. Owing to the difference in the route of recruitment, it seems that labour was divided into government-employed miners and bunkhouse miners. In the case of government-employed miners, they were placed under the rigid instruction of the officials. The "foremen" and the "co-ordinator" of the miners controlled the entire site and the "sub-foreman" controlled and supervised the miners directly. The bunkhouse miners, however, were placed under the so-called bunkhouse system, and they had an employment relationship only with the bunkhouse foreman who had complete authority over recruitment, labour supervision, instruction, and bunkhouse management.[6]

As pointed out earlier, initially the development of the Kayanuma coal mine did not progress as planned and it was sold to a civilian concern. However, Western technology, which had been introduced over a period, and the labour force, which was nurtured and trained at the same time, both bore fruit when they were transferred to the newly opened Horonai coal mine.

3. The Horonai Coal Mine

(1) Foreign Technology

It is said that coal was accidentally discovered at Horonai by a local resident in 1868. However, it was not until 1872 when Chōjūrō Hayakawa, a resident of Sapporo, brought coal lumps from Horonai to the Development Bureau that the place received any attention. Lyman began surveying in the spring of the following year, and Takeaki Enomoto undertook a survey in the summer. As stated already, Lyman went there repeatedly to conduct surveys. Based upon these surveys, it was determined that there were abundant deposits there and that the coal vein and coal quality were both excellent. Consequently from 1875 to the following year, high-ranking government officials such as Keisuke Ōtori, Kiyotaka Kuroda, Director of the Development Bureau, Hirobumi Itō and Aritomo Yamagata, members of the Privy Council, visited Horonai and promoted a state-run project. In the following year, Lyman submitted a survey report regarding Horonai. A development plan for the Horonai coal mine was formulated in 1877 on the basis of the report. In 1878, the

raising of ¥1,500,000 through industrial bonds to finance the development cost was approved (of this sum, ¥170,000 was for the improvement of the Kayanuma coal mine).[7]

Following the decision to have the Horonai coal mine run by the state, the Development Bureau established at its main office in Sapporo an administrative section for its opening and for coal extraction in October 1878. It also employed foreign engineers (see table 7) and began preparations for the opening of the mine in 1879. Owing to the fact that there was no means of transporting coal at the time, it was imperative to secure a coal-transport system. Thus, such government-employed foreigners as Crawford and Ghent conducted the necessary surveys for the installation of railways. After a careful examination of the survey results, a railway installation plan covering Horonai, Ebetsu, Sapporo, and Otaru/Temiya was decided on in December 1879 and railway construction work was started in January 1880. The Development Bureau sent Crawford to the United States so that he could purchase railway materials, engines, and machinery, as well as recruit operatives.

TABLE 7. Government-employed Foreigners at the Horonai Coal Mine

Name	Occupation	Year appointed
B.S. Lyman	Examination and survey of the Horonai coalfield	1873
H.S. Munroe	Chemical analysis and examination of Horonai coal	1874
J.U. Crawford	Instruction on railway installation between Horonai and Temiya	1879
L.C.E. Goujot*	Actual survey and mine-opening instruction	1879
Edward Parry	Instruction on mine opening and extraction	1879
Ghent	Survey and map-making of Ishikari River	1879
Joseph H. Dauss	Instruction on mine opening	1879
F.A. Potter	Inspection and instruction of mine-opening technology	1881
John Chambers	Inspection and instruction of mine-opening technology	1881

* Joseph H. Dauss worked between March and June 1879. Goujot worked from February 1879 and resigned in March 1880 due to illness. Thus Parry continued with the instruction until September 1881.

Railway installation began upon his return in July of the same year. Thus the railway between Otaru/Temiya and Sapporo was opened in November and between Sapporo and Ebetsu in June of the following year. The entire line, which covered a distance of about 90 kilometres between Temiya and Horonai, was opened upon the completion of the route between Ebetsu and Horonai in November 1881. A system for the transport of coal from the Horonai mine was secured (see diagram 1).

The development of the Horonai coal mine itself was carried out under the leadership of Goujot, who had done the same for the Kayanuma coal mine. A detailed survey had been conducted beginning in May 1878 and the mine was opened on 18 December of the same year. The excavation of the "big pit" (main gallery) was started the following January. This gallery, with a height of 2.1 metres and a width of 2.7 metres, was dug at a site which was about 94 metres above sea level at right angles running directly toward the coal bed. The gallery reached the edge of the coal bed at a point 450 metres from the portal in January 1881, and it reached the main coal bed in March. (The edge was about 72 centimetres in an incline of 50 degrees while the main coal bed reached in March was about 162 centimetres wide with an incline of 55 degrees.) In order to prepare for coal extraction, two adits each were dug to the right and left of the main gallery along the coal bed at this point. This was the method that Goujot carried out at the Kayanuma coal mine. In addition to the use of the gad and powder for excavation, it is thought that steam-powered rock drills were used for the excavation of some parts. Moreover, Frederick A. Potter, a British engineer employed by the Ministry of Industry who had supervised the excavation at the Miike coal mine visited the mine in 1881 and expressed the opinion that adits along the coal bed should be excavated directly from the exposed sites of the coal bed. Thus adits such as Takinosawa and Honsawa were opened along their respective coal beds (see table 8). It was June 1882 when full-scale coal extraction began, quick progress having been made in excavation.

The coal extraction method adopted by the Horonai coal mine was the coal pillar method in which two parallel adits along the coal bed were demarcated at an interval of about nine metres in order to set a coal face. Coal pillars with a width of about three to six metres were left to support the

TABLE 8. The Conditions of Excavation at the Horonai Coal mine

Pit Name		Date	Excavation Distance* (*Shaku***)	Remarks
Main Pit	Main gallery	Feb. 1879	2,094.5	Pit excavation
	East No.1 Adit	May 1882	175.0	Tentative closure in Feb. 1883
	West No.1 Adit	June 1882	62.0	Tentative closure in Nov. 1884
	East No.2 Adit	Jan. 1885	623.9	Excavation and extraction
	West No.2 Adit	Jan. 1885	873.8	- ditto -
	East No.3 Adit	Jan. 1886	516.6	- ditto -
	West No.3 Adit	Jan. 1886	212.1	Pit excavation to prepare for extraction
Takinosawa Pit	East No.1 Pit	Apr. 1882	827.0	Stopped excavation, only soft coal
	East No.1 Adit	Sept.1882	230.0	Tentative closure in June 1883
	West No.1 Pit	Sept.1882	2,254.1	Excavation and extraction
	West No.1 Adit	Aug. 1882	1,943.2	- ditto -
	West No.1 2nd adit	Oct. 1885	1,331.7	- ditto -
	East No.2 Adit	Sept.1882	1,680.9	- ditto -
	West No.2 Adit	Apr. 1882	473.0	Tentative closure in June 1883
	East No.3 Adit	Dec. 1882	1,725.9	Excavation and extraction
	West No.3 Adit	Dec. 1882	1,047.0	- ditto -
Honsawa Pit	East No.1 Pit	June 1882	1,236.7	Tentative closure in Aug. 1886
	East No.2 Pit	Apr. 1882	1,798	Tentative closure in Apr. 1887
	West No.2 Pit	Sept.1881	2,128.5	Excavation and extraction
	East No.3 Pit	Apr. 1882	291.0	Tentative closure in Jul. 1883
	East No.3 Adit	Jan. 1886	1,175.1	Excavation and extraction
	West No.3 Pit	Apr. 1882	295.5	Tentative closure in July 1883
	West No.3 Adit	July 1882	1,871.0	Excavation and extraction

* The excavation distance denotes the distance from the opening until October 1887.

** 1 *shaku* = approx. 30.3 cm.

ceiling rock. This method was also adopted by the Miike and the Takashima coal mines. What was different from these and other coal mines was the fact that powder was used for coal extraction, as was done at the Kayanuma coal mine. The Horonai method of blasting was the so-called solid digging method. The lower part of the coal bed was first dug to a depth of about 3 *shaku* 5 *sun* (166.5 centimetres) with a width of 5 *sun* (about 16.5 centimetres). Then a hole with a diameter of 8 *sun* and a depth of 3 *shaku* was dug, into which was placed 20 *momme* (about 7.4 grams) of powder. A powder train of about 120 centimetres was then ignited and coal was thus obtained through the destruction of the coal bed.[8]

The extracted coal was either carried manually in a coal box down to the coal funnel located in the adit along the coal bed, or the coal box was lowered to the adit with the use of a cage installed at the coal face. A pair of porters then pushed a four-wheel cart to the exterior of the pit through the main gallery. In other words, there was no mechanized coal transport in the mine during the period of state-ownership. The coal which was carried to the exterior was screened into lumps and powder and workers eliminated stones manually.

As for drainage, which usually presented problems to coal miners, natural drainage was sufficient as the extraction sites were above water level, and there was no need to use machinery. A sump created at the bottom of a pit at the time of excavation was drained with the use of a manually operated pulley with wooden buckets. Here was a big difference with the Miike coal mine in Kyushu whose history was one of constant struggle against water. However, as Horonai was faced with a massive amount of gas, much emphasis was therefore put on ventilation. Ventilation pits were excavated at ten spots and in August 1885 a furnace was equipped outside the East No.1 Pit of Takinosawa in order to ventilate air by convection. The installation of a power-driven fan, however, was actualized in 1889, five years after a similar fan was installed at Miike; the Geeval model, made in England, the same model as the one used at Miike, was installed. With regard to lighting, safety lamps were implemented at dangerous sites and regular lamps were used at safe sites.

The Horonai coal mine during the period of state-ownership did not quite reach the level of mechanization in drainage and coal transport achieved by Miike in view of the fact that the extraction sites were not only above water level but also shallow.[9] Nevertheless, as a result of the presence of foreign engineers from the very beginning, of the planned excavation of pits, and of the introduction of new extraction technology, Horonai together with Miike came to stand at the apex of coal-mining technology in Japan. Output grew rapidly, and the management became profitable and stable from the period of its transfer to a civilian concern. This was only possible because of its government-sponsored initial foundation (see table 9 regarding output and expenditure).

TABLE 9. Sales Record of the Horonai Coal Mine During the Period of State Ownership

Year	Output (tons)	Extraction Cost (cost per ton) (¥)	Sales Value (¥)	Profit and Loss (¥)
1882	3,677	14,521 (3.99)	6,575	-7,945
1883	17,301	99,773 (5.76)	75,998	-23,775
1884	31,648	148,514 (4.68)	157,572	9,058
1885	36,016	179,065 (4.97)	161,662	-17,403
1886	51,084	249,045 (4.87)	221,767	-37,278
1887	62,693	103,046 (1.64)	96,899	-6,147
1888	89,594	88,907 (0.99)	82,659	-6,248
1889	87,689	75,467 (0.86)	94,944	19,478

(2) The Procurement and Organization of Labour

The administrative section which was responsible for the opening of the mine and for extraction recruited workers directly through newspaper advertisements and through contractors. As stated earlier, in order to overcome the greatest problem, which was that of labour shortage, the administration made an effort to secure a labour force through the transfer of skilled miners from the Kayanuma coal-mine. The miners were mainly from the Tōhoku region, from such prefectures as Aomori, Iwate, and Akita.[10] However, when full-scale extraction started after the completion of a system facilitating extraction, the labour shortage became a grave problem. Thus, in order to

overcome the labour shortage, prison labor was introduced with the intention of minimizing expenditure, prisoners being hired at low wages. Needless to say, the introduction of prison labour by the state was nothing more than an example of the primitive accumulation of capital. Mining labour is the most symbolic case in point. After introducing prisoners from Sorachi Prison in 1883, the number of prisoners at the Horonai coal mine increased rapidly (see table 10). Around the time of the sale of the mine to a private concern, prison labour comprised 80 per cent of the total number of workers at the mine. Moreover, the key sectors involving extraction and transport were almost entirely dependent upon prison labour. However, the general labour force, including women and children, were allocated to supplementary sectors (see table 11 for the labour composition).

The labour force was controlled and organized as follows. The prison labourers were naturally supervised by the officials of the prison. Two types of control regarding the general miners, namely, direct employment and indirect employment (the bunkhouse system) existed. Miners who were directly employed worked under the direct leadership and supervision of a "sub-foremen," who was a government official. Miners who came under the system of indirect employment did not have a direct employment contract with the coal mine but were under the complete control of a contractor who was the bunkhouse foreman. The bunkhouse foreman not only controlled and supervised the miners at the production site but also exercised absolute authority over those who lived at his own bunkhouse and became an absolute figure at work as well as in daily life.[11] The existence of such a bunkhouse system became indispensable in the formative period of capitalism when the capitalists had a weak grasp of the production process and lacked the ability to control the work and when labour shortage was unavoidable. It was a means to secure forced labour that could be made to work cheaply for many hours. In other words, it was an efficient means to produce "absolute surplus value." In the case of the Horonai coal mine, however, all the participants in intra-mine work were obliged to follow "rules pertaining to the work in the mine" and "punitive rules pertaining to the excavation miners and labours" even though some of them came under the control of contractors. Therefore, the fact that a contractor was given only limited authority within the framework of the coal extraction plan set by the mine deserves attention. Such limitation

TABLE 10. Prison Labour at the Horonai Coal Mine

Year	Prison Labour (persons)	General Labour (persons)
1883	250	228
1884	400	202
1885		
1886	809	
1887	791	
1888	605	
1889	630	276
1890	1,043	183
1891	1,132	
1892	920	
1893	874	162
1894	about 500	about 539

Note: Figures for the empty spaces are unknown. Prison labour for 1883 was taken from the June figure and the number of general workers was taken from the November figure.

TABLE 11. Labour Composition at the Horonai Coal Mine (as of October 1884)

Occupation		No. of People
Officials		17
Government-employed operatives		20
Miners (normal citizens)		94
Carpenters, scaffolding men and porters		42
Odd jobbers		140
Women		112
Children	boys	43
	girls	59
Sorachi Prison Extended Office		
Officials		56
Officials' families		8
Employees (porters and janitors)		20
Prisoners		309

Note: The officials and prisoners of Sorachi Prison came out to Horonai and worked.

on the authority of a contractor signifies the fact that the managing personnel at the site had already accumulated control and supervisory capability. In other words, there existed the stratum of middle management, namely, a group of sub-foremen. In fact, as has been pointed out repeatedly, there were a group of "sub-foremen" who had acquired extraction technology in the Tōhoku metal mines, the Kayanuma coal mine, and then the Horonai coal mine. The Horonai coal mine thus came to possess a middle management which was transformed from endogenous metal miners to those who possessed appropriate technology required for coal mining. The Horonai coal mine, which was initially in the red, began to make a rapid profit after 1887 due to the accumulation of middle management on the one hand and to the utilization of prison labour on the other (see table 9).[12]

The following conclusions can be drawn on the basis of the examination made thus far with regard to factors which contributed to the financial stabilization of the Horonai coal mine. First, the mine's development comprised a part of the comprehensive development of Hokkaido and, thus a sufficient number of coal-mine-related facilities such as railways and ports were implemented in the knowledge that mine management would be in the red for a long time. Secondly, profit-oriented random extraction was avoided and a large-scale extraction plan was devised and pursued with the introduction of modern coal-mining technology. Thirdly, a knowledge of modern coal-mining technology was gained by engineers and workers not only through government-employed foreigners but also through the experiences at the Kayanuma coal mine. Fourthly, the introduction of prison labour made it possible to secure labour cheaply. Fifthly, the mine was run by the government and thus could withstand cumulative losses for a long period of time. These five points denote nothing but the primitive accumulation of capital, a policy pursued by the Meiji government under the slogan of "Increase production and promote industries." The fact that the Horonai coal mine was sold to a private concern at a time when the management was stable verifies this point.

Notes

1. These two foreigners are said to have taught the rock-blasting method by powder at the Yurappu mine for the first time.

2. The first survey conducted 1873-1875 by Lyman, who will be mentioned later, did not include the interior. This was pointed out by Takeaki Enomoto in his report: "Survey of Ikushibetsu Coal." In the same report, Enomoto gave the following coal analysis chart of Ikushibetsu coal. Takatō Oshima had already conducted a testing method of dividing the elements of coal into four groups, but the structuring ratio was very rough.

A Chart of the Ikushibetsu Coal Survey

Water	3.2/100
Combustible volatile elements	34.6/100
Solid carbon	59.6/100
Ash	2.6/100

or

Water	4 /100
Combustible volatile elements	32 /100
Solid carbon	61.4/100
Ash	2.6/100

3. The fact that Kiyotaka Kuroda, Director of the Development Bureau, was intent on actively employing Japanese engineers and making the Japanese absorb foreign technology without relying upon foreign engineers can be said to be a reflection of the policy of the Meiji government, which was striving for national independence. (Nevertheless, the natives of Hokkaido, i.e., the Ainu people, were forced to "assimilate.")

4. Mine-opening instruction undertaken by government-employed foreigners was based upon the idea of making progress in the improvement of coal mines while keeping profitability in mind. It was pointed out that the reason for the opening of the portal of the Kayanuma coal mine in the middle of the mountain was "that 'pumps' and other expenditures could be conserved." Improvement plans subsequently made by Netto and Lyman always emphasized this point.

5. For example, Kazusuke Akasaka for the Osarizawa mine was appointed as an "intra-mine co-ordinator" at the Kayanuma coal mine, after which he was promoted to "sub-foreman," in which position he directed and supervised mine labour.

6. Although this is an examination of the Horonai coal mine, it is assumed that the same applied to the Kayanuma coal mine.

7. However, the actual expenditure exceeded the budget and about ¥219,086 for the Horonai coal mine and about ¥1,430,537 for the Horonai railways were spent.

8. It has been pointed out that they used powder trains made in Sado. Moreover, as indicated already, powder usage reveals the correlation between Hokkaido mines and Tōhoku metal mines in terms of technology.

9. Steam-powered pulleys and drainage pumps were introduced at the Miike coal mine in 1879, a mine that had a history of coal extraction twenty years longer than Horonai. Because coal was extracted at deep sites, coal transportation became longer and there was a massive amount of seeping water. Thus the mechanization of transportation and drainage was an urgent task. Owing to the fact that the conditions of extraction of these two coal mines differed so much, their levels of technological progress cannot be compared merely on the basis of whether or not mechanization existed in the mine.

10. Moreover, with regard to the transfer of miners from the Kayanuma coal mine the following two transfers are recorded: 16 miners in September 1879 and 14 in October 1882.

11. Refer to the following for an example of a contractor:

> Kumagorō Kimura led a group of 50 underlings from the Kayanuma coal mine at the orders of a branch office of the coal extraction section of the Development Bureau in about 1880. He kept them at a bunkhouse operated by himself. Afterwards, workers were occasionally brought into the mine from the southern Tsugaru region [in Tōhoku]. At about the time when the intra-mine facilities were in order, Kentarō Akasaka came from Kayanuma. He extended the traditional bunkhouse and contracted the task of excavation, transportation of coal extraction materials, etc., with the use of the miners who boarded at his bunkhouse. He was totally in charge of not only of the supply of materials but also the payment of wages.

The eldest son of Kazusuke Akasaka, whose name was Kennosuke, was referred to by mistake as "Kentarō" in the above passage. Tadakichi Kainuma, who was one of the bunkhouse foremen at the Horonai coal mine, sold off his right as a bunkhouse foreman in 1887 to Magobei Tōya, a liquor dealer, because he had difficulty in returning his debts. It can be surmised from this fact that the function of a bunkhouse foreman at the Horonai coal mine was primarily to contract, to recruit, and to manage a bunkhouse and that the foreman's function regarding the intra-mine work, which required experience and skills, was fairly limited.

12. The foremost advantage of prison labour was the low wages. The average daily wages per person in 1887 of prison labour and general labor are 6.6 *sen* for the former and 27.1 *sen* for the latter. Prison labourers who were working at a coal face whose distance to the adit was less than 100 *shaku* (about 30 metres) were paid 3.9 *sen* and for a distance of over 500 *shaku* they were paid only 7.8 *sen*. Thus their extraction wages were 10 to 20 per cent of those paid in Kyushu (excluding Miike).

II. HOKKAIDO COAL MINING DURING THE INDUSTRIAL REVOLUTION

1. The Mechanization of Coal Mines — The Case of Hokutan

In 1889, when the foundation of coal-mine management had been laid and the prospect for growth was good, the Horonai coal mine together with the railway was sold to the Hokkaido Coal Mine Railway Company (after the nationalization of the railway, the company was renamed the Hokkaido Coal Mine Steam Ship Company Limited, henceforth abbreviated as Hokutan). This company was established by Motoi Hori to buy the Horonai coal mine. Hokutan bought up not only Horonai but also Ikushumbetsu (1889). Upon obtaining the lease district right of the Sorachi and the Yūbari coal mines, Hokutan immediately started excavation at these mines (coal was extracted in the first half of 1891 in Sorachi and in the latter half of 1892 in Yūbari). Mechanization was pursued in these mines. Until the middle of the 1900s Hokutan coal took up about 90 per cent of the Hokkaido coal output (see table 12) and thus achieved monopolistic growth. Technological development and the conditions of the mechanization process in the coal mines under Hokutan's control during the formative period of Japanese capitalism — from the time of the founding of Hokutan to the period after the Russo-Japanese war — will be traced here.

First of all, as far as the excavation technology of the pits that formed the framework of the mine was concerned, there was a new characteristic — the excavation of large-scale pits. This can be seen in the case of the Sorachi coal mine's Sakushi pit (about 210 metres in depth), excavated in 1895, and the Horonai coal mine's Yōrō pit (about 225 metres in depth), which was excavated in the following year. Pits which adjoined an inclining shaft played an important role in the progress of coal-mine management because they made it possible to overcome such difficulties as worsened ventilation and greater distances for coal transportation, which arose as a result

TABLE 12. The Proportion of Hokutan's Output in Hokkaido

Year	Hokutan (A) (ton)	All Hokkaido (B) (ton)	(A)/(B) (%)
1890	163,471	186,418	87.6
1891	312,721	267,451	?
1892	334,661	325,488	?
1893	304.062	331,956	91.5
1894	403,508	386,480	?
1895	345,255	430,515	80.1
1896	430,489	457,171	94.1
1897	566,770	596,195	95.0
1898	546,328	585,807	93.2
1899	556,093	634,617	87.6
1900	610,777	654,506	93.3
1901	763,873	815,580	93.6
1902	899.858	956,444	94.0
1903	938,331	1,053,852	89.0
1904	919,885	1,078,168	85.3
1905	978,891	1,177,511	83.1
1906	1,142,793	1,454,018	78.5
1907	1,014,111	1,384,349	73.2
1908	1,143,266	1,607,304	71.1
1909	1,254,643	1,691,930	74.1
1910	1,066,984	1,571,695	67.8
1911	1,098,773	1,702,051	64.5
1912	1,123,351	1,884,845	59.5
1913	1,069,774	2,026,805	52.7
1914	1,361,885	2,026,805	52.6
1915	1,555,679	2,611,562	59.5

of extraction at depth. (see table 13 for excavation conditions.) As for the excavation of pits, as well as conventional methods of manual digging and the use of black blasting powder — carbonite — rock drills were introduced as well. For example, small rock drills made by Flotman Company run on compressed air were put to test use for the excavation of the Yōrō pit.

TABLE 13. Excavation Conditions at Hokutan

Name of Coal Mine	Portal Name	Type	Excavation Type
Yūbari Coal Mine	Main pit area		
	Ishikari Pit	adit	Apr. 1890
	Tone Pit	inclined shaft	2nd half of 1895
	Tenryū Pit(2)	inclined shaft	1900
	Daishin Pit	pit	Oct. 1913
	Jintsū Pit	inclined shaft	?(Taishō period)
	Ōi Pit	pit	June 1917
	Sumida Pit	adit	1917
	No.36 Shaft	incline shaft	?(Taishō period)
	Teimi pit area		
	Chitose Pit	horizontal and then inclined	Apr. 1890
	Kitakami Pit(3)	inclined shaft	1891
	Mogami Pit	inclined shaft	Mar. 1913
	Nagara Pit	inclined shaft	?(Taisho period)
Horonai Coal Mine	Takinosawa Pit	adit	1879
	Honsawa Pit	adit	1879
	Otowa Pit	horizontal and then inclined	1879
	Yōrō Pit	pit	Mar. 1896
	Nachi Pit	pit	Feb. 1910
	Shimofuri Pit	?	Apr. 1916
	Nunobiki Pit(2)	pit	June 1917
	Shiraito	adit	Jan. 1918
Ikushumbetsu Coal Mine	Kasumi Pit	adit	Jun. 1885
	Aoba Pit	inclined shaft	July 1913
	Midori Pit	inclined shaft	July 1913
	Takambe Pit	adit	Oct. 1916
	Nishiki Pit	pit	Oct. 1917
Mayachi Coal Mine	Sakaki Pit	horizontal and then inclined	Oct. 1905
	Honryū Pit	adit	June 1907
	Jōban Pit	adit	July 1907
	Shimonosawa Adit	adit	July 1907
	Supportive Pit of Katsura Pit	pit	Aug. 1908
	Kashiwa Pit	horizontal and then inclined	Sept. 1908
	Yonshaku coal bed's inclined shaft	horizontal and then inclined	1912
	Katsura Pit	pit	Apr. 1914

Name of Coal Mine	Portal Name	Type	Excavation Type
Manji Coal Mine	Main pit area		
	Fukuju Pit	horizontal and then inclined	Nov. 1905
	Sumire Pit	adit	Nov. 1905
	Tachibana Pit	inclined shaft	Nov. 1905
	Futamizawa area		
	Aoi Pit	adit	1907
	Botan Pit	inclined shaft	Mar. 1909
	Kikyō Pit	adit	1909
	Sakura Pit	inclined shaft	First half of 1914
	Satsuki Pit	adit	First half of 1914
	Momiji Pit	inclined shaft	May 1919
	Miruto Area		
	Hinode Pit	adit	Feb. 1918
	Futaba Pit	adit	Feb. 1918
	Hatsune Pit	inclined shaft	May 1919
Sorachi Coal Mine	Utashinai area		
	Sakushi Pit	adit	1891
	Atago Pit	adit	1891
	Fushimi Pit	adit	June 1892
	Sakushi Pit	pit	June 1895
	Kōzu Pit	adit	Dec. 1897
	Maizuru Pit	pit	Mar. 1901
	Rukunshu Pit	adit	1908
	Ikoma Pit	adit	May 1912
	Maizuru Pit	inclined shaft	1913
	Arima Pit	adit	Jan. 1914
	Yoshino Pit	adit	First half of 1916
	Miyagi Pit	adit	Mar. 1917
	Akabira Area		
	Akabira Pit	adit	Apr. 1918
	Kashin Area		
	Takasago Pit	inclined shaft	May 1913
	Toyama Pit	adit	Jan. 1917
	Yawata Pit	inclined shaft	Aug. 1917
	Kurama Pit	adit	Mar. 1918
	Kamui Area		
	Kamui main Pit	adit	June 1891
	Takao Pit	adit	Oct. 1898
	Kasagi Pit	adit	July 1904
	Amagi Pit	adit	Oct. 1904
	Chihaya Pit	adit	Jan. 1906
	Miharu Pit	adit	Jan. 1908
	Tateyama Pit	pit	June 1916

Notes: 1) All the portal names were changed in July 1918. The above table uses the revised names.

2) The above table includes only the portals which were excavated up to the 1910. Moreover, when more than one portal was excavated in conjunction with the first portal, the type and the excavation date of the first portal is listed above, and the number of remaining portals are indicated in parentheses.

3) Shin Yūbari, Noborikawa, and Wakanabe mines, which were marged with Hokutan in the interim, are omitted.

4) A number of facts are modified from the original table.

In addition, water-liner rock drills made by Ingersoll Company were used in 1899 at both Sorachi and Yūbari coal mines. Then eight water-liner rock drills were purchased in 1908 for the excavation of the Daishin pit at the Yūbari coal mine and the Katsura pit at the Mayachi coal mine, and at around the same time Horonai also purchased one water-liner rock drill and two jack-hammers. Rock drills were introduced at other mines from World War I onwards but at a handful of coal mines such as the Miike coal mine they were actively used from an early period. The same could be said for Hokutan despite the fact that rock drills were first used on a test basis. It can be said that the introduction of machinery was needed and became financially feasible because of large-scale excavation.

In contrast to the active introduction of machinery to do with pit excavation, mechanization in the area of coal extraction hardly made any progress during this period either at Hokutan or at other coal mines. Extraction methods were, however, being improved gradually. In addition to the conventional methods of extraction at a coal bed with a sharp incline, new methods were used such as the "upward-steps method," creating a fake incline by setting a coal face at each step. In addition to the conventional pillar method, the Yūbari coal mine adopted a "retreating long-wall method" in 1897. This method involved the extraction of coal from the coal pillars which had been left in between coal faces. Extraction took place as the miners retreated from the coal face. Moreover, in the following year the mine adopted a method which was an amalgamation of the pillar method and the long-wall method for coal extraction at the 24-*shaku* coal bed. Although this was unsuccessful, the long-wall extraction method without filling in the mine was tried at the same 24-*shaku* coal bed in 1908. With regard to the slow progress of mechanization, it is noteworthy that the Yūbari coal mine started using five coal cutters run on an air compressor made by Ingersoll Company in January 1900. They were used for open work; the results were good, and ten more of the same model were purchased in the following year. Nevertheless, until the post-World War I period, mechanization at a coal extraction site which was constantly being moved to a deeper site did not come about on a full scale because it was not possible without the development of electric power.

Coal transportation, which comprised the major work process together with coal extraction, can be divided into transportation at the coal face, transportation in the adit along the coal bed, transportation in the main gallery (an inclined shaft or a pit), and transportation outside the pit. Transportation at a coal face which, like the extraction process, is constantly shifted was least developed at Hokutan, and the following conditions prevailed until after World War I:

> When the incline is gradual the coal can be transported in two ways. One way is for the cart to be brought directly into the coal face. The other way is to carry the coal as far as the gallery by means of a wheelbarrow, coal box, or sledge, after which it is transferred to the coal cart. When the incline is somewhat greater, bicycle drums are used. When the incline is very sharp, extracted coal is dropped in the chute lined with wooden boards, iron boards, and diagonal pipes to the funnel, and at times water is flushed down in order to transport the coal.

Transportation in the adit which connects to the coal face was also primarily managed either by manual power or by horse-pulled carts. A half-ton coal cart installed in the adit was pulled along the tracks manually or with the use of a horse.[1]

In contrast to the transportation system at the coal face and in the adit, mechanization in the main gallery progressed rapidly. Owing to the fact that the extraction sites shifted further down below water level, the conventional transportation in the main gallery, which was effected by manual power and horses, was superseded successively hoisting machines. The first such machine to be implemented was at the Ishikari pit (No. 1 inclined shaft) of the Yūbari mine in 1893, when a steam-powered hoisting machine made by Walker Brothers of England was installed at the portal. In the following year, a steam-powered endless rope of an under-rope model made by Jigsawman Manufacturing Co., U.S.A, was installed at the Kitakami pit (No.2 inclined shaft) of the same mine. In 1895, a hoisting cage was introduced at the Sakushi pit of the Sorachi mine. Moreover, the first engine run on an air compressor (made by H.K. Polter Co., U.S.A.) was put to use in Japan in 1900 at the Chitose pit (horizontal) of Yūbari. Thus, machinery was implemented in the main gallery at an early stage. Furthermore, even since the production of an electric endless rope in 1902 at Temiya Manufacturing Plant, which

belonged to Hokutan, and its installation at the Tenryū pit (No. 3 inclined shaft) of Yūbari, the motor power was rapidly changed from steam engine to electricity. (Refer to table 14 for the installation conditions of transportation machinery.)

TABLE 14. Installation Conditions of Transportation Machinery

		No. of Units	
		1908	1920
Yūbari	Steam-powered hoisting machine	4	-
Coal Mine	Steam-powered endless rope	-	1
No.1 and	Electric hoisting machine	1	4
No.2	Electric endless rope	-	7
	Electric cage	3	-
Sorachi	Steam-powered hoisting machine	2	-
Coal Mine	Electric hoisting machine	1	8
	Electric endless rope	-	1
Horonai	Steam-powered hoisting machine	1	4
Coal Mine	Electric endless machine	1	1
	Electric cage	-	3
	Electric hoisting machine	-	2
	Compressed air hoisting machine	1	-
Ikushumbetsu	Steam-powered hoisting machine	-	1
Coal Mine	Steam-powered cage	1	-
	Electric hoisting machine	-	3
	Electric endless rope	-	1

Notes: 1) Since data regarding the ropeway, train, and electric train were not available for both years, they are excluded. Moreover, the compact hoisting machine is also excluded.

2) Shin Yūbari, Wakanabe, Noborikawa, and Manji mines were added to arrive at the 1920 data.

The coal transported to the portal was sent either to the coal screening site or the storage site. Although transportation in between these points was primarily dependent upon horses until the early 1910s, mechanization progressed steadily. In 1901, an electric train (made by the Westinghouse Co., U.S.A.) was implemented between the Fushimi pit (Nakanosawa portal) to

the storage site of the Sorachi coal mine. In the following year, an electric endless rope made by Temiya Manufacturing Plant was installed from the Tenryū pit's portal to the coal-screening site of the Yūbari coal mine, An endless rope was also installed between the portal and the coal screening site of the Otowa pit at the Horonai coal mine in 1903. Thus, mechanization outside the pit progressed along with mechanization in the main gallery.

I would like next to examine the mechanization process in the supplementary areas of drainage, ventilation, coal screening, etc. As stated already, Hokutan was particularly keen on improving ventilation measures in the supplementary areas. The first move was the installation of a Geeval model fan at the Horonai coal mine in 1888, just before its sale to a private concern. This was second only to the Miike coal mine, and mechanization after that progressed rapidly. An electric fan was installed at the Yūbari coal mine as early as 1898. By 1902, a total of eight fans which consisted of two units of the Geeval model (steam-powered), one unit of the Champion model (steam-powered), and five units of the same model run on electricity were installed there. Moreover, from 1900 small fans powered by an air compressor were installed in the mine whenever necessary, and after the Russo-Japanese War efficient local Siroco model fans were introduced. Regardless of whether the type of fan was an electric fan or the local Siroco model fan, this was the earliest introduction of such machinery in Japan. Incidentally, it was in 1903 that an electric fan was introduced to the Miike coal mine and it was during the early 1910s that the local Siroco model fan was introduced.[2]

With regard to drainage, Hokutan was at an advantage in comparison to coal mines in other regions because many of the operation sites were above water and water seepage was, therefore, limited. However, as extraction moved further underground, mechanized drainage became necessary even at Hokutan. At the time of the excavation of the no.1 inclined shaft (the Ishikari pit) at the Yūbari coal mine, a steam pump was used for the first time. In 1894 two Cornish-model drainage pumps made by Evans and Rince Company were installed at a depth of about 167 meters in the same shaft. Various coal mines under the control of Hokutan, (the Yūbari coal mine was an exception), relied up on natural drainage until the late 1890s. It was in 1896 that the

first special duplex pump was installed at the Yōrō pit of Horonai. It was not until 1901 that the first steam pump was installed at the Sakushi pit of Sorachi, and as for the Ikushumbetsu coal mine the first pump was installed as late as 1914. The first electric pump was the five-geared turbine pump with 100 horsepower, which was introduced in 1909 to the Penke pit (Maizuru pit) at the Sorachi coal mine. By the end of the 1880s, 50 pumps were being used at the Miike coal mine, and in 1892 the most up-to-date deep-well pump was introduced. The electric pump was introduced in 1901. Thus when the Hokutan is compared with Miike, the differences in the extraction conditions — Miike being troubled by water and Hokutan by gas — are reflected explicitly in the development of mechanization.

With regard to coal screening, a simple coal-screening method — called the all-stone method — of dividing lump coal from powder coal (lump and powder were separated with the use of a fixed screen with bigger stones eliminated manually) was generally used by the Hokutan from the founding of the mine until around 1912. However, both the Hokutan and the Miike coal mines were pioneers in introducing coal-screening machines. Hokutan, in fact, implemented more efficient coal washers than the ones used at Miike. In 1896, a Jaguar coal washer which washed small coal lumps, was installed at the Horonai coal mine. The same type of machine was installed in various mines in the Yūbari and Sorachi regions, and each mine was equipped with a powder coal washer at around the time of the Russo-Japanese War. The coal screeners and coal washers were introduced in order to improve coal quality as well as to enhance the commodity value of coal in response to diversified coal demand. Full-scale mechanization in this part of the country, including Hokutan, did not come about about until after World War I. For example, it was after World War I that Jaguar washers were installed in most other coal mines. It can be seen therefore that Hokutan implemented the coal washer at an earlier stage than other coal mines. The early introduction of the coal washer was due to the fact that Hokutan had to respond on its own to the diversified demand of the Hokkaido coal market, which it monopolized, and that it was necessary to supply high-quality coal which met the demand so that the domestic and foreign coal markets could be maintained and expanded despite the disadvantage of long-distance transportation.

Together with the rapid progress of mechanization, motor power also shifted rapidly from steam power to electricity. The beginning of electrification was marked by the installation of a direct current 7.5 kilowatt generator in August 1898 at the Horonai coal mine; the generator was used to run a five-horsepower Champion model fan. Other electric power plants were built at Hokutan so that the shift from steam power to electricity could be promoted.[3] The progress in mechanization at Hokutan's mines cannot be compared to other coal mines in Hokkaido, in mechanization in the areas of ventilation and coal screening, for Hokutan had the most advanced mines in Japan (see table 15). In order to boost the development of mechanization inside and outside the mine, Hokutan gradually came to expend more effort on the manufacture of various types of machinery. Unlike the situation at the Miike coal-mine, Hokutan had relied upon imported coal-mining machinery from abroad.

TABLE 15. Mechanization in Hokkaido Coal Mining (1907

Name of Coal Mine		Steam Engine	Steam Machinery	Electric Machinery
Yūbari No.1 Pit	Hokutan	18	10	2
Yūbari No.2 Pit		6	8	-
Sorachi		21	14	5
Horonai		11	6	2
Ikushumbetsu		1	11	-
Shin Yūbari		1	1	-
Ōwada		1	1	-
Saitō		2	1	-
Harutori		1	1	-
No. of coal mines without power machinery			19	

However, in conjunction with the mechanization of the coal mine, the Temiya and Iwamizawa manufacturing plants, which were attached to Hokutan, began to produce not only railway-related machines but also coal-mining machinery such as the Champion model fan, the Jaguar washer, the hoisting machine, and electric generators. After the Russo-Japanese War, a plant for repairs and manufacturing was established at each coal mine for the repair and production of coal-mining machinery.[4] Thus, Hokutan accumulated a certain level

of technology required for self-sufficient production through the imitation of imported products. At the same time, superior foreign products were constantly introduced to achieve higher productive efficiency.

It can be seen from this discussion of the progress made in mechanization at the coal mines under the control of Hokutan that these mines were more advanced than others. Given adequate financial capability, the following three factors contributed to the promotion of mechanization: First, it was necessary to promote mechanization as a measure to overcome the labour shortage and the high cost of wages; secondly, due to the accumulation of technology since the period of government management, the necessary conditions for the acceptance of mechanization had already been formed; thirdly, due to the scale of production, the introduction of machinery was also effective in terms of profitability. This being the case, what was the influence of mechanization on the procurement and organization of labour? Let us move on to an examination of this aspect.

2. The Procurement and Organization of Labour — The Case of Hokutan

The following three types of employment existed at the mines when Hokutan was first founded. The first was prison labour; the second was the bunkhouse system, and the third was direct employment. The most important form of labour, however, at the time of the founding of Hokutan was prison labour.

Prison Labour

Prison labour was used in the Horonai coal-mine on a large scale in the latter period of government management. After the sale of the mine to Hokutan, the company was authorized to continue using prison labour, and thus prison labour, which was intensively applied to such key areas as coal extraction and transportation, constituted the core of Hokutan's labour force. (see table 16).[5] Prison labour reached its peak one or two years after the sale of the Horonai coal mine, and then it gradually decreased. The abandonment of prison labour was ordered in 1894 and its use thereafter stopped. Owing to the fact that underdeveloped Hokkaido suffered from a

labour shortage, without the existence of prison labour it was impossible for Hokutan to manage the coal-mine. Thus, the government authorized the use of prison labour even after the sale. Although the use of prison labour was prohibited on the face of it as a result of administrative considerations, it can safely be said that it was more due to the fact that the prospect had arisen of recruiting substitute labour. Nevertheless, Hokutan was placed in an advantageous position because prison labour was not only inexpensive but it also eliminated the labour shortage.

TABLE 16. Composition of Labour at the Time of the Founding of Hokutan (1889)

Section	Occupation	No. of Workers
Coal-mining section	Chief engineer	1
	Manager	1
	Assistant manager	1
	Engineer	1
	Clerks	9
	Hired hands	4
	Part-timer	1
	Full-timer	1
Horonai coal extraction office	Clerks	17
	Hired hands	10
	Coal-mine co-ordinators	24
	Janitors	2
	Operatives	6
	Miners	276
	Prison labour	630
Ikushumbetsu coal extraction office	Clerks	3
	Hired hands	9
	Coal-mine co-ordinators	7
	Janitor	1
	Full-timer	1
	Miners	480

Note: Other than the above, Hokutan had a general affairs section, engineering section, train section, transportation section, accounting section, storage section, and a Tokyo branch office, all of which employed a total of 1,303 workers.

The Bunkhouse System

The primary form of labour prevalent at the Hokutan mines in the period from the abolition of prison labour until after the Russo-Japanese War was to be found in the bunkhouse system. This system, which was introduced during the period of government management, was continued after the founding of Hokutan. Hokutan established Rules for Coal-mining Labour in 1892 and tightened its control over the miners. The bunkhouse foreman retained his position as foreman, and the status of the foreman was clearly established in the framework of coal-mine management. As stated already, the role of the foreman was divided into recruitment of miners and work supervision and control on the one hand and the management of a bunkhouse on the other. The foreman recruited miners through the "friendship system", a mutual assistance organization for miners, and through personal contracts. The majority of the miners recruited in the initial period of Hokutan's existence came from metal mines in the Tōhoku region. However, as the scale of Hokutan's operations grew, the ratio of miners from farming backgrounds in the Tōhoku region increased. Thus the background of the majority of Hokutan miners changed from the metal mines to the agrarian villages of the Tōhoku (see table 17).[6]

TABLE 17. Native Areas of Hokutan Miners (1901)

Native Prefecture	No.	Native Prefecture	No.
Akita	582	Aomori	32
Hokkaido	258	Ōita	23
Ishikawa	175	Ehime	23
Toyama	169	Hiroshima	17
Niigata	74	Tottori	15
Yamagata	53	Tokushima	14
Miyagi	45	Yamanashi	10
Fukui	39	Kagawa	10
Iwate	35	Other parts of the country	108
Fukushima	33	Total	1,715

* The table covers miners at Hokutan's Sorachi Coal Mine.

The miners recruited by a foreman were placed under the foreman's control without signing any direct contract with the company. One foreman was allotted one hundred miners and recruited miners were boarded at his own bunk-house (10 to 20 miners per bunk-house). The foreman controlled production, and the recruited miners were virtually forced into long hours of toil. After allocating the miners to various work sites and supervising their entrance into the pit, the foreman toured the mine in order to supervise intra-mine labor.[7] Furthermore, it was the foreman who received the wages; they came in the form of a lump sum from the company once a month to be distributed to the foreman's subordinate miners. Owing to this control over wages, the foreman had economic control over his subordinate miners and could make a tremendous profit through intermediate exploitation.[8]

The bunkhouse system thus became not only a means to confine the freedom of the miners, who were occupationally very mobile, but also a means for the foremen to enjoy intermediate exploitation. They exploited the miners through boarding fees and through the sale of various goods which were supplied to the miners by the company but were actually handed over by the foremen. Thus the miners became little more than indebted slaves at the mercy of usurers.

Direct Control System

Although the direct control system already existed during the period of government management, it was improved in the following way: a coal-mining section was established under a chief engineers, and this section controlled each mine. Engineers and clerks were allocated to each mine. Clerks, who took charge of various tasks in accordance with the orders given by the engineer, made hired hands supervise miners in each allotted section. Under each hired hand there was a sub-foreman, who directly supervised and controlled the work at the site in accordance with the Regulations of Sub-Foremen's Duties (see figure 2). It is assumed that miners who had long experience going back to the days of government management were promoted so that a group of sub-foremen could be established. Moreover, it appears that many of the miners who came under the direct control of the company during the early stage of Hokutan's establishment possessed various skills.[9]

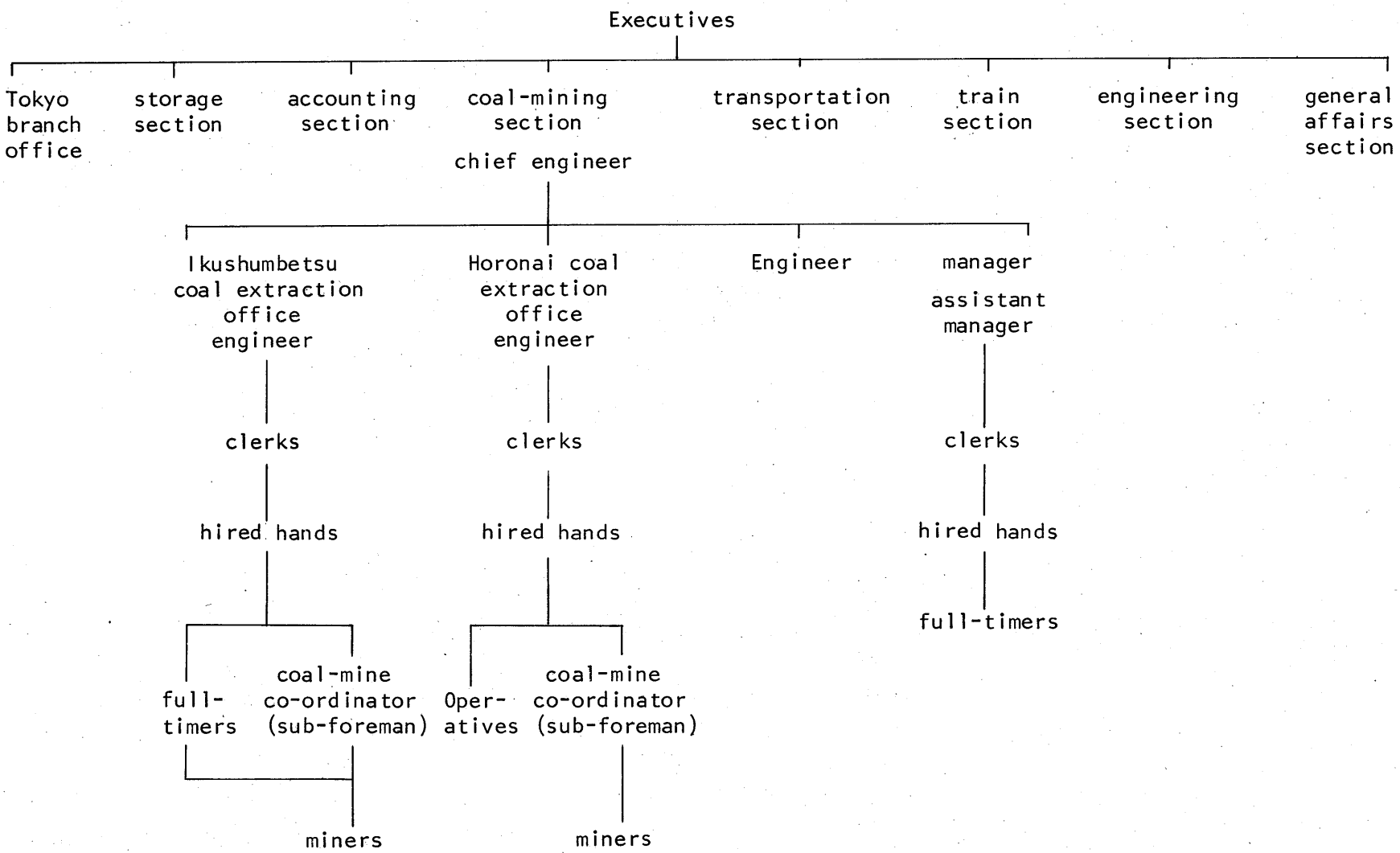

FIG. 2 Work Supervision Structure of Hokutan Mines

The progress made in mechanization at Hokutan brought about changes in the various forms of employment, and it ultimately led to the abolition of the bunkhouse system. The abolition of the bunkhouse system suggests that the system itself was such a burden to the coal-mine capitalist that it became necessary to place labour under direct control. The main factors which shaped and promoted the change were, first, that the coal-mine workers were overtly and covertly critical of the bunkhouse system and, secondly, the mechanization of coal mines had progressed. The progress made in mechanization necessitated unified control and supervision at each work section in the production process as well as the promotion of structuring and the planning of production. Production controlled by contractors who only possessed limited technological knowledge not only became the bane of both mutually unified control and the supervision of each work section, but also it contradicted planned production due to random extraction solely aimed at increased output. Moreover, intermediate exploitation promoted the depreciation of the labour force and thus hindered the effective utility of labour since the miners were uncooperative. The coal-mine entrepreneurs, therefore, abolished the bunkhouse system in order to eliminate these factors accompanying the system which hindered production.

It was at a relatively early stage that the abolition of the bunkhouse system was decided. Annoyed by a wage raise demanded by foremen of the Yūbari coal mine, who enjoined the support of their subordinate miners, in January 1893, the company enforced the abolition of the foreman system and with it the bunkhouse system in September of the same year. All the miners were placed under the company's direct control, and only the best foremen were chosen to be hired anew to fill the new position of miners' co-ordinators. In April of the following year, Regulations Regarding the Duties of Miners' Co-ordinators were formulated defining the work involved. The duties of co-ordinators included the following: to recruit and discharge miners; to grant miners licences or to collect expired licences; to supervise work and check work records; to convey various notices to the company and to write them out for the miners; to maintain and control miners' barracks; and to supervise the general health and hygiene of the miners. Thus they took over all the duties of the foremen. The abolition of the bunkhouse system, however,, was only possible because of the existence of abundant prison labour. In

other words, irrespective of the attitude of miners under the foremen, the conditions for uninterrupted production were secured by the existence of prison labour together with the existence of directly employed miners. Thus, when the order ending prison labour was issued in the same year, the transition to the direct control system became difficult. The foremost problem was labour shortage, in particular the lack of coal extraction workers. Furthermore, in view of the fact that the company did not have sufficient power to control the miners, work efficiency was low. In addition, the occupational mobility of the miners became even higher. As a result of this, the bunkhouse system was, *de facto*, revived, although not under the same conditions as before. In relation to the progress of mechanization inside and outside the mine, the company steadily prepared the necessary conditions for the total abolition of the bunkhouse system.

Paving the way for this move, Hokutan opened a general goods store which was directly run by the company and so eliminated the powers of intermediate exploitation enjoyed thus far by the foremen. In 1895 the position of barrack chief, assistant to the co-ordinator, was established; barrack chiefs were to supervise regular attendance at work as well as promote good behaviour at the bunkhouse. In 1899 the position of patrolman was created to reinforce supervision. Furthermore, recruitment, which used to be entirely handled by each contractor (foreman) haphazardly, was unified through the establishment of the terms of employment regarding loans and traveling expenses. As can be seen, the coal-mine owners, who had been dependent on bunkhouse foremen, deprived these men of their various functions, such as recruitment, supervision, control of work, and bunkhouse management. The Sorachi coal mine opened a company-managed boarding house in April 1905 and appointed a "board-master" to supervise the miners. Former bunkhouses were bought up by the company and bunkhouse foremen were paid compensation and were discharged. The Sorachi coal mine thus put an end to the bunkhouse system. As in the past, those foremen whom the company considered to be good workers were re-employed as co-ordinators or patrolmen. The Sorachi coal mine had set a precedent and after the Russo-Japanese War, the bunkhouse system at various Hokutan mines was abolished and a semi-controlled system called the co-ordinator system was introduced.

The abolition of the bunkhouse system and the transition to the co-ordinator system corresponded to the standard of productivity of the coal mine at this stage, namely, mechanization. Despite the fact that mechanization progressed rapidly, the extraction process itself continued to rely upon manual labour even after World War I. Thus the existence of co-ordinators who supervised the workers and their labour was indispensable. The co-ordinators were allowed neither to receive gifts and money from the miners nor to socialize with them. They were made to carry out work operations such as recruitment and supervision of attendance in accordance with the instructions given by various coal-mine officials.

In conjunction with the abolition of the bunkhouse system, the method of promoting work attendance productive efficiency, and the behaviour of the miners was transformed from the conventional method of enforced confinement under the bunkhouse system to a method where miners could be motivated on a voluntary basis. A work encouragement system was established in which miners who went out to work for more days than the set standard were paid bonuses in proportion to the number of extra days they engaged in work. The Horonai coal mine introduced the increased output system in 1901, and this spread to other mines (in this system, miners whose output was more than the set number of boxes were paid higher wages than the standard). This system contradicted the bunkhouse system where foremen received a lump sum which then was paid out by them to the miners. There is no doubt that the existence of foremen who ruthlessly exploited the labour force hindered the promotion incentives for miners'. Thus, another reason for the abolition of the bunkhouse system was efficient labour utility. At the same time, in order to enhance production efficiency and increase working days without the bunkhouse system, it was necessary to reinforce the above-mentioned systems of work encouragement and increased output.

Measures for the stability of the miners progressed in relation to the transition to the "direct control system," and these measures were rapidly implemented, especially after the abolition of the bunkhouse system. This was because it became impossible to keep the miners by enforcing measures which confined their freedom. The new measures adopted were as follows: the establishment of welfare facilities (hospitals, bath houses, distribution

centres, elementary schools, etc.); incentives for long service (those who served for a long period were awarded a certificate and a bonus from 1901 onward, and an award ceremony for long-timers and a system of paying annual bonuses based upon seniority of service were put into effect from 1908); betterment of a mutual aid system; allotment of farmland in order to nurture a sense of permanence; and the employment of more miners with a family. As a result of these measures, taken to increase the stability of the miners, the mobility rate of Hokutan's miners was lowered and thus the type of miner changed from the "single migrant labour" type to the permanent skilled miner and miners with families. (see table 18)

The discussion thus far has dealt with the progress of mechanization and the conditions of the labour force and labour organization at the Hokutan mines during the Japanese industrial revolution. The development was so much faster than at mines belonging to other companies in Hokkaido that it was as if it had a monopoly on progress. Hokutan was able to achieve this rapid development for to the following reasons. Firstly, there was an accumulation of coal-mining technology introduced by government-employed foreigners during the period of government management. Secondly, in the period when labor recruitment was difficult, Hokutan was permitted to use cheap prison labour, which solved the problems of labour shortage and cost. Thirdly, Hokutan had a monopolistic ownership of the means of transportation (railways and port). In 1896, Hokutan ventured into marine transportation with the use of its own vessels as part of its business activities so that the company could overcome the difficulty of its isolated position from the coal market. Fourthly, the government granted financial aid such as subsidies on interest payments.[10] The mechanization of coal mines became possible for the first time due to abundant capital. Supported by these various conditions, Hokutan was able to overcome a geographical disadvantage and make monopolistic progress.

3. Local Capital

The domestic coal market grew in relation to the progress of the industrial revolution in Japan. Other than those owned by Hokutan, in the 1900s a

TABLE 18. Miners' Mobility Rate, Length of Service, and the Ratio of Miners with Families at Hokutan

Coal Mine Name	Mobility Rate (%)			Length of Service (%)										% of Married Miners
				1906					1910					
	1908	1909	1910	less than 1 year	less than 3 years	less than 5 years	less than 10 years	More than 10 years	less than 1 year	less than 3 years	less than 5 years	less than 10 years	more than 10 years	(1910)
Yūbari No.1 (Male)	76.7	69.5	85.2	42.3	34.6	9.2	10.6	3.2	38.5	30.3	15.5	10.0	5.5	41
(Female)	74.9	94.2	80.2						49.7	35.2	10.0	3.6	1.2	48
Yūbari No.2 (Male)	111.7	75.5	75.4	77.1	23.9	-	-	-	48.8	32.6	16.7	1.6	0.1	53
(Female)	70.3	125.1	87.0						62.9	33.7	3.3	-	-	38
Sorachi (Male)	79.4	43.4	37.8	-	77.1	8.3	13.3	1.0	20.1	34.7	23.5	14.6	6.8	68
(Female)	67.1	59.8	63.1						39.9	8.6	3.1	1.2	0.5	71
Horonai (Male)	73.2	39.7	24.2	19.5	37.1	12.0	19.7	11.5	13.1	28.7	25.7	19.9	12.3	71
(Female)	58.6	53.0	37.9						35.9	6.5	20.1	1.9	1.4	66
Ikushumbetsu (Male)	87.1	51.3	35.5	41.7	29.6	12.0	11.1	5.4	18.2	35.4	21.2	17.0	7.9	70
(Female)	70.3	75.9	38.7						42.8	32.6	18.3	5.1	1.0	56

number of coal mines were opened in Hokkaido by local capital. At the time of the founding of Hokutan, there were only two other coal mines, namely, Kayanuma and Harutori. Even around 1900, the only addition to the above two coal mines was the Beppo coal mine in Kushiro (opened in 1896 with an annual output of 10,000 tons). However, from 1900 several new coal mines were opened by local capitalists — 12 in the first decade of this century. The following were the major coal mines at this time: Naie, Utakami, Hombetsu, Noboribetsu, Shin Yūbari, Monju, Nakamura, Dai Yūbari, and Noborikawa at the Ishikari coalfield, Daitō and Ōwada at the Rumoi coalfield, and Ōsaka at the Kushiro coalfield. Those who opened these coal mines can be classified into several types. The first type consisted of old local families who ventured into coal-mine management. The second type consisted of those who had been involved in mining such as burkhouse foremen and engineers. The third consisted of businessmen engaged in shipping, construction, trading, and commerce who also managed coal mines. It is noteworthy that more than half of them came from outside Hokkaido. The rise of such small- and medium-sized coal mines was due to the expansion of the domestic coal market as well as to the nationalization of the railways, which led to the decline of Hokutan's monopoly over transportation. These coal mines, however, lagged behind in their facilities. As of 1907, only two coal mines Ōwada and Harutori — were equipped with steam-powered hoisting machines. As of 1908, only three mines — Ōwada, Harutori, and Saitō — were equipped with drainage pumps. The use of ventilation fans was nonexistent event at these mines. It can be said that the small- and medium-sized coal mines were clearly different not only in the amount of capital possessed and in scale but also in the degree of mechanization. In addition to the delay in mechanization, transportation costs were high because of the long distance to the market, and the wages were also high as a result of the labour shortage and high commodity prices. Consequently, the management of small- and medium-scale mines was not profitable and coal mines operated by local capital such as were seen in the Chikuhō area of Kyushu never developed in Hokkaido. Most of these coal-mine managers had very little technical knowledge, and they viewed coal-mine management as a side business. In the 1910s, these coal mines were absorbed by capital coming into Hokkaido from by corporations in Tokyo.

Notes

1. The Yūbari coal mine also pursued mechanization in the adits along the coal-bed through the installation of a small hoist run by low-pressure compressed air power at sites of sharp inclines so that it could be used for the transportation of materials.

2. Hokutan, which suffered from gas, established the rules of ventilation for pit workers on 6 July 1892 (they were revised as the rules of ventilation for specialists on 5 October 1897) and allocated ventilation specialists.

3. The only electric machine installed in the pit in the 1900s was the drainage pump introduced at the Sorachi coal mine. All the other electric machines were installed outside the mine. This was because electric machines were not suitable for intra-mine use because the open system brought the risk of gas explosion in the Hokutan coal mines, which suffered from abundant gas.

4. There were the following four coal-mine-related manufacturing plants at Hokutan: Yūbari manufacturing plant (established in 1904), Sorachi manufacturing plant(stated in 1901), Manji manufacturing plant(started in about 1907), Horonai manufacturing plant(the foundation date is unknown; however, in April 1907, the plant established rules pertaining to the handling of products and repairs and calculation order). The major production work was handled by the Yūbari manufacturing plant, and the remaining three plants were primarily in charge of repairs and the production of parts. A full-scale plant was established in the Yūbari manufacturing plant in 1906 equipped with 15 lathes, 1 planer, 1 shaping machine, 1 milling machine, 1 boring and turning mill, and 1 screw cutter. In 1915, there were 130 operatives (30 lathe workers, 50 production workers and blacksmiths, 30 welding and wooden-mold workers, and 30 finishing workers). Sorachi manufacturing plant was started initially with 5 furnaces and 15 operatives, and even in 1912, there were only 12 furnaces with 36 operatives. Subsequently, by World War I, however, a hand lathe(1) and electric lathes(2) were purchased, and a welding factory was built. The number of operatives was also increased to 50. When Manji manufacturing plant was first established, it had 2 furnaces and was engaged in only minor repairs done by contracted blacksmiths. In 1913, however, it was equipped with 2 lathes and 1 drilling machine. Then in 1915 the number of furnaces was increased to 3. In 1917, the number of operatives was increased to 50. Until after the Russo-Japanese War, Horonai manufacturing plant was engaged in iron repairs and production of simple iron products. In 1917, however, 1 blast furnace, 1 copper pyrite furnace, 5 furnaces, 2 lathes, 1 drilling machine, and 1 screw cutter were installed and the operatives were increased to 30. In the following year, the number of operatives was increased to about 80.

5. In addition to the Horonai coal mine, Hokutan considered introducing prison labour at Sorachi, Ikushumbetsu, and Yūbari. According to the permit request submitted to the Hokkaido municipal bureau, Hokutan submitted a plan to introduce 3,500 prison laborers in five years until 1895.

6. In the initial years of Hokutan's founding, the miners' backgrounds varied according to each mine. Manpower at each mine comprised the following: at Yūbari the miners were from Kyushu coal mines, and Akita and Sado metal mines; at Ikushumbetsu migrant labourers came from Kyushu; miners from Akita and the Hokuriku region were at Sorachi; and prison labour was used at Horonai.

7. Concerning the bunkhouse foremen, the *Fifty-Year History of Hokutan* states as follows:

> The foremen subcontracted the work of coal screening at an unfloored site outside the pit, coal extraction at various specified sites, the repairing of pits, or coal transportation. All the miners engaged in these tasks had nothing to do with the company, and were recruited by foremen independently. Moreover, bunkhouse boarders were never allowed to be engaged in company-run projects.

The miners' hours of work from the time of the founding of the mine to 1905 were 12 hours with two shifts, and the average number of work days per month was around 20 days.

8. Although it was decided that the foremen's handling charge should be less than 7 per cent of the miners', they actually took a far greater share.

9. The case of a skilled miner being promoted to sub-foreman was mentioned in the previous chapter pertaining to the Horonai coal mine. The group of sub-foremen at the Miike coal mine in Kyushu also consisted mainly of skilled miners with long service who had been promoted.

10. The interest subsidy paid for the railway installation fund was 5 *shu* per annum up to 1897. For a period of 8 years after the railway opened, it was 5 *shu* of the running cost.

III. THE ADVANCEMENT OF *ZAIBATSU* CAPITAL

1. Circumstances

When Hokutan's railway monopoly declined due to the railway nationalization in 1906, capital from the big-business world of the *zaibatsu* (financial, commercial, and industrial conglomerates), on the basis of increased coal demand triggered by the development of domestic heavy industries, moved into Hokkaido.

Mitsui bought up Noborikawa coal mine in 1911 and opened a pit in the Sunagawa coal district in 1913. In the same year, it also obtained control over the management of Hokutan, which was faced with financial difficulties, and thus placed Hokutan under its ownership. In addition, Mitsui made Ishikari Coal Mine Co., Ltd. (founded by Sōichirō Asano in May 1906) merge with Hokutan in January 1920. In August 1911 Mitsubishi established a Temporary Hokkaido Survey Section in the head office of Mitsubishi Co. It came to own a coal extraction district of about 194.7 hectares in 1913 and conducted test boring which covered an area of approximately 35,955 hectares. In the following year, 1914, the Ashibetsu Coal Mine was newly excavated. This was the first excavation of a new coal mine for the Mitsubishi Co. Ltd. in Hokkaido. Furthermore, Mitsubishi Co. bought up the Dai Yūbari coal mine in January 1916. Following Mitsui and Mitsubishi, Sumitomo and Okura also ventured into Hokkaido, bolstered by an economic boom during World War I (see table 19). Thus by the mid-1980s, coal mining in Hokkaido was under the complete control of *zaibatsu* capital, which either purchased or merged coal mines run by small and medium local concerns in financial difficulties (see table 20).

The following were the reasons which made it easy for *zaibatsu* capital to advance into Hokkaido coal mining. Firstly, there was abundant underdeveloped

land in Hokkaido whose ownership right was not established. *Zaibatsu* capital possessed the accumulated technology and massive capital required for test boring, which was an effective means of utilizing this underdeveloped land.

TABLE 19. Advancement of *Zaibatsu* Capital into Ishikari Coalfield

Zaibatsu	Year	Coal Mine	Purchased or opened	Remarks
Mitsui Mine	1911	Noboribetsu	Purchased	From Yūki and Iida. Later sold to Hokutan in 1919
	1915	Sunagawa	Opened	
	1922	Monju	Purchased	From Tanaka Mining Company
	1928	Bibai	Purchased	Purchased to Kōshu Coal Mine from Nippon Petroleum Co., Ltd.
	1939	Ashibetsu	Opened	
Mitsubishi Mining	1914	Ashibetsu	Opened	
	1915	Bibai	Purchased	From Nobetarō Iida
	1916	Dai Yūbari	Purchased	From Dai Yūbari Coal Mining Co.
Sumitomo Mining	1916	Karamatsu	Purchased	
	1924	Kami Utashinai	Joint management	With Ban Coal Mining Co. Became independent in 1929
	1928	Utashinai	Purchased	From Yamashita Shipping Co.
	1928	Shin Utashinai	Purchased	"
	1928	Naie	Purchased	"
	1928	Hombetsu	Purchased	"
	1936	Akabira	Opened	
	1937	Kami Akabira	Opened	
Ōkura Mining	1918	Moshiri	Opened	→ to Yūbetsu
Yamashita Shipping	1916	Utashinai	Purchased	→ to Sumitomo
	1916	Shin Utashinai	Purchased	→ to Sumitomo
	1916	Naie	Purchased	→ to Sumitomo
	1916	Hombetsu	Purchased	→ to Sumitomo
Yūbetsu Coal Mining Railway	1935	Moshiri	Purchased	from Okura Mining → to Mitsubishi

Notes: 1) Part of the original table is revised.

2) Ishikari coalfield produced 94 per cent of the total Hokkaido coal output in 1918.

TABLE 20. Proportion of *Zaibatsu* Capital in Hokkaido Coal Mining

	1910	1914	1918	1921	1925	1930
All Hokkaido	1,609*	2,580	4,057	3,590	5,345	6,724
Hokutan	[1,075]**	1,406	2,129	2,030	2,795	2,847
Mitsui	-	144	248	195	509	817
Ishikari Coal	-	-	369	-	-	-
Taiheiyō	-	-	-	124	230	316
Mitsui Group Sub-total	[1,075]	1,550	2,746	2,349	3,533	3,980
Mitsubishi	-	2	565	625	835	1,255
Dai Yūbari	-	93	-	-	-	-
Yūbetsu	-	-	-	-	151	396
Mitsubishi Group Sub-total	-	95	565	625	986	1,651
Sumitomo	-	-	12	-	116	637
Ōkura	-	-	5	102	232	211
Total of Zaibatsu Group	[1,075]	1,645	3,327	3,076	4,867	6,479
(Mitsui Group percentage)	(0%)	(94.2%)	(82.5%)	(76.3%)	(72.5%)	(61.4%)
Ratio of the above to all Hokkaido	[67.5%)	63.7%	82.0%	85.7%	91.0%	96.3%

* All figures refer to thousands of tons.

** The percentage is partially revised. Since Hokutan was not part of the Mitsui Group prior to 1914, the figures are in brackets.

Secondly, unlike Kyushu and other regions, related facilities such as ports had to be possessed independently due to underdevelopment. Because of higher wages and transportation costs, it was necessary to lower production costs through large-scale production and mechanization. Owing to the fact that all these entailed great expense, it was advantageous for the *zaibatsu* groups with their abundant capital. Thirdly, backed by great financial resources, *zaibatsu* capital ventured into Hokkaido while correlating coal mining and other kinds of business (i.e., pump and electricity), so that redundancy of a single business could be effectively minimized without damaging general further profitability.

The development of new coal mines undertaken by *zaibatsu* capital was pursued with the introduction of technology used in the Kyushu region. Those who were in charge of this development studied technology at imperial universities and higher technical colleges, and then received practical training whi which they could implement at Miike and Chikuhō in Kyushu. As a result of the transfer of these engineers by *zaibatsu* capital, large-scale coal mines other than the ones belonging to Hokutan were opened in Hokkaido. However, the coal output at Hokutan, which was now under the ownership of Mitsui, consistently occupied more than 50 per cent of the total output in Hokkaido even after the development of Hokkaido coal mining in general (see table 21).

TABLE 21. Coal Output and the Number of Miners throughout Japan, in Hokkaido, and in Hokutan Mines

	Nation-wide		All Hokkaido		Hokutan		(d)/(a) %	(d)/(b) %	(e)/(c) %	(f)/(d) %
	Coal output (a)	No. of miners (b)	Coal output (c)	No. of miners (d)	Coal output (e)	No. of miners (f)				
	in tons		in tons		in tons					
1880	882,055		524		-	-	0	-	-	-
1885	1,293,678		36,071		-	-	2.7	-	-	-
1890	2,628,284		186,418		163,471	1,132	7.0	-	87.6	-
1895	4,772,658		430,515		345,255	3,452	9.0	-	80.1	-
1900	7,471,684	70,508	654,506	7,725	610,777	5,871	8.7	10.9	93.3	76.0
1905	11,637,188	79,905	1,177,511	8,959	978,891	8,800	10.1	11.2	83.1	98.2
1910	15,681,324	137,467	1,571,695	12,120	1,066,984	9,092	10.0	8.8	67.8	75.0
1915	20,490,747	180,100	2,611,562	17,899	1,555,679	11,037	12.7	9.9	59.5	61.6
1920	29,245,384	342,873	4,509,582	38,297	2,569,382	17,828	15.4	11.1	56.9	46.5
1925	31,459,415	252,898	5,639,103	27,756	2,838,399	13,342	17.9	10.9	50.3	48.0
1930	31,376,213	204,526	6,726,579	26,988	2,940,452	10,030	21.4	13.1	43.7	37.1

Note: Figures for empty columns unknown.

2. Coal mine Management by *Zaibatsu* Capital -- The Case of Hokutan

Hokutan's coal-mine management made progress in both production technology and use of labour during the recession of post Russo-Japanese War period and in the 1910s. The following points can be mentioned with regard to the progress made in production technology.

First, the main adits which used to be in the coal-bed stratum came to be

set up in a rock-bed so as to prevent cave-ins. For this purpose, it became necessary to introduce new rock drills. Thus the company changed from the conventional jackhammer of the water-liner model made by Ingersoll Co. to the B.A.R. 33 model made by the same company. Secondly, improvements were made in the long-wall extraction method. For example, non-filling long-wall extraction was tested in the 24-*shaku* coal bed from 1908 onward at the Yūbari coal mine. In February 1918, an Extraction Method Improvement Committee was established at Yūbari, and in the same year the sand-filling long-wall extraction method was tried. Together with the effort to move toward the long-wall method, various machines were introduced (test use following the extraction process). In 1916 a chain-type coal cutter made by Hopkinson and in 1918 a bar-type coal cutter were put to test use. The introduction of machinery in the extraction process, which progressed rapidly in the latter half of the 1920s, was truly the outcome of this improvement as well as of the prevalence of the long-wall coal extraction method, which was successfully introduced during this period. Nevertheless, mechanization in the extraction process in the 1910s was limited to a restricted number of processes. Moreover, it was not the coal cutter, which was put to test use in the 1910s, but the coal pick that prevailed in the latter half of the 1920s as extraction machinery (see table 22).

TABLE 22. Introduction of Extraction Machinery

	Yūbari Coal Mine		Manji Coal Mine		Sorachi Coal Mine	
	Cutter*	Pick	Cutter	Pick	Cutter	Pick
1916	1	0	1	0	0	0
1921	2	0	1	0	0	0
1926	2	141	1	5	0	28
1929	3	141	2	5	1	29

* The above figures denote the number possessed in each year.

Thirdly, coal-screening machines were systematized. At Yūbari, for example, coal which was dropped from the chipper to the screen was divided into lumps, medium lumps, and powder. Lumps and powder coal were sent to the washer on a conveyor belt. Lump coal was moved onto the picking band, where stones

were picked out manually. Screened coal was put back on the conveyor belt to be sent out.[1]

Fourthly, together with the progress made in mechanization, the transition from steam power to electric power was pursued rapidly. Electricity, which was introduced around 1900, soon took over after the Russo-Japanese War of 1905 and at the time of World War I, and most of the intra-mine machinery at Hokutan came to be electrified in 1922. In response to electrification, Hokutan constructed its own large-scale power plants during this period.

Fifthly, in conjunction with the progress made in mechanization, Hokutan put in a great deal of effort to expand and improve manufacturing plants. While importing the latest machinery from the West on the one hand, Hokutan, on the other hand, aimed at the self-sufficient production of necessary parts and machinery.[2]

Although there was a partial introduction of machinery into the extraction process as seen above, mechanization during this stage made the lacuna between manual work in the extraction process and the progress of mechanization in the other areas more pronounced. The change in the labor structure due to the imbalanced development of mechanization and the rise of the labour movement due to the economic boom triggered by World War I, made a characteristic imprint upon the procurement of labour and its organization at Hokutan.

As far as labour procurement was concerned, most characteristic was the introduction of Korean labourers and an improved employees' training system. As far as labour organization was concerned, it was the total disappearance of the bunkhouse system and the formation of a new labour control system which was explicitly revealed by the establishment of the Isshin Kai (the United Association), which was an organization designed to harmonize labour and management.

The following two points can be made with regard to the change in the labour structure. The first is that while the number of intra-mine porters, intra-mine odd-jobbers, and coal screeners was drastically reduced as a result of mechanization inside and outside the mine, the number of workers involved in

pitwood work and the operation of various machines increased (see table 23). This change shows the effect on the rationalization of manual labour and diversification of work caused by mechanization. The second point pertains to the fact that the number of extraction workers tended to increase up to

TABLE 23. Changes in the Composition of Labour at the Yūbari Coal Mine

			1906	1913	1925	1927
Extraction workers			persons 1,484	persons 1,317	persons 1,433	persons 1,875
Pitwood workers			120	92	458	586
Coal-screening workers		male	707	215	-	-
		female	609	271	105	126
		children	-	17	-	-
Porters	male	inside pit	1,258	564	581	282
		outside pit	-	146	186	152
	female	inside pit	74	131	62	25
		outside pit		11	-	-
Operatives	Operators	inside pit	?	59	79	244
		outside pit		229	323	322
	mechanics	inside pit	?	40	98	186
		outside pit		119	152	227
Odd-jobbers and others	male	inside pit	517	252	103	109
		outside pit	782	358	299	364
	female	inside pit	16	24	7	58
		outside pit	-	107	73	4
	children	outside pit	75	-	12	-
	Total			3,952	4,027	4,560

Notes: 1) There was one child each among coal-screening workers and among outside pit operatives in 1925. Extraction and pitwood workers and operatives were all male. The figure for outside mechanics in 1927 includes 77 electricians.

2) Coal pushers are included as "inside pit" porters.

3) This table shows the total for Yūbari No.1 and No.2 mines.

4) According to Otaru Commercial College's *Hokkaidō Sekitangyō Gairon* (1916), there were the following operatives at the Yūbari coal mine as of the end of June 1912: 127 operatives (40 intra-mine, 87 outside the mine) and 92 mechanics (19 intra-mine, 73 outside the mine).

the middle of the 1920s, a reflection of the delay in the mechanization of the extraction process despite the influence of economic trends. In other words, this shows that the increase in output at this stage was dependent upon the increase in the number of extraction workers. Consequently, the total number of miners was consistently on the increase, and the labour shortage became serious at the time of World War I.

The increase in the number of operatives due to mechanization signifies that there was an increase in skilled and semi-skilled jobs rather than in conventional manual jobs. It became necessary, therefore, to supply skilled and semi-skilled workers of various levels including a group of engineering leaders. For this purpose, an Engineering School Student Loan System (to lend money for the tuition fees of employees' children) had already been established in 1907 as part of the engineering training. In 1917 this system was improved and the Rules of the Loan System (Hokutan employees and the children of Hokutan workers age between 14 to 30 were granted tuition loans) were established. Hokutan helped found the Sapporo Engineering School in 1918. In 1920 Hokutan independently founded the Yūbari Engineering School and the required knowledge for coal extraction was taught there so that Hokutan coal-mine workers could be trained. (Approximately 30 students were admitted every year for a three-year training course. This program continued for 13 years and sent out 409 graduates.) While these systems and schools were the training centers for middle management, the Labour Training Centre was established in the Yūbari coal mine with the objective of teaching knowledge and skills to general miners who had completed elementary education. They had up to this point acquired such skills on-the-job from senior miners. The first characteristic change in the labour structure thus led to improved employee training centres which helped labour procurement.

The second point, the shortage of miners caused by the economic boom of World War I, was especially severe in Hokkaido. The lack of an agrarian surplus population and soaring wages because of the labour shortage were serious problems for coal-mine managers. Korean labour was introduced as a result of this. The first instance was the Yūbari coal mine, which took on 33 Koreans in 1916, and the number of Korean workers increased rapidly in the area centring around Yūbari (see table 24).

TABLE 24. Introduction of Korean Labour

Year	No.	Year	No.
1916	35	1926	1,206
1917	370	1927	1,323
1918	659	1928	1,505
1919	754	1929	1,205
1920	703	1930	540
1921	577	1931	145
1922	907	1932	70
1923	819	1933	120
1924	1,028	1934	93
1925	1,005	1935	114

Note: Most of the Korean labourers were employed at the Yūbari, Wakanabe, and Manji coal mines.

The form of labour organization was also changed as a result of the changes in the labour structure and the new conditions of labour procurement. One of the principal changes in the labour structure was a decline in the number of low-income earners, a group which had been typified by the odd-jobbers, and a relative increases in well-paid jobs (see table 25). This fact reveals that the Hokutan workers had risen out of the so-called lower social strata and were joining the growing ranks of skilled working classes. It can thus be said that a broad foundation for the acceptance of the labour movement was being formed. Owing to the labor shortage caused by the economic boom of World War I, each of the Hokutan coal mines faced frequent strikes. Demanding wage increases and an improvement in labour conditions, workers went on strikes at the Mayachi coal mine in April 1917, at the Wakanabe pit in November, and again at Mayachi and Shin Yūbari in July of the following year. Moreover, the Yūbari branch of the national miners' association was formed in November 1919. In response to these events, Hokutan got rid of the remains of the bunkhouse system in the form of an indirect and forceful labour control system(the bunkhouse itself disappeared in 1922), and began the full-scale direct control of labour. Labour affairs were separated from the General Affairs Section in order to "modernize" management of labour. In December 1919, in order to compete against the establishment of the Yūbari branch of

TABLE 25. Average Daily Wages According to Occupation at Major Coal Mines (1906)

(yen)

Name of the Coal Mine	Occupational Category							
	extraction worker	pitwood worker	screening worker		porter	operative	odd-jobber	
			male	female			male	female
Yūbari No.1	1.343	1.904	0.486	0.272	0.877	-	0.549	-
Horonai	1.002	1.254	0.366	0.200	0.619	0.581	0.428	-
Ikushumbetsu	0.999	1.090	0.412	0.220	0.611	0.634	0.420	-
Sorachi	0.971	1.055	0.473	0.316	0.733	0.369	0.517	-
Iriyama	0.650	0.700	-	0.180	0.350	0.380	0.300	-
Ōnoura	0.630	0.680	0.390	0.280	0.440	0.500	0.420	0.310
Namazuta	0.592	0.615	0.340	0.260	0.473	0.506	0.495	0.330
Miike	0.566	0.461	0.220	0.202	0.368	0.493	0.280	0.237
Yoshiya	0.665	0.480	-	0.200	0.450	0.550	0.370	-

Note: Wages for occupational categories without reference to male or female apply to male workers. Wages for porters, operatives, and odd-jobbers indicate those of workers inside the pit.

the national miners' association, the management established the Isshin Kai (the United Association) in imitation of the English factory committee system, an organization designed to bring about cooperation between labour and management.

As can be seen from the above, it was on the basis of rapid mechanization at the coal mines in the years up till the end of the 1910s that new labour and management relations were established at Hokutan, and it became difficult for the management to make unilateral decisions on the workers' wages. Consequently, in spite of the prolonged recession after World War I, management found it difficult to cut down on wage costs, which had soared during the war. Wage costs thus became a burden to the coal-mine management. In order to overcome this situation, various coal-mining companies created a cartel to maintain prices and at the same time promoted complete "rationalization" in the production process from the latter half of the 1920s. Coal cutters and coal picks were introduced to the extraction process and the mechanization of transportation at the coal face was promoted simultaneously through the introduction of conveyor belts. Owing to this progress

in the mechanization of the extraction process, the organization of labour shifted from the indirect co-ordinator system to a totally direct control system.

Notes

1. Although the water used for coal washing in the screening process might have contaminated river water, the problems which might have arisen or the solutions for them were not necessarily fully clarified.

2. Regarding this point, see Chapter 2, note (4) of this paper.

CONCLUSION

This paper has clarified the manner in which Hokkaido coal mining during its initial phase of development was confronted with more difficulties than that of other regions and how it overcame them and developed rapidly in both use of technology and labour. When the foundation for the development of Hokkaido coal mining is summarized in relation to the objectives stated at the beginning of this paper, the following points can be made. Firstly, the problems pertaining to the lack of technological knowledge and experience were overcome through the adoption of the following four methods: (i) management actively employed and utilized Japanese engineers who had acquired coal-mining technology under the Tokugawa regime; (ii) foreign engineers were introduced and at the same time their technology was absorbed through experience by Japanese assistants; (iii) students were sent abroad so that they could acquire modern coal-mining technology; (iv) management endeavoured to propagate coal-mining technology through training at school. Owing to these methods, foreign coal-mining technology spread and took root among the Japanese without the need for total dependence on foreign countries. In addition to this accumulation of technological knowledge, the mechanization of coal-mines, which was actively pursued (through purchases of foreign products as well as domestic production by means of imitation) for the 1890s onwards, and favourable natural conditions made it possible for Hokkaido coal mining to achieve remarkable development.

Secondly, the development of Hokkaido coal mining was carried out as part of the general development of Hokkaido under government management, the government being prepared to accept losses for a long period. Consequently, transportation means such as railways and ports or coal-mine-related facilities which required a massive amount of initial capital were well organized. Moreover, it was possible to plan and pursue a large-scale excavation plan with

the introduction of modern excavation technology, thus avoiding random excavation aimed at immediate profitability. In other words, a business foundation was laid systematically during the period of government management, which set the stage for development after sales to a private concern.

Thirdly, the difficulties deriving from the long distance from the market were overcome as a result of the large-scale operation of the coal-mines, increased output through mechanization, and lower transportation costs through management not only of railways but also of shipping.

Fourthly, the greatest obstacle — labour shortage — was overcome in different ways in each period of development. In the initial period of development, labour shortage was solved through the introduction of miners from the metal mines as well as through the massive application of prison labour. Moreover, miners from the metal mines were transformed into workers with the appropriate skills for coal mining. After the abolition of the use of prison labour, the labour shortage was overcome by absorbing the surplus aprarian population, mainly from the Tōhoku region. The contractor system, in the form of the bunkhouse system, was the core of labor organization during this period. It was a system which was most suitable for the procurement and organization of labour. When the labour shortage became serious due to the economic boom of World War I, it also became difficult to procure labour from the agrarian villages which once supplied the labour. From then on, therefore, Hokutan solved the problem of labour shortage through the massive transfer of Korean labour from colonized Korea. While Hokutan was able to overcome labour shortages in each period, it also endeavoured to improve the quality of the labour force in the post Russo-Japanese War period and after, and it established training systems for engineers and workers of various levels. As a background to this, there was a rapid development in the mechanization of coal-mines. Between 1906 of thereabouts and World War I, labour organization was transformed from the conventional bunkhouse system to a semi-control system of co-ordinators, thereby resulting in a new labour and management relationship.

By the end of the 1920s, Hokkaido coal mining, which developed around Hokutan, was completely taken over by *zaibatsu* concerns, which had advanced into

Hokkaido during the World War I period with their abundant capital and technological know-how, and it subsequently came to achieve remarkable progress.