

# METAL MINING AND FOREIGN EMPLOYEES

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## INTRODUCTION

**T**HE isolationist policies of the Tokugawa shogunate, which had been upheld as an unquestionable course of action by the rulers of Japan for over two hundred years, came to an end when the Japan-United States Treaty of Peace and Amity was signed with Commodore Perry in 1854.

The resultant opening of the country to the world made unavoidable an unprecedented turnabout in policy, which led, four years later in 1858, at the insistence of Townsend Harris, the American consul general, to the conclusion of the Japan-United States Treaty of Friendship and Commerce.

This treaty provided the impetus for the commencement in 1859 of trade with five signatories of commercial treaties: the United States, Britain, France, Russia, and Holland. Japan was thus squeezed, suddenly and mercilessly, into the framework of the world capitalist economy.

It could well be expected, therefore, that Japan, whose production was then insufficiently developed to meet the sudden and extensive demands of the world market, was in grave danger of becoming a Western colony.

Furthermore, as a result of the extreme disparity in the relative values of silver and gold between Japan and other countries, approximately five hundred thousand *ryō* in gold coin left the country in the course of only a few years.

To counter this, the Tokugawa shogunate resorted to recoinage, but this instead lent impetus to rising prices, a troubled economic situation that still showed no signs of relenting when the Meiji era began in 1868.

The subject of this paper is the response shown under these circumstances by the mining industry, a major supplier of the so-called nonferrous metals (gold, silver, and copper) for the coinage which was declining qualitatively and quantitatively.

Sir Harry Smith Parkes, British minister from the late 1860s to the 1890s, played a prominent part as the leader of the foreign diplomatic corps in the Western diplomatic offensive against Japan after the establishment of the Meiji government. In no uncertain terms, he stressed to the high officials of the government that to stabilize Japan's troubled economy and normalize foreign trade, the most important thing was to mint and issue a unified currency, and that implementation of this was a matter of urgency, for the honor of the Emperor as well. He assailed the government with this demand, unanimously supported by Japan's trade partners, who, he alleged, were suffering great losses in the course of development of their trade with Japan.

Amidst this pressure from the outside world, the Meiji government was forced toward a speedy modernization of industry: first, in order to stabilize foreign trade and overcome the danger of colonization that existed since the fall of the shogunate, and also, domestically, in order to consolidate the centralization and unification of power through maintenance of gold and silver as the raw materials of coinage and through the establishment of a new unified currency system based on the gold standard, thus bringing the troubled old currency system up to date. The modernization of the mining industry was an integral part of this effort.

However, when we view the mining industry as a whole without dividing it into ferrous and nonferrous sectors, we can state that the modernization of the mining industry was the result of the development of management with a variety of objectives including the maintenance of gold, silver, and copper as raw materials for coins, the export of copper and coal, and the military use of copper, iron, and coal.

Be that as it may, the Meiji government set about modernizing the mining industry as a direct government operation in affirmation of its resolve to implement these modernization policies.

This led to government-operated mines. The reason for government operation was that the position of Japan's industrial capital was very weak due to the severe restrictions placed on commercial activity under the Tokugawa shogunate.

Japan's mining industry had by the 1830s reached a nadir of inactivity and stagnation. If we limit ourselves to the principal causative factors in the excavating sector alone, the following points can be mentioned: (1) Sloppy excavation concentrating only on bringing out the highest-quality ore, and the bad state of repair of tunnels; (2) Burial or discarding of ore that with Western smelting methods would have been profitably refinable in tunnels or at tunnel exits as slag; (3) Clumsy technology to deal with water and ventilation; (4) Shortage of manpower—the skilled miners (*horidaiku*) and their assistants (*horiko*) who formed the backbone of the workforce—due to silicosis, the occupational disease caused by inhalation of dust in tunnels.

These problems had arisen in stages since the sixteenth century in the course of the development of the "gallery (tunnel) method" of excavation that was prevalent in Japanese mines. Therefore, the stagnation of mining activity that set in at the middle of the nineteenth century can be attributed to the synergistic interactions of all these factors.

I will go into more detail presently, but these defects originated in the arbitrary subcontracting system in which the entire process of mining production, from excavation to ore selection and refining, whether managed directly by the shogunate or *han* governments, or indirectly by private individuals, was left in the hands of *yamashi* and *kanako* (subcontractors) throughout the entire Tokugawa period.

To overcome these problems and achieve its objectives, the Meiji government brought mining specialists and technicians from England, the United States, France, Germany and other advanced countries and assigned them to manage the government-operated mines. A total of seventy-eight foreigners were em-

ployed, and fifty of these were assigned to nonferrous mining operations. Twenty-four came from France, thirteen from Germany, eleven from England, and two from the United States.

These men were called "foreign employees" but their employment was not only limited to government-controlled mines; they were also employed in the gold, silver, and copper mines whose ownership was opened to private individuals.

What we are interested in is not whether they were employed by the government or by the private sector, but rather how they conceived modernization at the mines where they were assigned, and more concretely, how they promoted the modernization of these mines. The goal of this paper, then, is to answer the above questions.

The success of this policy of employing foreigners in the government to carry out modernization measures in the areas of their specialty, and in the face of the danger of colonization, can be called an "evolved exclusionism," because success in modernization did away with the threat of colonization.

#### I. THE FOREIGN EMPLOYEES' KNOWLEDGE OF PRACTICAL MATTERS AND THEIR IDEAS ON MODERNIZATION

There is much that we should today like to know in more detail about the activities of the foreign employees who came to work at mines in Japan in the early Meiji era after 1868. However, we are still able to read the various reports and prospectuses which they left behind. These tell us about their periodic observations and surveys, and about the launching of new enterprises.

For example, F. Coignet wrote "Note sur la Richesse Minérale du Japon" [1] as well as an account of policies of mine administration in Japan and a report on the Ani copper mines. We also have such interesting accounts as *Nihon kōzan-hen* [On mining and mines in Japan] by C. Netto<sup>1</sup> and a translation of notes on the latter's lectures at Tokyo University published by the Ministry of Education in 1883 under the title *Nesshi yakingaku* [Mr. Netto's metallurgy]; a report on the Besshi mines by L. Larroque;<sup>2</sup> a report on the Ani mines and "Einiges über Bergbau und Hüttenwesen in Japan" [Some thoughts on Japanese mining and metallurgy] by A. Mezger [7, February 1884]; "Mittheilungen aus Innai" [Report from the Innai mines] by B. Roesing [7, February 1884]; "Reise nach Kosaka und Aufenthalt daselbst" [Journey to Kosaka and stay there] by C. Hagmaier [7, 1877]; a report on the Oppu copper mines by E. Naumann; and detailed accounts of visits to mines in central and northeastern Japan as well as along the Japan Sea coast by J. Godfrey.<sup>3</sup>

If we analyze these various reports, we can say that the authors showed a common awareness that modernization meant more than mere technological

<sup>1</sup> An English translation is published in *Nature* (August 5, 1880), and a Japanese translation is contained in [12].

<sup>2</sup> The original manuscript is kept by the Sumitomo Historical Compilation Bureau at Kōbe.

<sup>3</sup> Godfrey's and Naumann's reports, unpublished to the knowledge of the author, are kept in the Resources Engineering Department Library at Kyushu University.

innovations. Without exception, the type of "modernization" which they helped plan and which they played a leading role in putting into practice did not neglect essential changes in the system of management.

The sort of modernization which they planned and guided invariably aimed at reforming the old system by which the opening and managing of mines had been delegated to subcontractors (*yamashi*, *kanako*, etc.) who kept under their control the necessary labor force with its knowledge and special skills and who also acted as middle-men in buying and reselling ore and refined metal.

The foreign employees in all cases wished to replace this old system by one in which the *yamashi* and *kanako* would be absorbed into positions which would support the work of the new owner-operators who would ideally be well acquainted with both the theory and practice of advanced mine management. The foreign employees further proposed that in the new systems the mine-related laborers, i.e., the specially skilled *horidaiku* miners and their *horiko* assistants, and skilled traditional ore refining specialists known as *fukidaiku* and their *fukiko* assistants, be given specific wage contracts to replace the former type of depending on subcontractors with its lack of a fixed income.

Significantly, the new concepts proposed centralizing control over all production and management activities in the hands of the new owner-operators, whether government or private.

In his "Notes sur la Richesse Minérale du Japon," written at the Ikuno silver mines in 1874 [1], F. Coignet noted that in the second half of the sixteenth century, which had been a brief period of unrestricted trade and intercourse with Europeans, older mining and metallurgical practices underwent a technological change—in the case of mining, a change from the open-cut method to the gallery (tunnel) method, and in the case of refining, the adoption of cupellation and Western methods of extracting copper—and as a result, the mining industry rapidly developed. However, he also noted that the industry flourished for only a century and then gradually declined until 1869, the second year of the new Meiji government [1, pp. 50, 105]. F. Coignet ascribed this decline in productivity to the following causes:

(1) The use of chemical explosives to excavate hard rock formations was unknown, and since the only excavating tools were the mining chisel (*tagane*) and pickaxe (*tsuchi*), only areas with especially rich ore were mined, while at the same time only relatively "soft" and easy-to-dig areas were mined. Areas which fit both these conditions tended to become exhausted rather quickly.

(2) Channels for water drainage often had to be cut through hard rock in order to operate efficiently, but because of high construction costs the practice of opening such drainage channels was gradually abandoned. The only mechanical devices for eliminating water were bamboo pumps, and in places where these could not operate efficiently, water seepage in the tunnels made mining operations extremely difficult or impossible.

(3) The tunnels were very small (sixty centimeters wide and ninety centimeters, or sometimes only sixty centimeters high). They were also unsystematically located and very winding, making it extremely difficult for the *horiko* workers to carry

out the ore, especially from the deeper tunnels.

F. Coignet noted that in the traditional processes of ore selection and refining much ore had been discarded which by more modern treatment processes could have brought profitable yields of gold and silver.

Most of this "waste" from the mines was piled up near the tunnel entrances. F. Coignet writes that until not long before the time of his observations, ore which contained less than 7 per cent of refinable metal was discarded as being too expensive to refine. He mentions that he ran a test on some discarded ore which he happened to obtain from a tin mine about twenty kilometers southwest of Kagoshima and found that it contained some 75 grams of gold and 1,279 grams of silver per ton. On the basis of these results he judged that it should be feasible to introduce Western methods to redevelop mining and refining throughout Japan.

In his opinion, the introduction of Western operations should not be limited to machines and technologies in the hands of foreign employees like himself, but should include the training of Japanese technicians, who should be made well acquainted with the new methods.

He then proposed setting up at the Ikuno mines (to which he was attached) the "Apprenticeship Center" to train Japanese mining engineers. The institution which F. Coignet envisaged for Ikuno but which appears never to have been realized in practice, aimed also at the dissolution of the old and ineffectual *yamashi-kanako* subcontracting system and at putting whole production process directly under the more up-to-date control of government owner-operators.

The same need for training courses was also pointed out by C. Netto at the Kosaka silver mines and by A. Mezger at the Ani copper mines. Both set to work to give concrete form to their proposals.

C. Netto, who directed the modernization process at the government-operated Kosaka mines, noted in his afore-mentioned account of Japanese mines that in general the mine owners purchased the ore from "middlemen" who on the one hand controlled groups of miners and who on the other hand sold the ore produced at prices set according to the proportion, by weight, of metal. He writes as follows: "The decisions as to which miners will be made to excavate at which places and by what methods are in the hands of the subcontractors, and the latter, being wholly driven by individual greed, are interested only in excavating soft areas in search of especially high-quality ores, while they avoid and pay no attention to hard [rock] areas."

Netto considered that the mine owners' authority over these subcontractors was not being sufficiently well exercised, and concluded that "the subcontracting system is the greatest evil in the mining industry" [12, pp. 137, 144].

A. Mezger, who was employed to direct the modernization process at the government-operated Ani copper mines in 1879, wrote a report on the mines which greatly revised some of the plans for the mine which had earlier been drawn up by F. Coignet. For example, due partly to budgetary restrictions, Mezger's plans omitted Coignet's ambitious proposal for a large refining plant on the coast of the Ōga Peninsula which would have used coking coal brought

by ship from the Miike mines in Kyūshū and which would have refined ore from several different mines in Akita Prefecture.

Mezger's report, while long (twenty-two chapters) and detailed, set forth in its preface the problem of the traditional subcontract system. In his preface Mezger states: "What I have especially paid attention to is the matter of subcontracting. Insofar as the system has been a custom in the mining industry for several hundreds of years, it is by no means with an easy heart that I set to work to abolish it. However, at this time when it is necessary to make specific plans for developing the mining industry and to plan for new installations, this problem cannot be avoided."

Problem areas which should be reformed are pointed out in more detail in the third and ninth chapters of the report, which deal with "control and management."

Mezger notes that "In Japan, if one compares officials at government-operated mines who are in charge of business procedures with those in charge of technology, the authority of the former is superior. The scope of the technical officials' authority is only to check ore veins, leaving their actual exploitation to subcontractors. They only become involved again at the time of purchasing the ore which has been mined and selected by these subcontractors."

Mezger goes on to say that "the subcontractors throw away ore that should be quite suitable for refining, losing half of the usable ore in the selection process." He concludes that "mine operation by subcontractors by no means promotes the development of mining but, on the contrary, impedes it."

As a means of eliminating the subcontract system, he proposed dividing mine officials into two separate sections: technical and general affairs. The two sections should be jointly controlled by a superior-ranking person who was familiar with the duties of both. Officials of the technical section should direct the management of the entire process of production, including mining, ore selection, and refining.

He proposed that the refining sector should be mechanized and put firmly under the control of the mine owners (i.e., the government). Former *yamashi* and *kanako* subcontractors should be made to assist in excavating ore which had previously been neglected as being of too poor quality, and should thus be made to assist in providing ore in quantities which would meet the capacities of the mechanized refining technologies. Washing and concentration plants should, he suggested, accept ore only in batches of at least five tons, while smelters should accept batches of at least one ton.

Purchasing transactions should be calculated according to prices set by the standard Mansfeld table for ore assays, developed in Germany. Not only the former subcontractors, but also the manual mine workers (*horidaiku* and *horiko*) who had been subordinate to them, should be put under the effective control of Japanese engineers and skilled workers who were well-versed in all aspects of modern mine technology.

These proposals to have the mine owners (in this case, the government) take firm hold of the refining sector, set minimum quotas for ore volumes and set

purchasing prices according to scientific standards, were aimed in large part at the dissolution of the *yamashi-kanako* subcontracting system. This system, with antiquated hand-excavating methods using only the mine chisel and pickaxe as tools, was expected to find it difficult to meet the requirements of mechanized refining. In the result the mine owners would be forced to close the excavating sector.

The above proposals were also based on the knowledge that in general the subcontract system was less firmly rooted in the refining sector than in the mining (excavating) sector, where an immediate transition to more modern methods would in general be more difficult.

Let us note, however, that the subcontract system patterns tended to vary according to the type of metal being mined. For example, in Japan's gold and silver mines, to a greater extent than in other types of mines, subcontractors had traditionally tended to monopolize not only mining as such, but also the concentration and refining processes.

In any event, in the case of the Ani copper mines, A. Mezger estimated that from one to two years would be necessary to bring all process of production and pricing under the firm control of the mine owners, namely, the government.

After finishing his term of employment at the Ani copper mines from September 1882, A. Mezger, for one year replaced C. Netto (who returned on leave to Germany) as lecturer on mining and metallurgy at Tokyo University. In his lectures he gave many specific examples, taken from his experiences at the Innai and Ani mines, of the dissolution of the *yamashi-kanako* subcontract system, and he also discussed various problems in the overall process of modernized production, especially in the modernization of the refining sector.<sup>4</sup>

Still another example of the way in which the above-described *yamashi-kanako* subcontract system had caused stagnation in Japan's mining industry is seen in the case of the Besshi mines (on the island of Shikoku), which had since 1691 been Japan's largest copper mines.

According to a history of these mines,

the reason why all mining operations in this country were unable to show progress during the latter part of the Tokugawa period [1600-1868] was that operations were impeded by water seepage inside the mines. Another reason that must be listed is the fact that there was a lack of [good] passageways for transporting ore. The only tunnels which existed for mining and transport were extremely small and required exceedingly great amounts of time and labor to traverse. The subcontractors as operators were not willing to bear the costs [that were necessary to remodel the tunnels]. The Besshi copper mines were no exception. Without eliminating the inconvenient working conditions in such mines and without remodeling the facilities within them, no hope can reasonably be put in a continuance of operations, regardless of how complete the facilities outside the mines and management practices may be. . . . [4, pp. 309-11]

In the course of its efforts to overcome these conditions at the Besshi copper

<sup>4</sup> See "Einiges über Bergbau und Hüttenwesen in Japan" by A. Mezger issued in [7].

mines, the Meiji government, although not the owner of the mines, ordered Saihei Hirose, a top manager of the privately owned mining company, to visit the Innai silver mines to receive instruction in Western management practices from F. Coignet. On Hirose's suggestion, L. Larroque was in 1874 employed at the Besshi mines, where he set to work at planning the mines' modernization. Larroque's report, whose suggestions seem to have met his employers' expectations, was principally concerned with the following four topics: (1) facilities inside the mines, especially the opening of new, methodically planned horizontal and vertical tunnels (galleries); (2) roads, railroads, and other transport facilities; (3) installations for ore refining, construction of a smelter, and manufacture of bricks needed for such construction; (4) new mining methods and the installation of ore-pulverizing machines and other modern equipment [4, pp. 309-10].

It is worth noting that in this case, too, the plans for modernizing and centralizing the refining sector, with the building of a central smelter, were an important foundation for doing away with the *yamashi-kanako* subcontract system and turning over to the mine owners effective control of the entire process of production.

## II. THE PROGRESS OF MODERNIZATION

Modernization in Japan's nonferrous mining industry began with the modernization, i.e., the mechanization, of the refining processes. This fact is clearly pointed out in a book on Japan's mines by the foreign employee Curt Netto.<sup>5</sup>

Writing in 1879, Netto discusses those mines, both government and privately operated, which had up until then "put the new methods into practice." He describes the sectors of production in which modernization began at each mine as follows:

(1) At the gold and silver mines on Sado Island, there were introduced an ore refinery for preliminary processing, an extraction plant for a higher degree of processing, and an amalgam process using iron pans. These facilities were originally set up by foreign employees but were at the time of writing being operated wholly by Japanese.

(2) At the Ikuno silver mines in the northern part of present-day Hyōgo Prefecture, modernization began with the introduction of one hundred rotating iron stampmills driven by waterwheels, together with a refinery using a Rittinger table (a type of jigger for separating different sizes of ores) and a Freiberg-type amalgam method making use of barrels. Twelve persons from France had earlier been employed, but their number at the time of writing had been reduced to eight.

(3) At the Ōkuzo gold mines in present-day Akita Prefecture, modernization began with the introduction of the California-type amalgam method using iron pans, together with the Hungary-type stamp amalgam method using a kind of

<sup>5</sup> His report was translated into Japanese under the title of *Nihon kōzan-hen* reprinted in [12].



mortar. Ten waterwheel-driven iron stampmills for pulverizing ore were also introduced. The equipment had been first installed by engineers from America, but at the time of writing it was being wholly operated by Japanese.

(4) At the Kosaka silver and copper mines, also in present-day Akita Prefecture, a smelter using both the Ziervogel and the Hunt-Douglas metallurgical processes had been introduced. The work of smelting had been initiated by engineers from Germany but was at the time of writing being done wholly by Japanese. The Ōkuzo and Kosaka mines had originally belonged to local *han* governments, and after the Meiji Restoration of 1868 both the ownership and management of the mines passed into the hands of the new central government which took the initiative in introducing new mining methods.

(5) At the Yamagano gold mines in present-day Kagoshima Prefecture, modernization began with the introduction of the California amalgam method and the installation of ten waterwheel-driven iron stampmills for pulverizing ore. French engineers were still in charge of the refining operations.

(6) At the Handa silver mines in present-day Fukushima Prefecture, modernization began with the introduction of a mill using wooden ore-pulverizing pestles fitted with iron rings, together with a Freiberg-type amalgam method using barrels. At the time of writing, the manual operators were all Japanese, but they were employing European methods.

We can see from the above summary that important initial stages in mechanical refining were the introduction of iron machinery for crushing and pulverizing and apparatus for concentrating the pulverized ore. And we see that various amalgam methods as well as the Ziervogel and Hunt-Douglas smelting processes were adopted in order to raise the degree of purity of gold, silver, copper and other metals.

In his book, Netto notes that although in 1875 tests of a new amalgamation refining process at the Sado gold mines were successful, the total output of refined metal did not increase as fast as it might have due to the fact that still-backward mining methods did not supply enough ore to meet the capacity of the new refining process. We may easily see from Netto's first-hand account that it was indeed in the refining sector, not in the mining sector, that the modernization process had its beginning.<sup>6</sup>

We should note that in the case of mercury amalgam processes, different mines, in a rather uncoordinated way, introduced and adopted different methods, e.g., the California pan method, the Freiberg barrel method, and the Hungary stamp method. This situation reflected the fact that, as shown in Table I, the foreigners employed at the various mines had a variety of nationalities (Britain, U.S.A., France, Germany, etc.) and thus a variety of technological traditions. It also reflects the fact that Japanese at that time lacked sufficient ability to make technological choices on their own initiative or to coordinate and standardize the types of new technologies adopted.

<sup>6</sup> See [8, pp. 54-55]. The official government publication *Kōbushō enkaku hōkoku* also testifies to the fact that modernization began in the refining sector [5, pp. 96-149].

TABLE I  
FOREIGN EMPLOYEES IN GOVERNMENT-OPERATED NONFERROUS  
METAL MINES, 1868-83

Place of Work	Country of Origin	Number	Work Description
Ministry of Industries, Head Bureau	England	5	a chief mining engineer; a secretary; an instructor (excavation engineer, and expert in mineral analysis); an assistant chief mining engineer; an instructor (mining engineer, metallurgist)
	Germany	1	an instructor
Ikuno	France	24	a mining engineer; 9 miners; 4 geologists; a bricklayer; 2 medical officers; 2 smelters workers; 2 mechanics; 2 instrument specialists; a forge worker
	England	5	an ore preparation expert; an instrumentation and ore preparation expert; 3 miners
Sado	United States	1	a mining and ore preparation expert
	Germany	1	a tunnel excavator
	England	1	a miner
	Germany	2	a mining and ore preparation expert; an instrument specialist
Kosaka	England	1	a miner; an instructor and mining and ore preparation expert; an instrument specialist
	United States	1	a mining, instrumentation, and ore preparation expert
Ōkuzo	Germany	5	a chief of instrumentation; a mine foreman; a mechanic; an assistant mining engineer; a smelting engineer
	Germany	5	a mine foreman; a chief of instrumentation; a mechanic; an ore-washing foreman; a smelting engineer

Source: [5, pp. 91-96].

The California-type method, by which amalgams were made in pan-like containers, was introduced on Sado Island by E. Gower (Britain) and A. Janin (U.S.A.); at the Ōkuzo mines by R. Carlyle (U.S.A.); and at the Yamagano mines by P. Ogier (France).

The last-mentioned engineer, P. Ogier, came to Japan in 1877 with a strong recommendation from F. Coignet, and the next year he was employed by the Yamagano mines to direct their technological progress. Very likely on the advice of F. Coignet, he had on his way to Japan stopped in California and Nevada where he helped open new veins of gold ore at the mines around Virginia City, at Gold Hill, and at Glass Valley. He also had the opportunity to see and study the mechanical apparatus and the details of the chlorination method through which gold is separated from the ore through the addition of chlorine. Ogier's

various experiences in California had an important and fundamental effect on the guidance which he imparted while employed at the Yamagano mines [13, pp. 6, 93].

In Europe, the study of mining and especially of metallurgical technology may be said to have developed and expanded through much of the continent and later, through much of the world, as a result of the "silver rush" which took place in the mid-twelfth century around Freiberg, in the southern part of the present-day German Democratic Republic [3, pp. 48–54]. It is not surprising, then, that in spite of the fact that F. Coignet (a European who had studied at the mining school in St. Etienne) had worked in California, he chose the familiar Freiberg amalgam method, from which the other amalgam methods developed, to be tried and then adopted at the Ikuno mines. The Freiberg method was later also adopted at the Handa mines.

It is interesting to note, however, that previous to his coming to Japan, where he was originally employed by the Satsuma *han* in 1867, Coignet had had experience in surveying gold mines in California, and that as a result of this experience he ordered much of the necessary small-scale refining apparatus for the Ikuno mines from the United States, which had greatly developed its metallurgical technology in the course of the mid-century "gold rush" in the Western states [1, pp. 3, 22–23] [2, p. 102].

The Handa mines were privately owned by the financier and politician Tomotsu Godai, who had formed a close personal friendship with F. Coignet. It is not surprising, then, that both direct and indirect guidance from Coignet was requested. Refining and other facilities at the new Handa mines are described as follows:<sup>7</sup>

My Handa silver mines use an amalgam method patterned wholly after that of the government-operated Ikuno silver mines. At the time my mines opened in 1874, they had a dressing plant, an ore-crushing plant with fifteen stampmills capable of pulverizing approximately 1,200 *kamme* (3,500 kilograms) of ore in twenty-four hours, a roasting plant, a reverberatory furnace which measured 1 *jō* (about 300 centimeters) in length and 4.5 *jō* in length, an amalgam plant with twelve amalgamation barrels, and also a plant for the final production of silver, an office, workshops, and warehouses, all of them newly constructed. [9, p. 111]

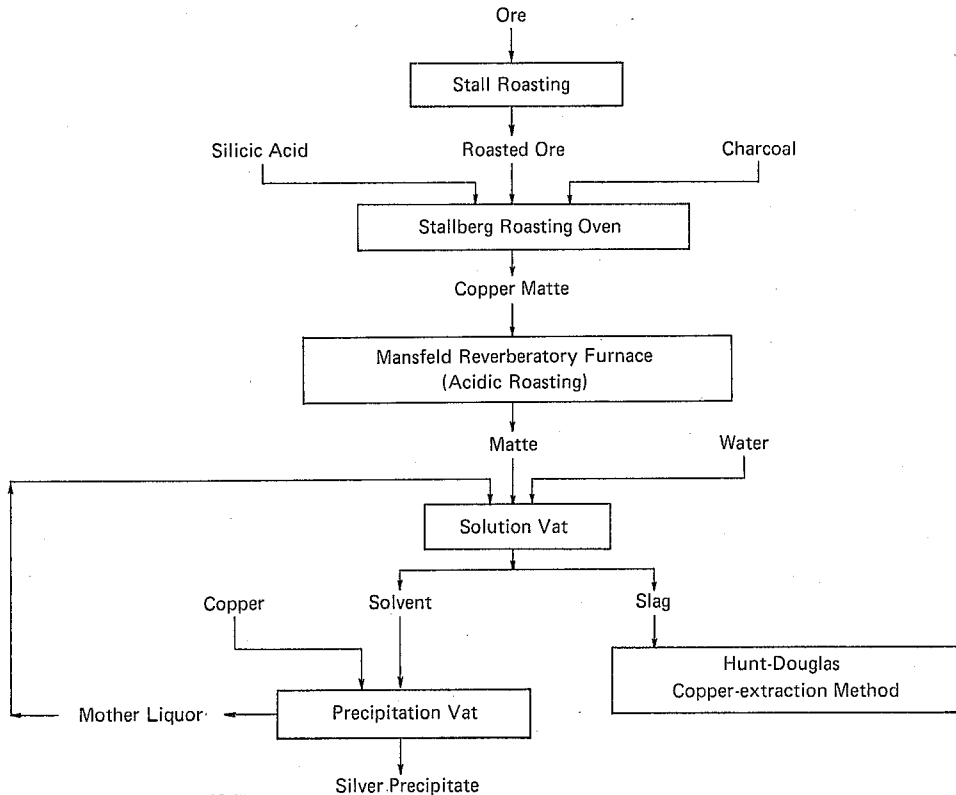
F. Coignet visited the Handa mines in 1876 and gave direct guidance with respect to all process of production [9, p. 106].

The following quotation describes the introduction at the Kosaka mines of the Hunt-Douglas and the Ziervogel methods for extracting silver.

When Netto assumed his post as chief processing engineer at the Kosaka mines in 1873, he changed the design of the smelter to the Mansfeld type since the previously used dry-type refining methods had not given a very high yield in relation to the costs incurred. Plans were thus laid to reduce the consumption of charcoal fuel

<sup>7</sup> See also K. Matsuura ed., "Handa ginzan kōgyō enkaku-shi" [History of mining at the Handa silver mines] written in 1887 and available on microfilm (R28–45–961) at the Osaka Chamber of Commerce Library.

Fig. 1. Refining System at Kosaka Mines



Source: [10, p. 404].

and to adopt the wet-type method for the treatment of matte. By this new method, the matte formed was pulverized and then roasted in a specially constructed furnace in which the silver and copper contents were transformed into water soluble sulphates. First a copper plate was introduced into the solvent to retrieve silver precipitate by the Ziervogel method, and then an iron plate was introduced to collect copper precipitate by the Hunt-Douglas method. [See Figure 1.]

Thus, the type of refining technology introduced at the Kosaka mines was different from the technology introduced at other mines. The reason for this was the peculiar quality of the ore at Kosaka, consisting of a mixture of three types of ore: black, yellow, and siliceous. [2, pp. 24, 31–32]

As already mentioned, the modernization of the nonferrous mining industry in Japan developed around the mechanization of the refining sector. However, this mechanization process by no means proceeded smoothly.<sup>8</sup> As we shall see

<sup>8</sup> One example may be seen in [13, p. 35], in a letter of June 20, 1879 sent to Coignet from P. Ogier in Tokyo, in which it is stated that "The manual workers from Satsuma are all excellent. However, once they gain some position of authority, no matter how low, they do not obey orders, and there is not one among such persons in some position of authority who does not appear to be trying to paralyze the attempts at improvements

in more detail later, there was a stubborn repetition of actions which were aimed at protesting or obstructing the modernization which was taking place under the guidance of the foreign employees. Such actions were carried out not only by the *yamashi* and *kanako* subcontractors, but also by manual laborers subordinate to them.

The foreign employees, however, not only persisted, despite many hardships, in pushing forward the modernization of the refining sector, but they also promoted the training of Japanese who would take a frontline role in the modernization of the mining and concentration (ore dressing) sectors. As the results, in the process of modernization the *yamashi*, *kanako* subcontractors would withdraw from these sectors. The foreign employees were convinced that only by the proper training of such Japanese workers would be possible to bring all process of production effectively under the control of the mine owners, whether government or private.

For example, in making plans for the modernized redevelopment of the Ikuno silver mines, F. Coignet already in 1869 foresaw the need to train Japanese mining engineers, and in that year received permission to establish a mining school. By 1872, the school had trained a total of fifteen engineers.

It is unknown what became of the school afterward or what sort of curriculum it had, but in Coignet's "letter of proposal" asking for permission to establish the training facilities, he wrote that "to set up equipment and machinery in the Kanagase mining subdistrict of the Ikuno region, to contribute thereby to industry and to use it for the education of students should make it possible to train a number of mining specialists and to promote their work" [5, p. 102]. From the foregoing, we may suppose that some sort of on-the-job training was given with respect to mechanical refining methods.

The Meiji government issued a directive to prefectures throughout the country, ordering that students be sent to Ikuno. However, the residences of those students who came to Coignet's school were in fact limited to the area of Ikuno itself (present-day Hyōgo Prefecture) and to such nearby prefectures as Okayama, Hiroshima, and according to one source, Kanazawa. The trainees were given "scholarships" in the form of rice by their native prefectures [11, pp. 64-67].

At the Ani copper mine which was in 1875 designated a "government-operated mine," managerial reforms were attempted by the government-appointed head supervisor Motoi Ichijō. However, the attempted reforms tended to stagnate because of opposition from the *yamashi* and *kanako* subcontractors who tried to maintain the old ways that had prevailed since the pre-1868 Tokugawa era. As a means of trying to overcome the old mining practices, the managers of the Ani mines in 1876 sent thirteen miners, under the leadership of Yoshitarō Tanaka, a lower ranking government official who was ordinarily posted at one of the six Ani mining areas, to the Ikuno silver mines in order that they learn

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that have been so laboriously made. The supervisor Jirō is a good person and works without giving rise to problems, but the officials who assist him, who are too many, have a clear antipathy for European ways."

through direct, concrete experience how to change to more modern practices [5, p. 122].

The practice of sending mine workers to the Ikuno mines was also seen in the case of the privately operated Besshi copper mines on the island of Shikoku. Since 1691 the management of the Besshi copper mines had been entrusted to the Sumitomo family, generation after generation. This management tradition was allowed to continue by the new Meiji government after 1868. In the latter year and again in 1871, the mines' general manager Saihei Hirose personally visited the Ikuno mines to receive direct instruction from F. Coignet concerning Western mining, metallurgy, and managerial practices. This experience influenced the decision in 1874 to employ L. Larroque as an adviser at the Besshi mines [4, pp. 278-79, 298-99].

In the case of the Ani copper mines, the results of the experiments with sending workers to the Ikuno mines for on-the-job training appear not to have been sufficiently thorough, and the efforts to make mining and managerial practices more up-to-date continued to falter. However, in 1879, efforts were begun in earnest to modernize along lines suggested by the German engineer A. Mezger. Conditions at the Ani mines at that time are described in a report by Tominori Kitsunezaki, head of the refining division, as follows:<sup>9</sup>

Because the populace at the mines were accustomed only to old makeshift methods and had no thought of promoting new methods, a group of around forty or fifty miners was made to learn the new methods, and those among them who came to understand the new methods were made foremen (*kōfu-gashira*) directing the work of other miners. [In order to train these foremen] to work in all the various mines [in the Ani area], a foreman who was a foreign employee, namely, a German named Mr. Reichel, was sent to the Mukai silver mine where he gave instruction in mining practices and brought renewed prosperity to the mine in question. The Mukai mine is located on the opposite bank of the Ani River and has rich veins of gold and silver at a distance of about 1/2 *ri* [or about 2 kilometers] from the [Ani] mine's head office. It is said that when in a former time the mine in question was first opened, [the surrounding region] was extremely prosperous, now there is a village known as Ginzan-chō. There are three large veins of ore, which go by the names of Detokindate, Ōkindate, and Unjōhi. . . . According to oldtimers, what had caused the Mukai mine to cease operation was the fact that excavations had been done in an unplanned, makeshift way, with the result that the tunnels became filled with water, and even though it was known that there was good ore in the depths of the mine, it had become impossible to apply mining techniques. It is said that when the Ono-gumi [a Kyoto-based group of merchants and entrepreneurs] was operating there some years ago it excavated some good ore, but that it ceased operations because of the very poor condition of the tunnels, a demerit which was too great to overcome. The recent plans to revive the mine aim at improving the tunnels, facilitating ore transport, pumping out accumulated water, and educating mine foremen who will be able to excavate good ore. [6, pp. 230-31]

<sup>9</sup> The *Kōbushō enkaku hōkoku* also points out the need to refine discarded ore at the Ani mines, where the ore selection process had been far from thorough [5, p. 124].

The on-the-job training necessary for modernization in the mining sector in the Ani region was completed in December 1880.<sup>10</sup> According to a government report, starting in November 1879 "government personnel and miners who had received instruction in mining at the Mukai gold and silver mine were sent to various mining sites, including the Daira mine, where they set to work improving mining practices. In the process, the traditional operators, i.e., *kanako*, are gradually being eliminated" [5, p. 125]. We may see that, as a result, the entire range of production factors (including on-site management) at the Ani mines was being returned to the control of the mine owners, in this case the government.<sup>11</sup>

There are many other examples of deliberate efforts to break up the old managerial system by which subcontractors (*yamashi* and *kanako*) had monopolized production. Our example is that of the Innai silver mines, described below.

As of 1876, the management system used at the Innai silver mines was one by which, in spite of the fact that the mines had the previous year been designated as "government-operated," the government was continuing to purchase from the *kanako* subcontractors metal which the mine workers (who were subordinate to the *kanako*) had themselves refined at their own homes to the highest state of purity possible with the traditional technology. Such silver was known as *yamabukigin* and had a slightly yellow color due to the remaining impurities.

Because this system was proving inefficient and unprofitable for the government, the latter began to search for means of improvement. After a period of study, in 1878 the government set up an ore concentration plant to which all the ore excavated under the *kanako* system was brought together in one place and where the processes of concentration, washing, and refining were carried out under direct government control. However, the government was not without certain fears in regard to the reform.

According to the same government report quoted above,

an official notice had already been posted to the effect that after the completion of the ore concentration plant the old usages were to be abandoned and that the

<sup>10</sup> According to A. Mezger, "Einiges über Bergbau und Hüttenwesen in Japan" [7, February 1884], as a result of the training of mine foremen at the Mukai training center, production at the Daira lead mine, sixty miles away, increased by threefold. He states that these good results were because of strong efforts directed to the following three points: (1) the roles for which the foremen were trained; (2) improving the productivity of all mine workers; (3) more care given to the ore-concentration process. According to A. Mezger's earlier mentioned report on the Ani mines in particular, and also according to the *Kōbushō enkaku hōkoku* [5], prerequisites for modern mining were: (1) opening horizontal tunnels with tracks for ore carts; (2) opening vertical shafts with machinery installed to facilitate the lifting of ore; (3) the use of chemical explosives (later, dynamite); (4) installation of water drainage tunnels. A fifth important means of overcoming the traditional methods of hand-excavation was guidance in the introduction of rock cutting machines.

<sup>11</sup> In 1879 the Ani copper mines consisted of six subdivisions bearing such names as Ozawa, Makizawa, Sanmai, Ichinomata, and Kayakusa. A. Mezger referred to each of these as a separate mine site.

*kanako*, etc., were to be transferred to operate there. But unexpectedly, complaints might be made. We saw that if matters were left as they are, it would be impossible to change the old ways, and therefore we were resolute in our decision to carry through the reforms. But we were apprehensive that when reforms were made in customs that had existed for hundreds of years, [those opposed to the new system] might for a time cause disturbances aimed at impeding the government operations. Therefore we took the precaution of posting beforehand fifteen police personnel. When the ore concentration plant was completed on July 6, 1878, the *kanako* were to be assembled there and made to work at refining the silver. The purchase price for their metal was increased from 8.6 *sen* per *momme* [unit of weight equal to 3.75 grams] to 9.2 *sen* per *momme*. . . . Since previously ore was refined at individual houses, a part of the refined silver had been concealed. However, by refining at the ore concentration plant this evil will disappear.

However, when we look at later developments at the mines, it appears that opposition from *yamashi* and *kanako* subcontractors continued and that the government tried to be conciliatory by raising from time to time the purchase price for refined silver. In June 1879, the purchase price was raised by 0.3 *sen* and in September it was further raised by 0.5 *sen* to reach 10 *sen* per *momme*. In June of the following year the price was again raised by 0.5 *sen*. Then, in April 1881 it was reported that the *kanako* were demanding an additional price rise of 1 *sen*. The government at that point hardened its decision to eliminate completely the system of using the *kanako* as middlemen. June 30, 1881 was set as the date for eliminating the system, until which time silver would be bought at the price of 15 *sen* per *momme*, which was somewhat higher than the middlemen had been demanding.

The *kanako* pleaded for an extension of the above date, and the government, by granting an extension of one year as a condition for compliance, finally succeeded in bringing the management of all production and related business into its own hands [5, pp. 129–31].

After the end of the former managerial system, the former *yamashi* and *kanako* tended to be incorporated into on-the-job supervisory positions as direct government employees. The *horidaiku* and other mine workers became "wage laborers" and for the first time enjoyed "modern" employment contracts between themselves and the mine managers.

Thus, at the Innai mines, discussed above, the subcontract system which had depended on the former *yamashi* and *kanako* was being deliberately pulled down. But this is not to say that all systems of subcontract in Japan's mines came to an end during the same years.

In coal mines, a subcontract managerial system known as the *naya* ("barn") system grew up during the Meiji era and lasted until the 1930s, and in certain other nonferrous mines there flourished so-called *hanba* subcontract systems. Such systems had the common feature of being based on pseudo-family relationships (*tomoko*) between "parent and child" or between "older and younger brother," and the Japanese words to designate these differences in social position reflected this way of thinking.



However, the *yamashi-kanako* subcontract system and the newer types of subcontract systems used in the coal mines and in other nonferrous mines had different *raison d'être*. The former system pervaded almost the whole of production and sales relationships and caused economic activities to tend to be carried out mainly for short-term profits only. However, in many cases the latter systems were deliberately introduced within a framework of management and labor policies elaborated by mine owner-operators who were well acquainted with effective management theory and techniques.

### POSTSCRIPT

It was extremely fortunate for the modernization of the Japanese mining industry that the foreign employees understood clearly and correctly the conditions of Japanese mining at the time.

These conditions were that the owner-operators of the mines, the shogunate and *han* governments, had no practical knowledge of, and none of the technical skills needed in, mining, while the *yamashi* and *kanako* (subcontractors) who under the subcontracting system were entrusted with the entire process of production, from excavating to selection and refining, were the sole masters of the specialized know-how, techniques, capital, and manpower needed.

Had the foreign employees lacked an accurate knowledge of actual conditions, the modernization effort would probably have brought about nothing more than abandoned hulks of rusting machinery exposed to the elements around and about mines in outlying areas.

With great acumen, they saw how the arbitrary production methods of the *yamashi* and *kanako* (subcontractors) who were the pillars of the subcontracting system hindered the development of the mines. They also stressed that modernization of Japanese mines would be made possible if the owners had a thorough knowledge of the techniques necessary for the development of their enterprise, and that by such knowledge management and production plans could be drawn up. At the same time the foreign employees devoted themselves to implementing the entirety of their proposals.

This is commonly seen and confirmed in their reports and prospectuses on inspection tours, surveys, and launching of new enterprises, the product of their extensive travels throughout Japan.

Therefore, the machines and techniques they devised and introduced took root solely because of the dismantling of the *yamashi* and *kanako* subcontracting system. The establishment of these machines and techniques ultimately helped the later promotion and development of more distinctively Japanese ones.

But it cannot be said that the dismantling of the subcontracting system was carried out entirely without consideration for the *yamashi* and *kanako*. A. Mezger reflects the circumstances of this period very well as quoted in Section I.

Be that as it may, it is impossible to entirely avoid resistance and disorder when for any reason customs and traditions handed down over a long period of time become the object of reform or change. Despite the attentions given

by the foreign employees to such considerations, typified by A. Mezger quoted above, there was a common tendency to obstruct development at all the mines slated for modernization.

Yet it is impossible to overlook the existence of a small number of Japanese who, understanding correctly the sentiments and intentions of the foreigners, devoted themselves to acting as intermediaries in the cause of mutual understanding.

These were the "technical apprentices of the Ministry of Technology" and trainees of the "Mining Trading School" and the "Apprenticeship Center" at the Ikuno silver mines and the Ani copper mines. They filled the gap until such time as it became possible to send graduates of the College of Technology and the Faculty of Science of Tokyo University, established by the Meiji government with the aim of training professional mining experts to the "front line" in the mines with the necessary skills.

Most of those attending these schools were descendants of low-ranking samurai under the older system. But being intellectuals of a decent caliber, they were well equipped to understand the intentions of the foreign employees and to facilitate the success of modernization by transmitting what they understood to the other Japanese, many in number, who stood in the way of progress.

It is true that a great deal of trial and error took place before the ideas of the foreign employees were implemented correctly. But in their consideration for customs and traditions, in their overcoming the mine management problems that actually existed, and in their unshaken belief that therein lay the future of the Japanese mining industry, could be seen, despite much trial and error, the ultimate basis for the modern mining industry in Japan.

To our regret, we have poor knowledge of the personal histories of foreign employees except a few persons, e.g., C. Netto. This prevents us from appraising their achievements pertinently in historical perspective, as well as understanding the modernization of mining substantially. The international cooperation in these studies is fully expected.

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APPENDIX TABLE I  
EXCAVATION METHODS IN JAPANESE MINES, 1868-1932

Type of Deposit	Excavation Method	Place of Use	Time of First Use	Remarks	
(a) Vein deposits	Traditional pickaxe method (unsystematic)	All mines before the Meiji period; some small mines at present			
	Overhand stoping	Presently used at most mines	After 1868	Introduced by foreign engineers at Ikuno and Sado	
	Underhand stoping	Presently used in part at most mines Especially, Yamagano	After 1868	Used to excavate ore nodules lying beneath tunnels; a supplementary method used with overhand stoping	
	Shrinkage method		Hitachi	1905	Presently no longer used
			Osatizawa	1915	Standard method at present
			Arakawa	1916	Still used at present
			Hoshino	1920	Standard method at present
			Kōnomai	1925	Standard method at present
			Taio	1928	Standard method at present
	Filled rill stoping		Sado, Iwami		
		Arakawa	1924	Used at present	
		Yamagano		Standard method at present	
Filled flat-back stoping		Kushikino		Standard method at present	
	Chamber method	Mines with especially wide veins		An old method with many applications; used in a supplementary way	
(b) Massive ore deposits	Open-cut method	Used in the vicinity of outcroppings of black mineral deposits, at such mines as Kosaka, Kunitomi, Meiji, Abenojō, Taishō, Yoshino, Tōdoya; also used at iron mines (Kamaishi, Semmin, Kutchan, Abuta, etc.) and		Traditional method, still used in part; begun at Kosaka in 1908	

APPENDIX TABLE I (Continued)

Type of Deposit	Excavation Method	Place of Use	Time of First Use	Remarks
		at the Kamioka lead and zinc mines		
	Overhand stoping	Ofuku	1924	
	Filled chamber method	Kamaishi, Kunitomi, Ashio (for extracting nodules from quartz formations)		At Ashio, replaced the square-set method as the standard method in 1916
	Shrinkage method	Ashio (liparite nodules)		Presently used for very hard deposits only
		Kamioka		
		Kamaishi	1930	
(c) Small deposits, metasomatic deposits, and iron deposits	Pillar and room method	Hanaoka		Presently in use (with refilling)
	Filled diagonal stoping method	Yanahara Yoshino	1920 1926	Presently in use
	Filled flat-back stoping	Kosaka Kamioka		Standard method at present
	Square-set method	Iwami Hitachi	1923 1905	Standard method at present No longer in use
	Caving-type chamber method	Ashio (for extract-nodules in quartz formations) Various mines	1919	No longer in use Presently in use
	Sub-level caving method	Takara	1923	Standard method at present
	Undercut caving method	Tsuchihata	1925	Standard method at present
(d) Copper-containing sulphide deposits	Overhand stoping	Makimine, etc.		Ordinarily used with refilling
Gently sloping strata	Overhand stoping	Suwa, Imori, Takagoshi, Minawa, Shirataki		Standard method at present, ordinarily used with refilling
Steeply sloping strata	Overhand stoping			

APPENDIX TABLE I (Continued)

Type of Deposit	Excavation Method	Place of Use	Time of First Use	Remarks
	Underhand stoping	Various mines		Presently used only in special cases
	Filled flat-back stoping	Hitachi, Besshi		Standard method at present
	Shrinkage	Hitachi	1907	Discontinued in 1914
		Higashiyama	1914	Not used at present
		Besshi	1920	Presently used as a supplementary method
	Filled diagonal stoping	Hitachi	1920	Standard method at present
Lump formations	Filled overhand stoping	Kune		Standard method at present
	Shrinkage	Kune	1917	Not presently in use
	Filled flat-back stoping leaving rock support pillars	Hitachi		
	Filled diagonal stoping leaving rock support pillars	Hitachi		Used at present; commonly called "cutting-fill method"

Source: Kōzan-konwakai, ed., *Nihon kōgyō hattatsu-shi* [History of the development of Japanese mining] (Tokyo, 1932), Vol. 1, pp. 142-45.

Note: The word "presently" as used above, refers to the year 1932.