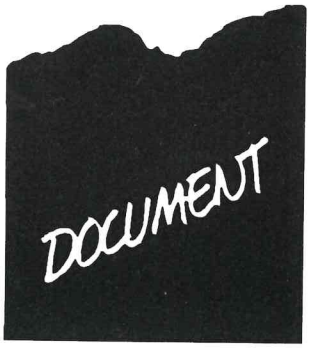


The future direction of Japan's nonferrous metal smelting

By Mining Division, Ministry of International Trade and Industry (MITI)

Japanese companies have been reconsidering their strategy of securing a stable supply of metals over the last few years. Equity participation will become more important in the future.

This document has been kindly submitted by the Metal Mining Agency of Japan. It was published as "New progress of overseas mine development and promotion of overseas mine development", by the Mining Division of the Ministry of International Trade and Industry in January 1994. In Raw Materials Report the appendix, with detailed demand model calculations, and the statistical annex are not included.

Ministry of International Trade and Industry (MITI), 1–3–1 Kasumigaseki, Chiyoda-Ku, Tokyo, Japan.

Nonferrous metals, i.e. base metals (copper, lead, and zinc), precious metals (gold and silver), as well as rare metals, are essential factor inputs for telecommunications and electrical appliance industries, automobile industries and construction industries. Petroleum and nonferrous metals like steel are indispensable materials in order to maintain our living standards and to keep industrial activities and must be supplied steadily.

Japan is one of major consumers of nonferrous metals in the world. For example, Japan consumes more than 10 per cent of refined copper and zinc, and even larger proportions of precious metals and rare metals. These situations reflects the fact that Japanese industries consuming nonferrous metals, such as electronics and automobile industries, are world scale producers in many respects. Hence, a stable supply of nonferrous metals is essential task in order to secure operations of these world scale industries, which are critically important for the Japanese national economy.

Nonferrous metals in Japan

The United States and Western European countries consume more nonferrous metals than Japan. On the other hand, major nonferrous metal firms of these countries, which possess both large mines and smelters, are expanding their integrated operations. Traditionally, these firms cover a series of stages: exploration, mining, smelting, processing and can be seen as vertically integrated producers.

The Japanese nonferrous metal industries have placed too much emphasis on smelting and processing. Most of the Japanese producers can be seen as custom smelters since they purchase most of the necessary concentrates from foreign mining companies. This situation stems from the past whereby Japanese domestic mines, which once had met a considerable portion of their concentrate demand, have increasingly been forced to close down and the investment in overseas mines has not satisfactorily kept pace. From the view point of ensuring a stable supply of nonferrous metals over a medium and long term, we have a lot of issues to discuss.

The world demand for nonferrous metals could be expected to increase in the near future, if the Asian demands expand steadily.

On the other hand, the world wide nonferrous metal markets can not avoid the influences of structural changes of international political and economic situations such as the collapse of the USSR and increased concerns related to global environmental problems. Japanese mineral policy must focus on maximization of the stability of nonferrous metal supply under these new global circumstances.

Production of nonferrous metals includes financially risky exploration, exploitation of deposits, smelting and refining processes. Therefore, it is necessary for both the Japanese national government and private firms to take appropriate measures based upon their responsibility for each of these stages.

This report places emphasis on smelting operations and developments of overseas mines in accordance with the above mentioned viewpoints.

Supply and demand

With respect to the worldwide demands for nonferrous metals, demand for copper and zinc is predicted to increase; the annual demand for copper is expected to increase from the current amount of 11 Mt to 13 – 14 Mt (an increase of 2.0 – 3.2 per cent) and that for zinc, from 6.9 Mt to 8 – 8.5 Mt (an increase of 2.0 – 2.6 per cent). On the other hand, the demand for lead is predicted to remain at the current amount of around 5.5 Mt.

Regionally, the demands for nonferrous metals in advanced countries such as Japan, North America and West European countries accounted for over 50 per cent of worldwide demand in 1992. For example, the total demand for copper in these countries accounted for 63.2 per

cent of worldwide demand (Japan: 12.7 per cent, North America: 21.2 per cent, West Europe: 29.3 per cent), while that for lead and zinc, was 61.8 per cent and 56.0 per cent respectively. However, since larger demands in these countries are not expected, the current conditions will remain unchanged in the foreseeable future.

On the other hand, it has been noted that demands for nonferrous metals in Asian countries other than Japan are on the rise. The annual economic growth of these countries is expected to reach a high rate of 5 – 10 per cent towards the year 2000. Moreover, the coefficient of elasticity of GDP for nonferrous metal consumption covering these five years is mostly 1 – 2 although they may vary with different countries and ore types. This is in clear contrast to Japan, North America and West European countries whose coefficient of elasticity of GDP is around zero because their economies have already reached maturity. (Even if their GDPs do improve, their nonferrous metal consumption will remain virtually unchanged.) Taking these situations into account, the demands for copper and zinc in East and Southeast Asia are predicted to mushroom. In China for example, if the current growth in demand is maintained, the annual consumption of copper and zinc by the year 2000 may reach 2 Mt and over 1 Mt, respectively. There is a strong possibility therefore, that China will surpass Japan with this enormous consumption of copper and zinc.

In the former Communist bloc countries, in the confusion accompanying the transition of their economies, the demands for nonferrous metals may remain sluggish in the short term.

Before and after the collapse of the USSR, the demand for nonferrous metals in this region was low enabling not only a sharp increase in metal exports to the West (including toll production), but also sluggish international market prices. It is considered therefore, that a rapid recovery in the demand for nonferrous metals is difficult under the current circumstances in this region. However, there is the possibility of recovery in the medium-to long-term on the condition that economic systems are stabilized and that a certain degree of economic growth is realized.

To meet the anticipated demand for nonferrous metals by the year 2000 (Cu: 13 – 14 Mt;, Pb: approximately 5.5 Mt; Zn: 8 – 8.5 Mt),the annual smelting capacities for copper and zinc need to be increased by 2 – 3 Mt and 1 – 1.5 Mt respectively. However, for lead, as the demand is predicted to remain about the same as for the present, the current smelting capacity may be sufficient to meet any future demands.

By totaling the expected capacities currently under consideration in individual countries, the annual smelting capacity for the year 1997 (including the amounts obtained by the Solvent-Extraction Electrowinning (SX-EW) method) will be: approximately 1.4 Mt of copper and approximately 0.4 Mt of zinc. To ensure sufficient supply capacity to meet these demands by the year 2000, further additional facilities will be required.

Although demand is expected to be largely centered in Asia, a gap between supply and demand will occur as the existing capacity of nonferrous metal production in these countries is small. Therefore, an important consideration in the near future is to improve the nonferrous metal supply system in Asia.

Supply/demand and ore type

The prospects for the supply and demand of copper, lead and zinc are as follows:

The demand for copper is predicted to grow toward the year 2000 at an annual rate of 2 – 3 per cent, mainly due to an expected increase in consumption within Asia. However, due to the current recession in Japan and elsewhere, a large increase is not expected in the near future.

On the other hand, the capacity of metal production may expand with the introduction of the SX-EW Method, and with the continued inflow of metals from the former Communist bloc countries, there exists a high possibility for an oversupply of refined copper to occur in the market economy countries over the short term.

In the medium term, however, as demands may recover in the major industrial countries and copper consumption in China and Southeast Asia may expand by 6 – 10 per cent, an overdemand may occur.

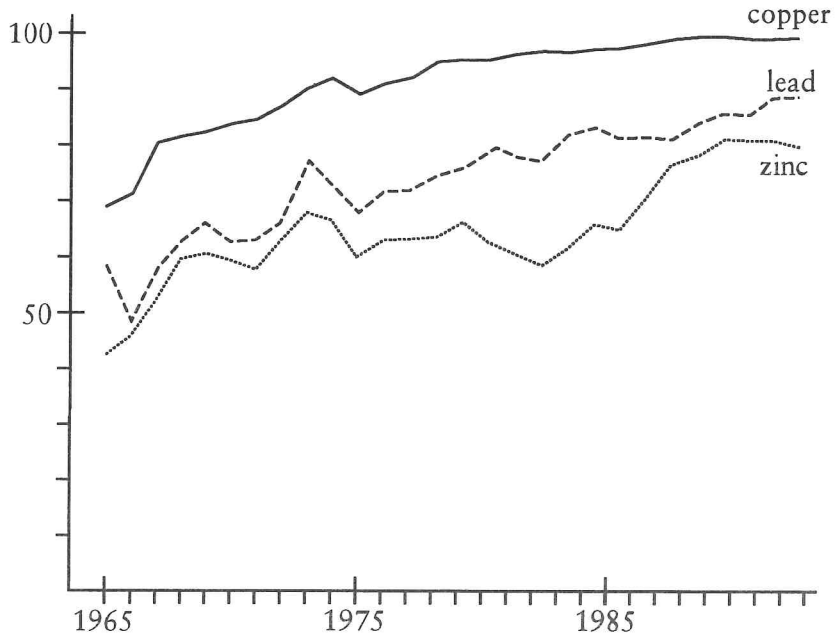
For lead, it is predicted that demand will either remain at the same level or decrease. Even if its probable growth in Asia is taken into account, the demand towards the year 2000 may show no marked fluctuations. Where no growth in demand is expected and there is a continuous inflow of lead from the former Communist bloc countries, an excessive supply of lead will eventuate over the short term in market economy countries. A possible solution to such an oversupply may be if former Communist bloc countries start to import lead as a result of possible economic developments there. However, with the added factor of developments in lead recycling, a situation may arise where the supply and demand of lead will be tight in the medium term.

In countries where industrialization has reached maturity, such as North America and Japan, the demand for zinc may revert from a decreasing trend to that of a slight increase.

However, since there is the prospect of steady growth in demand for zinc in Asian countries, other than Japan, demand on the whole may increase.

At present, due to the sluggish demand in developed countries and the inflow of zinc metal from the former Communist bloc countries, an oversupply of zinc is prevalent. However, since a certain level of growth in demand, centering on Asia, is anticipated over the medium term, the supply and demand of zinc in the market economy countries will balance out if metal production is kept under control.

Figure 1
Japanese reliance on overseas supply of base metals (per cent of total supply)



Domestic supply/demand

The domestic demand for nonferrous metals showed a steady rise up to fiscal 1991, resulting from an expansion in capital investment and consumer spending. However, since fiscal 1992 under the influence of the economic recession, demand has been decreasing.

In the past, the demand for copper steadily increased in response to the growth in demand for wire cable, whose consumption accounted for about 70 per cent of the entire copper consumption. Because of the growth in the use of electric wire for electronic equipment and in the construction industry, its consumption reached approximately 1.7 Mt in fiscal 1990, marking the highest record in our history. However, from fiscal 1991 the demand has decreased dramatically as a result of the recession, and in fiscal 1992 it was reduced to approximately 1.51 Mt.

The demand for lead had remained relatively stable in response to an increase in the demand for lead batteries used in automobiles, and reached an approximately 0.36 Mt in fiscal 1992. However, demand took a turn for the worse in fiscal 1993, reflecting the reduced production of automobiles.

The demand for zinc was quite firm in fiscal 1991 (approximately 0.81 Mt) in response to an increase in the demand for zinc galvanized sheets for use in automobiles, electrical machines and in construction materials. However, it decreased somewhat in fiscal 1992 reflecting the reduction in automobile production.

The domestic supply of nonferrous metals increased in response to an increase in demand up until fiscal 1991 with a corresponding increase in the import of metals. Moreover, with regard to domestic production, high net operating costs were unavoidable (the net operating costs for copper, lead and zinc smelters in fiscal 1992 were 97 per cent, 82 per cent and 81 per cent, respectively). Also, an upgrade of facilities was realized with the introduction of an operation using enriched oxygen. To cope with these situations, an increase in supply was sought.

In fiscal 1992, the level of domestic production was maintained in spite of a decrease in demand. As a result, the amount of imported metals decreased.

Stable growth in demand for copper and zinc is expected within the medium term, as a result of future increases in consumer spending and the restoration of capital investment accompanied by an anticipated business recovery. Growth will also be supported by a possible increase in the requirements for rust prevention for electronic equipment and facilities based on social overhead capital. However, if overseas industries, which are users of copper and zinc, accelerate under the influence of a strong yen, and even if there is stable domestic demand, growth at a low rate or a slight reduction is a strong possibility.

Demand for lead may increase in the medium term centering on the production of batteries for automobiles. However, in the event of a strong yen and depending upon the trend of automobile industries abroad, the domestic consumption of lead may in fact decrease.

Future of Japan's nonferrous metal smelting

Nonferrous metal smelting in Japan started in the smelters attached to domestic mines. In the 1960s, in response to the strong demand for nonferrous metals caused by high economic growth, large-scale seaside smelters were erected one after another. These were to be managed by a single firm or a group of firms with a view to processing concentrates imported from abroad. As a result of these capital investments, our smelting capacity increased dramatically: the annual outputs of copper, lead and zinc in fiscal 1967, were 0.5 Mt, 0.18 Mt and 0.57 Mt respectively. However in fiscal 1975, outputs increased to 1.23 Mt, 0.27 Mt and 1.02 Mt, respectively.

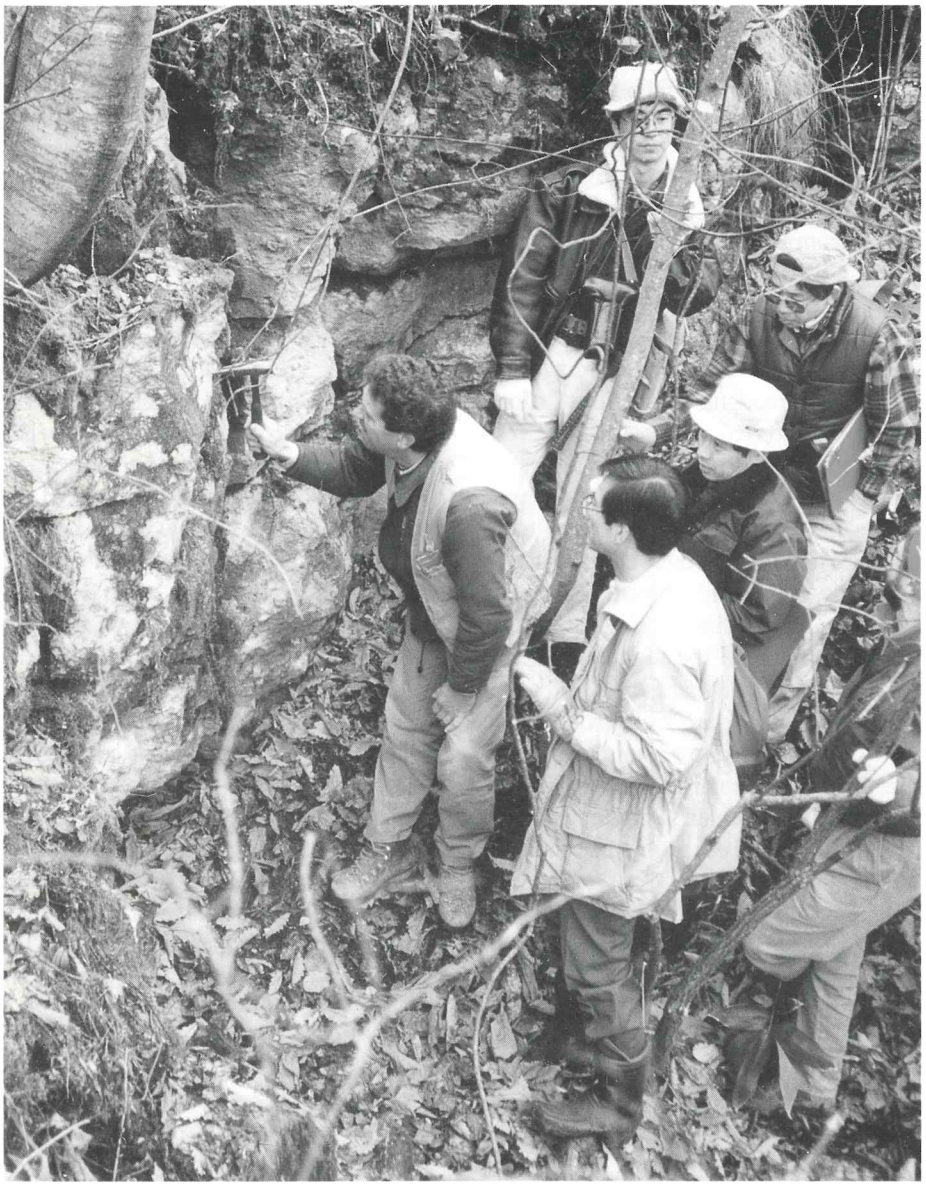
From the middle of the 1970s, a sharp rise in energy and infrastructure costs, together with labor costs, resulted in a severe economic climate for smelter man-

Mineral prospecting in Japan by the Metal Mining Agency of Japan.

agement. As a result, further upgrading of existing facilities was curtailed, and copper/zinc smelting capacities were reduced owing to the disposal of worn out facilities in the latter half of the 1980s.

Since 1990, the demand for nonferrous metals has increased in response to increases in capital investment and consumer spending. Moreover, the existing facilities (for copper/zinc smelting) were improved to some extent due to increased performance with the oxygen enrichment process. Consequently, the annual capacities of copper, lead and zinc smelting in fiscal 1992 were approximately 1.2 Mt, 0.33 Mt and 0.86 Mt, respectively. These capacities of copper, lead and zinc smelters hold important positions in the market economy world, accounting for approximately 12 per cent, 5 per cent and 14 per cent respectively of the total worldwide smelting capacities.

For the nonferrous metals smelting business in Japan, the sales amounts (in fiscal 1992) of copper, lead and zinc smelting were 392.2 billion JPY, 27.5 billion JPY and 142.8 billion JPY respectively, totaling 562.5 billion JPY. The number of employees engaged in copper, lead and zinc smelting are 4 517, 1 028 and 2 075 respectively, totaling 7 620.



Structural changes

The income of nonferrous metal smelters (treatment and refining charges) depends on international market prices (the prices at the LME – London Metal Exchange), the trend of supply and demand of concentrates, and is paid in dollars. Therefore, the income of Japanese nonferrous metals smelters, in yen, depends on treatment and refining charges receivable and the exchange rates. Concerning the future income of our smelters, the forecast is as follows:

With the worldwide economic recession and the inflow of metals from the former Communist bloc, the stockpiles of the LME have enlarged and, consequently, the LME prices of copper, lead and zinc have been sluggish. However, there is the possibility of a recovery in demand in the future, based on the economic recovery of advanced countries such as the USA, an increase in demand in Asia, and a possible recovery in demand in the former Communist bloc as a result of expected economic stabilization. In the short term however, it is predicted that the sluggish demand will continue, but many feel that it will take some time before a full-scale recovery of prices is realized.

Owing to the sluggish international metal prices, plans for the new development of mines are likely to be delayed. In addition, mines with high operating costs will face closure or reduced production. Also, as the worldwide supply and demand of concentrates has tightened, it is quite possible that this will lead to a decrease in treatment and refining charges.

It is hard to imagine that the Current exchange rates around 110 JPY/USD will change dramatically to that of a weak yen rate. It is considered, therefore, that such a restraint concerning the ex-

Table 1
Rates of Equity Ores

Ore Type	Percentage of total imports
Copper	5.0
Lead	5.1
Zinc	4.6
Oil	12.8[1]

Source: Mining Handbook (Kogyo Binran), Oil Development Material.
Note: 1. Fiscal year 1992.

change rate, which constitutes an important factor in deciding the income of nonferrous smelters in Japan, will continue.

Although most copper has conventionally been produced by pyrometallurgy of copper concentrates, prospects are good for the rapid and wide introduction of the SX-EW method centering on North America and South America. It is anticipated, therefore, that the annual refined copper production capacity produced by this system will amount to approximately 1.7 Mt in 1997, accounting for 14.6 per cent of the total production capacity of the market economies (the actual output for 1992 was approximately 0.9 Mt accounting for 8.9 per cent of the total copper production of the market economies). The SX-EW method is particularly applicable to low grade ores, to which the conventional method was inapplicable. Supported by its competitiveness, owing to its low cost (50 – 60 per cent of the cost of the conventional method), the development of new mines intending to adopt the SX-EW method may restrict the ore supply to nonferrous metal smelting firms in Japan. Depending on its future progress, this method may lead not only to difficulties in ensuring ores to be smelted in Japan, but also to a reduction in the treatment and refining charges receivable.

Decrease in tariff

Except for preferential imports from developing countries, the current tariff imposed on copper, lead and zinc are 15 000 JPY/t, 8 000 JPY/t and 8 000 JPY/t, respectively.

In the market access negotiations of the Uruguay Round of GATT settled in December, 1993, a reduction of the tariff on refined copper, lead and zinc in stages was settled and will be enforced over five years beginning in 1995. The final tariff for copper, lead and zinc will be equivalent to 3 per cent.

Recognizing such a reduction in tariffs, the nonferrous metals smelters in Japan will need to further promote their competitiveness.

Environmental restrictions

In Japan, environmental pollution has arisen from mining in the late Meiji era (early 1900s) to the 1970s as a result of heavy metals contained in mine drainage and acidic sulfurous gas emission from smelters. However, as the damage has since been recognized, various efforts have been exerted in Japan in the construction of concentration facilities to protect both water and air quality, as well as the development of protective technologies against further environmental problems. As a result, Japanese smelters have various facilities and technologies in place to ensure the highest levels of environmental safeguards.

However, there are many smelters in the world that operate without taking sufficient environmental safeguards, such as those in the former Communist bloc countries. Therefore, problems related to acid rain caused by sulfurous gas as well as health damages to residents will continue to arise. (Although 90 per cent or more of sulfur oxide can be removed from exhaust both in Japan and the USA, the removal level at smelters in other major nonferrous metal producing countries such as Canada, Zambia, Zaire, Chile, etc is still less than 30 per cent.)

However, a rapid change is being observed in both developing countries and the former Communist bloc where the necessity for environmental protection has been recognized more than ever recently. It goes without saying, that from now on full-scale environmental protection measures should be enforced, not only at existing smelters, but at all new smelters to be constructed in the future.

Recently, environmental protection have been increasingly required. From the viewpoint of preventing global warming, "Action Program for the Prevention of Global Warming" was concluded in Japan in October, 1990. It is aimed at maintaining the amount of carbon dioxide exhausted per person from the year 2000 at the same level as that achieved in 1990. Therefore, drastic measures are also required by the nonferrous metal smelting industry in energy conservation.

In order to strengthen the energy-saving policies so far developed, the government has revised the law to rationalize the use of energy, and established a temporary expedient law to promote the business activities on the rationalization of energy and the use of reproduced resources. Taking this into account, nonferrous metal smelters, as users of a lot of energy, are required to cope with the problem of energy consumption control.

Today, our measures for environmental protection concerning emission and sewage emissions from factories are regarded as most effective and are rigidly enforced. In addition, environmental protection has been further developed with an increase in the restrictions on drainage, and is currently under examination. Nonferrous metal smelters in our country are indeed front runners in the world with respect to environmental protection technology.

To maintain stable operations in Japan, it is important to continue our efforts aimed at further preservation of the environment.

Future direction

The trend in the demand for nonferrous metals to the year 2000, is expected to show growth in overseas countries, especially in Asia. While the domestic demands for copper and zinc will rise to some extent, the demand for lead will remain mostly at the same level. Depending on the situation of industries abroad that use such metals, demand may actually fall a little. Even in this case, demand will fall only slightly. If the production capacity of Japanese nonferrous metal smelters is maintained at present levels, the domestic market is predicted to outpace their capacities.

The nonferrous metals smelters in Japan have maintained their international competitiveness for the following reasons:

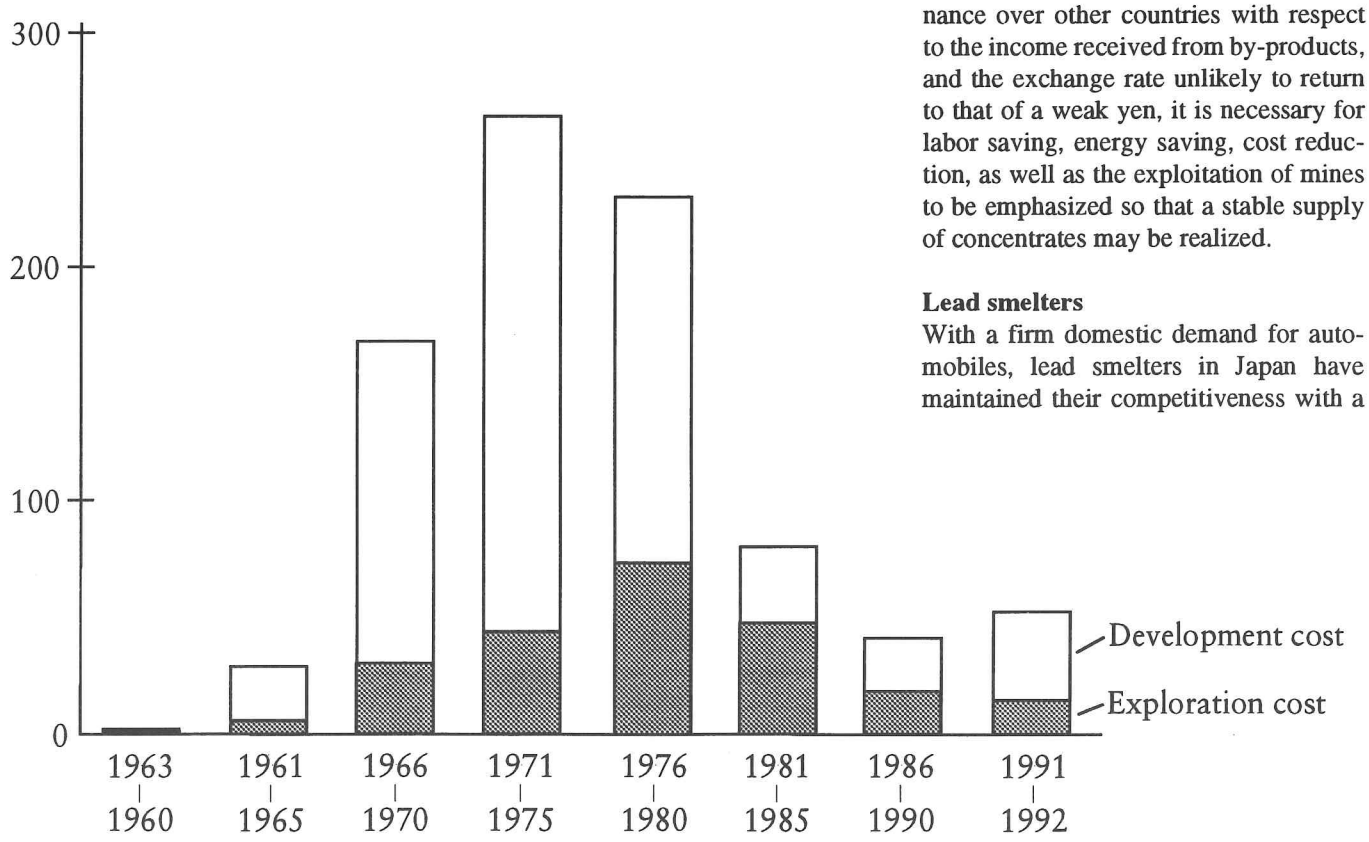
(a) Most smelters were constructed before the first oil crisis. Moreover, countermeasures against pollution have already been enforced.

(b) They pay careful attention to the specifications of the users and they are able to supply the materials strictly in compliance with those requirements.

(c) In response to higher energy costs and personnel expenses, they have emphasized labor saving, investment in energy saving and contrived to reduce all costs.

As for the competitiveness of smelters for individual ore types, our analysis is as follows:

Figure 2
Overseas costs of exploration and development by Japanese companies 1963 – 1992 (MJPY/year)



Copper smelters

Owing to labor costs and power rates which are higher than those in other countries, Japan's international competitiveness in copper smelting is low. However, the smelters do have some advantages such as the measures taken against pollution (which are better than those of other countries), repayment of facility costs (which have mostly been completed), and an income from the sale of by-products to nearby sulfuric acid markets.

As to the future international competitiveness of the copper smelting industry in Japan, even if worldwide copper demand increases in the future, because of the enormous amount of investment required to build new smelters, the competitiveness of overseas smelters may not be sufficient enough to supersede the smelters in Japan. However, taking into account the decline in the demand for sulfuric acid, a decrease in the predominance over other countries with respect to the income received from by-products, and the exchange rate unlikely to return to that of a weak yen, it is necessary for labor saving, energy saving, cost reduction, as well as the exploitation of mines to be emphasized so that a stable supply of concentrates may be realized.

Lead smelters

With a firm domestic demand for automobiles, lead smelters in Japan have maintained their competitiveness with a

Table 2
Sales and exploration costs of major nonferrous mining companies (MJYP)

Company	Year	Sales	Exploration cost	Exploration cost /amount sold x 100
RTZ	1986	837 587	5 773	0.69
	1987	874 348	4 097	0.47
	1988	910 368	3 016	0.33
	1989	1 111 360	12 880	1.16
	1990	1 013 154	13 362	1.32
	1991	859 584	16 456	1.91
Phelps	1986	143 810	1 528	1.06
Dodge	1987	241 760	2 595	1.07
	1988	299 250	3 541	1.18
	1989	375 247	4 056	1.08
	1990	384 856	6 862	1.78
	1991	331 060	6 882	2.06
ASARCO	1986	179 611	1 399	0.78
	1987	203 284	1 350	0.66
	1988	256 463	2 036	0.79
	1989	307 296	3 311	1.08
	1990	322 514	3 942	1.22
	1991	259 760	3 595	1.38
INCO	1986	253 256	2 834	1.12
	1987	273 823	3 286	1.20
	1988	420 934	5 545	1.32
	1989	548 769	7 720	1.41
	1990	453 797	6 701	1.48
	1991	407 891	5 399	1.32
Eight major	1986	1 997 249	5.430	0.27
copper-	1987	2 413 335	4 544	0.19
producing	1988	2 563,164	4 240	0.16
firms in	1989	2 793 810	5 052	0.18
Japan	1990	3,193 320	4 064	0.13
	1991	2 958 386	3 092	0.10

Source: Data of the eight major copper-producing firms in Japan – Securities Report. Others – Annual reports of relevant firms.

net operating rate of over 80 per cent. However, in addition to recent sluggish international prices, the strong yen has caused further concern for management.

With the use of lead in pipes and inorganic chemicals on the decrease, the demand for lead may not increase as much as that for copper and zinc and, consequently, it is difficult to anticipate an increase in worldwide lead smelting capacity. Instead, the expected worldwide smelting capacity may induce the need for a review of the capacity of current lead smelting facilities.

However, since lead smelting has a certain role to play in the recycling of used car batteries, its importance must be emphasized from the viewpoints of environmental protection and resource conservation.

Zinc smelters

Basically, zinc smelting in Japan is under the same competitive conditions as copper smelting. However, since power costs for zinc smelting in proportion to its entire production cost are larger than that for copper smelting, international competitiveness is less and, therefore, more efforts in cost reduction will be necessary in comparison with copper smelting.

Reviewing the above, cost structures vary considerably depending on ore types; while energy is effectively used in copper smelting, power consumption is relatively large in zinc smelting. However, by continuing our efforts to reduce costs and thus enable an improvement in productivity, it is predicted that, in the medium - term, most existing smelters will continue to be competitive in comparison with newly founded smelters. Moreover, with the existing nonferrous metals smelting capacity likely to be maintained until the year 2000, the nonferrous metal smelting industry is expected to play an important role in the domestic economy as a stable supplier of basic materials.

However, some smelters in Japan may possibly lose their competitiveness on

account of various factors such as obsolete equipment. For example, by disposal of such equipment while at the same time emphasizing efficiency, economies of scale will result. In this case, the Antimonopoly Act should be properly applied so as to enable a possible joint investment in new equipment.

Moreover, since the amount of sulfur collected from oil is assumed to increase, efforts must be made to enlarge the demand for sulfuric acid.

Nonferrous metal smelters in Japan have a production capacity accounting for approximately 10 per cent of worldwide production capacity. It is therefore, critical to build and maintain a supply system to correspond with worldwide demand for nonferrous metals, which will rise toward the year 2000, in order to stabilize the relationship between supply and demand in the future.

In particular, now that environmental issues are mostly recognized in the world community, it is difficult to establish new smelters. From this point of view, the nonferrous metals smelters in Japan are significant in that various measures have been taken to preserve the environment and to realize an industry that is in harmony with the environment.

Necessity for overseas smelters

Up to now, several plans to found new smelters have been announced in resource-producing countries, or in those with a large growth in consumption, with Japanese nonferrous metal smelting firms involved in some of them. Based on the present conditions of supply and demand and prices, problems are foreseen in the foundation of new overseas smelters, including ensuring that the smelting charges receivable exceed the depreciation cost and/or interest to be paid on invested funds. As a result, many of these plans still remain unrealized.

However, taking into consideration the possible future recovery of market prices, the steady growth of demand in overseas countries (especially in Asia), low labor costs, as well as the necessity for value-added industries in resource-producing countries, Japanese nonferrous metal smelters, while striving to ensure domestic competitiveness, must think of developing their smelting business abroad based on the necessity for competitiveness and business development.

For nonferrous metal smelters in Japan, having already acquired the technology of efficient smelting in tandem with environmental protection, it will be important to participate in plans to construct smelters in, for example, Southeast Asia and China.

In these areas, the gap between supply and demand will grow, and a strong demand for value-added industries will be realized through advancing their smelting divisions abroad. The above participation is also significant in building a worldwide stable system to supply nonferrous metals and for ensuring global environmental protection, and therefore, we hope that Japanese smelting companies will positively examine the possibility of such participation.

In entering into such ventures, careful consideration will be required to attain a secure operation, such as, ascertaining the trend of supply and demand in the area and inviting the participation of overseas firms who are familiar with the labor conditions and legal regulations in such areas.

Environmental protection and technological development

At present, many of the smelters located in the former Communist bloc (including the former USSR), as well as in developing countries, are continuing their production without taking sufficient environmental safeguards, for example, applying no measures to reduce acidic sulfur gas exhaust. This situation has caused not only serious environmental pollution, but also the low-cost production of inexpensive metals appearing on the international market.

Since it is important to have in place proper competitive conditions worldwide, Japan should positively urge the parties concerned to decide on measures for environmental protection.

If smelters operate without sufficient measures for environmental protection, serious environmental problems will occur. Therefore, if developing countries request technical cooperation regarding environmental protection, Japan must give technical and funding assistance in order to upgrade existing smelters.

In many cases, matters which have no direct bearing on an increase in productivity do not result in any official request by the government of a developing country, because no importance is placed on such matters by these governments. Therefore, technical cooperation is often difficult to enforce if it is in part, not specifically requested by a developing country. Therefore, it is also important for us to take the initiative in any discussions toward submission of such requests.

Recycling

Since the amount of waste is increasing, the capacities of the existing intermediate processing and disposal facilities are now reaching their limits.

Public requests are increasing for the improvement of such processing and disposal capacities, a reduction in the amount of waste, and the establishment of a resource-recycling system. Since nonferrous metals are recyclable resources, a recycling system should be established so that a long-lasting, stable supply of inexpensive resources is ensured.

Since nonferrous metal smelters handle not only ores but also scrap metal as their raw materials, they also function as recycling centers. To realize full-scale recycling in the future, nonferrous metal smelters will play an important role. To realize the smooth recycling of nonferrous metals whose prices fluctuate widely, an important task is to establish a system that is economic in the collection,

reprocessing and reuse, even when prices are sluggish. So, we hope that nonferrous metal smelters which are responsible for ensuring a stable supply of such metals will take part in establishing such a system.

Small quantities of various kinds of nonferrous metals are often used in industrial products such as household electrical appliances. Therefore, advanced technologies are required to promote the recycling of nonferrous metals. For this purpose, the government has already undertaken the Nonferrous Metal Recycling Promotion R&D Project. Since nonferrous metal smelters in Japan have already acquired a technical basis in efficiently selecting and refining metals from complex materials, they should seek to develop technologies that further promote recycling.

In addition to accepting materials as renewable resources from other industries, nonferrous metal smelters are required to take measures (such as the preparation of specifications) to promote the utilization of recyclable resources, for example, nonferrous metal slag, a by-product obtained during the process of smelting.

Technological development

The R&D of nonferrous metal smelting technology is actively promoted worldwide, both in the pyrometallurgical and hydrometallurgical fields. In pyrometallurgy, R&D is performed mainly by private firms, and successful results have been obtained through the ISASMELT method for lead and copper smelting (Australian MIM) and the Kivcet method for lead smelting (in the former USSR). In hydrometallurgy, R&D is performed mainly by governmental research institutes in countries such as the USA, Canada and Australia. As for the SX-EW method which is now in use, improvement in the leaching rate of iron sulfide and development of a new extractor are regarded as future technological issues, while the ammonia leaching method which uses chloride for concentrating and hydrometallurgy are noted as new smelting methods.

In the development of smelting technology in Japan, key issues have been the improvement of conventional pyrometallurgy, including technological development in energy conservation, labor saving, and environmental protection. On the other hand, technologies that enable drastic changes in smelting process have not actively been developed.

Gold mining in Japan. Hishikari mine.

Urgent and important issues in nonferrous metal smelting technology are energy conservation, labor saving and environmental protection which are intended to improve existing smelting technology. Basically, these technologies should be developed by the efforts of individual private corporations. However, the technologies that affect the public conscience such as energy conservation and environmental protection should be quickly promoted by actively utilizing subsidies for energy-saving applications as well as various means of taxing these facilities.

The development of technologies over the medium and long terms should emphasize the introduction of technologies related to improved production. These technologies may overcome various difficult smelting conditions such as low-grade ore and difficulties in processing which result from fine grained ores. Such technologies may also fulfill environmental protection requirements. Fundamental R&D activities directed at the introduction of new metal production technology are now being undertaken by governmental research institutes throughout the world such as the Bureau of Mines of the USA.

Japanese smelting companies also actively promote R&D of new smelting technology by using as a basis smelting technology that has already been developed. The Agency of Industrial Science and Technology is now examining the establishment of R&D for next-generation metal production. In addition to the above, issues related to the introduction of new technologies may include: a research system focussed on broad industry-university-government cooperation, an increase in cooperation with overseas research institutes and mining companies, and the supplementation of the system for collecting technological information.

Exploitation of overseas mines

Although worldwide exploration activities for nonferrous metal resources have fallen to some extent owing to sluggish market conditions for nonferrous metals, an increase in exploration for new mines is important as both the number of mines that have closed and demand for concentrates have increased. Therefore, mine exploration has been actively promoted centering on Central and South America as well as Oceania.

With regard to copper, due to the full-scale application of hydrometallurgy, the recent development of copper mines has been based on the SX-EW method of production. It is considered, therefore, that these situations will affect the future of the Japanese nonferrous metal industry, the operation of which mainly relies on the procurement of overseas ores its domestic smelting.

Calculations based on the ore reserves of existing deposits and the amount of ores produced in 1991, show that the total remaining minable years at present are 62.8 years for copper, 35.9 years for lead and 39.5 years for zinc; comparable to that for oil with 45.3 years. Since exploration efforts are still active throughout the world, the above numbers of minable years are unlikely to fall from now on.

However, in the case of a large scale mine, it takes a lead time of 10 to 15 years from the commencement of exploration till actual operation. Therefore, to maintain the above mentioned minable years and to ensure a long-standing stable supply of ores, persistent exploration activities must continue.

Major nonferrous metal companies in Europe and America are continuing their mine exploitation while maintaining the management, operation and ownership rights of their mines. Moreover, from the latter half of the 1980s onward, they have been seeking the enlargement of such rights and interests through M&As and capital tie-ups.

Additionally, in recent international bidding with the opening of mine areas in Central and South America to foreign capital, the rights and interests tend to be concentrated in the major nonferrous metal mining companies. This is reflected in the cases where such firms have made successful bids through their strategy of making enormous investments at times of sluggish market conditions.

As stated above, an oligopoly is gradually forming in the worldwide nonferrous metal market.

Japan and overseas mines

Owing to a decrease in the number of domestic mines, the Japanese nonferrous metal industry has been forced to increase the import of ores from abroad in order to satisfy the ore demands of domestic smelters (the self-supply rates of ore in fiscal 1992: Cu 0.5 per cent, Pb 10.8 per cent, Zn 18.9 per cent. Figure 1.)

As a result, Japan has become an outstanding ore importer as reflected in the proportions of its import amounts to the worldwide amounts of ore trade in fiscal 1991: Cu 49.7 per cent, Pb 23.9 per cent, Zn 18.8 per cent. While the above situation constitutes bargaining power in setting favorable conditions for the purchase of ores, it becomes vulnerable when the supply and demand of ores are tight, and we fear that this trend may affect the intended stable supply.

Concerning the form of ore procurement from abroad, as a reflection of the recent decrease in overseas exploration and exploitation, the amounts of "equity ores" (obtained through direct participation in exploitation) account for only 5.0 per cent (Cu), 5.1 per cent (Pb) and 4.6 per cent (Zn) of the total amounts of ores imported in 1991 (Table 1).

Although the amount of copper ore purchased through financing, accounts for 38.6 per cent of the total amount of copper ore imported (lead and zinc ores are not subject to purchase through financing), the ore imports of Japan generally depend on what is called "simply-purchased ores." Also, from this point of view, the above-mentioned vulnerability is undeniable.

Full-scale exploration and exploitation abroad by Japanese firms started due to a rapid increase in domestic nonferrous metal demand accompanied by high economic growth in the 1960s, and the resultant progress in domestic nonferrous metal smelting. Although some of their attempts ended in failure, exploration was conducted at the Musoshi Mine in Zaire, the Mamut Mine in Malaysia, and the Huanzala Mine in Peru, for example. As a result, exploitation was conditional on Japanese firms possessing either 100 per cent or most of the rights and interest in the mines.

Although the percentage of the rights and interest later changed, operation of the above mines still continues.

From the latter half of the 1970s onward, the Japanese nonferrous metal industry has been confronted with a severe management environment accompanied by a transit to the floating currency exchange rate system. The growth in domestic demand for nonferrous metals fell after the first oil crisis, and, affected by this, the exploitation activities abroad by the Japanese nonferrous metal industry stagnated.

Also, in the latter half of the 1980s, owing to an exchange rate in favor of the yen (which intensified several times after the Plaza Accord), a sharp rise in personnel and energy costs, and the sluggish nonferrous metal market, many domestic mines were forced to close, and thus overseas exploration remained stagnant.

The above situation is best reflected in the amounts of money spent by Japanese firms for their overseas exploration and exploitation. Although the amounts of annual average exploration and exploitation costs for the period 1976 to 1980 were 7.5 billion JPY and 15.6 billion JPY respectively, the average exploration and exploitation costs for the period 1986 to 1990 dropped to 2 billion JPY and 2.5 billion JPY respectively (Figure 2)

Compared with the records of major overseas nonferrous metal companies, the percentage of exploration costs to sales amounts obtained by such overseas firms in 1991 was 1.0 – 1.4 per cent ; the corresponding rate obtained by Japanese firms was only 0.1 0.2 per cent, indicating that it was only one tenth of that obtained by overseas firms (Table 2).

The rapid recovery of the nonferrous metal market from 1987 onward and the efforts of individual corporations in rationalization, stopped any subsequent worsening in the management of the nonferrous metal smelters in Japan, and signs of a positive situation with investment in their exploration and exploitation abroad, finally began to appear.

At the same time, since overseas exploration by Japanese firms did not result in the opening of any mines which they could own and operate, they came to participate, as a means to obtain more profit from their investment, in the exploitation of projects operated by their partners. In this way, Japanese firms have taken an active part in recent years, although their shares are limited, in large-scale copper mining development projects (such as Morenci in the USA, as well as Escondida and La Candelaria in Chile) at the stages of exploitation and operation.

On the other hand, there is also an increasing trend where overseas mining companies ask Japanese companies to participate in their projects for the purpose of risk dispersion. In the case of the McArthur River Mine, an Australian mining company asked for Japanese participation, noting superiority in possessing a smelter that would buy their ore as well as having the ore-dressing technology to handle the hard to process ore.

In the case of the Tizapa Mine in Mexico, success achieved by a Japanese ODA (Official Development Assistance) cooperation led to the development of a mine by the Japanese company concerned.

Although the prices of nonferrous metals have been falling rapidly since 1992, the recent tendency of a strong yen, a tightening in the worldwide supply and demand of ores, as well as a sense of crisis derived from ore procurement based on "simply-purchased ores", the eagerness of Japanese firms to invest in overseas exploration and exploitation has intensified.

The international situation

The governments of the countries in Central and South America came to recognize the necessity for introducing foreign capital when their economic situations worsened as represented by their accumulated deficits and runaway inflation in the 1980s.

Although direct foreign investment in Brazil has not been promoted owing to confusion in its economy, the provisions of the Foreign Investment Acts and Mining Acts in other countries have been revised to open nonferrous metal resources to foreign investment, and privatization of national mines is now actively being promoted in Chile, Mexico, Bolivia, Peru, for example. In Chile, a large-scale project owned by CODELCO (Corporacion Nacional del Cobre de Chile) was put up for bidding, with more than 50 per cent of the ownership rights going to foreign companies. In Mexico, CFM (Comision de Fomento Minero) of SEMIP (Secretaria de Energia Minas e Industria Paraestatal) which had been in charge of middle and small-scale mine support policy was dissolved, and the privatization of all national mines was promoted. In Bolivia, the privatization of mines under COMIBOL (Corporacion Minera de Bolivia) is now being promoted. In Peru, where the economy has started to recover, the privatization of national mines is now in progress.

The opening to foreign capital in resource rich countries in Central and South America offers new investment chances to foreign companies.

Worldwide nonferrous metal supply and demand is increasingly affected by the independence of the former USSR countries. This influence is currently reflected only in the amount of metals exported to Western countries. These coun-

Electrolytic cells in the Akita Zinc Co. complex by the Akita bay in Japan.

tries are noted for being rich, not only in base metals such as copper, lead and zinc, but also in precious metals such as gold and platinum as well as in rare metals such as nickel, chromium and titanium. These countries, therefore, have considerable influence on the worldwide supply and demand of nonferrous metals.

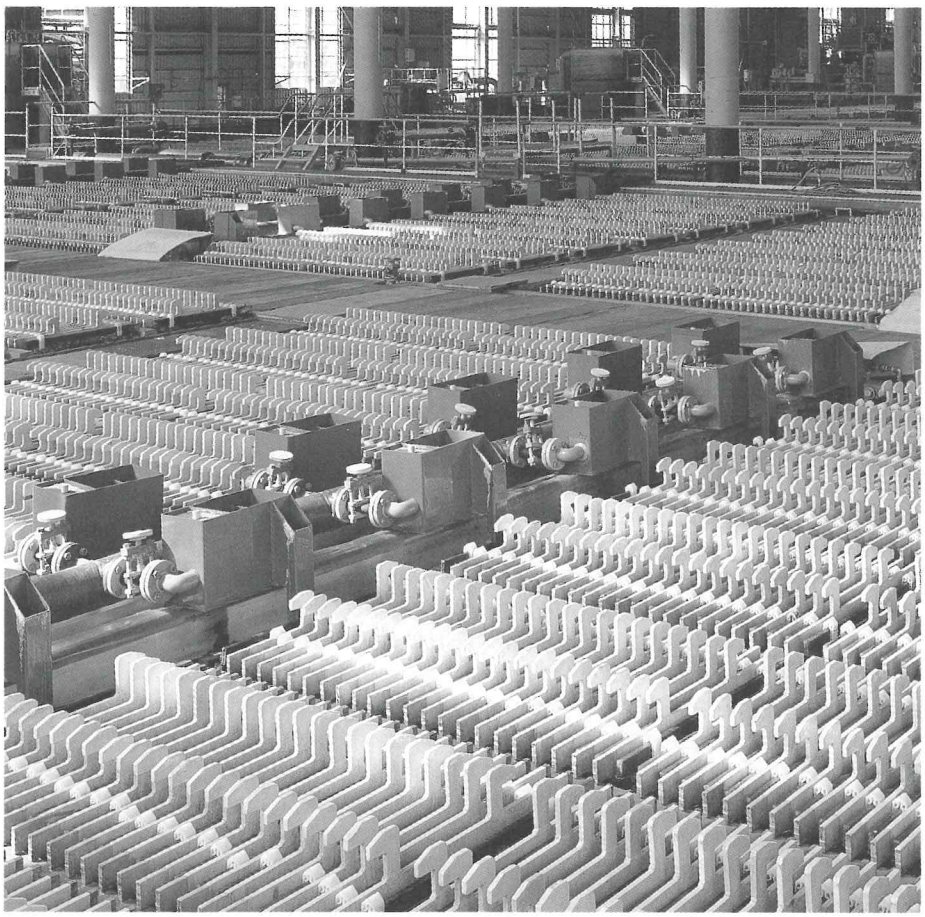
In the countries of Central Asia, especially Kazakhstan and Uzbekistan, whose economies largely depend on the nonferrous metal industry, it has been noted that lowered mine production has led to a recent decrease in the operating rate of smelters as a result of an ore shortage.

Under these circumstances, the Central Asian countries are now asking Western countries for capital and technological cooperation. At present, direct investment in mines is not progressing as expected, as many unstable factors still influence these economies. From a medium and long-range viewpoint, however, these countries could be considered by Japan as suitable for new investment and cooperation.

Since the five countries in Central Asia have became eligible for Official Development Assistance (ODA) in January, 1993, both the World Bank and the IMF have started to provide support for organizational adjustment projects in these countries.

Increasing importance of Asia

In the Asian countries of ASEAN the high economic growth rates have led to an increase in demand for nonferrous metals, and, excluding Japan, their demands for copper, lead and zinc ores and metals (other than copper ore) are still far in excess of their supply even today.



In response to a remarkable increase in demand, China has recently started importing large amounts of copper ore and metal and, therefore, one of the important policies of China is to ensure the supply of copper, including the development of copper mines. However, as a country in which to invest, China's preparedness to receive direct foreign investment is insufficient as reflected in the fact that the purchase and sale of mining rights are not granted there.

In Vietnam, trade and investment have been restricted untill recently. However, based on its policy of opening "doi moi" (meaning "innovation"), investment of Western capital has been promoted, enabling rapid progress within the country. Moreover, Vietnam has been eligible for ODA since 1992.

As for Asian countries, from the viewpoint of mine development, considerable progress has been made both in the Philippines and Indonesia. However, other countries may also be evaluated as appropriate for further geological surveys and mineral exploration and exploitation, as their labor costs are lower than those of advanced countries, and their infrastructure is relatively well developed when compared with other developing countries.

Strategic metals

Since rare metals such as nickel and chromium are unevenly distributed in a relatively small number of countries whose political situations are often unstable, the Japanese government has already taken necessary measures in stockpiling them. However, with the end of the cold war and the occurrence of frequent racial disputes, notable changes have taken place in the political situations of major strategic metal supplying countries.

In South Africa, which is one of the greatest suppliers of precious metals such as gold, platinum and palladium as well as various kinds of rare metals including manganese, a trend towards democratization is currently in progress. At the same

time, however, this trend is apt to invite complex internal conflicts and disputes. Accordingly, the political situation in South Africa has worsened. Although there may be different scenarios in the medium and long term, it is difficult to conclude how the situation will develop.

In Zaire, a major supplier of cobalt, considerable insecurity still remains in its supply as a result of uncertainty in its political situation.

With regard to the former USSR, in Russia, which has outstanding resources of gold, platinum and palladium, like South Africa, its political and economic situation is still in turmoil.

Central Asia, a notable supplier of chromium and titanium, is now requesting Western countries to provide assistance and cooperation so that its economic independence may be realized. Consequently, it is too early to conclude now that a stable supply of metals will be assured.

Exploration and exploitation abroad

Japan, whose consumption of nonferrous metals accounts for approximately 10 per cent of the entire world production, is second to the USA as consumer. However, the present situation in Japan where the amount of equity ores accounts for only a few per cent of the entire amount of ores imported, should be regarded as an insecure supply factor from the viewpoint of the maintenance and development of our future industrial strength. In addition, taking into account the recent trend of domestic mine closures, Japanese firms must conduct mineral exploration and exploitation abroad to improve the proportion of equity ores.

In promoting the exploration and exploitation of overseas mines, Japanese firms must play their part in the present overall market situation while maintaining and increasing their own economic efficiency and international competitiveness.

However, nonferrous metal resources are affected by the following:

Exploitation of mines requires a long lead time. Moreover, nonferrous metals are not renewable but are finite. Therefore, unless continuous exploration is carried out to discover new deposits to meet the amount depleted, a long lasting stable supply of mineral resources may not be ensured.

If this is impossible, economic and social development of the world may be obstructed as a result of a possible sharp rise in the prices of fundamental materials.

In addition to exploration risk which is unavoidable in overseas exploration and exploitation of nonferrous metal resources, there is an economic risk caused by variable market conditions and exchange rates. Moreover, exploration and exploitation activities are mostly restricted to countries of high risk.

In the case where Japanese firms participate in an overseas project at the exploitation stage, unlike the exploration stages, business risk may be smaller owing to the relatively small possibility of failure involved. However, possible disadvantages may be that an enormous amount of funds will be required and that a risk of long term investment covering 3 to 5 years must be borne while facing variable prices for products.

On the other hand, the situation specific to our country and our nonferrous metal industry is as follows:

For Japan, which largely depends on the supply of ores from abroad, with the amount of its imported ores accounting for an outstanding proportion of the total amount of ores traded in the world, it is vital to own mines which have been developed, so as to promote a stable nationwide supply of ores.

In exploiting a mine, a favorable situation is where the operator reaches a level of production that raises a large amount of profit and then invests the profit in subsequent exploration which it hopes will result in the successful re-use of mine infrastructure.

This may be possible for a group of corporations, such as major nonferrous metal mining companies in Europe and America, which have already established a system to secure good deposits and to absorb possible risks. However, for nonferrous metal mining companies in Japan, whose management structure is fragile due to the past need to take measures to reduce the capacity of domestic mines and to dispose of pollution caused by their mining and smelting, support must be obtained to reduce any possible risks.

As stated above, the Japanese government must support measures to promote overseas exploration and exploitation. In the medium and long terms, it is desirable for Japanese nonferrous metal mining companies to work as international companies acquires managerial and technological expertise. From this point of view, support should be established at the exploration stage in order to acquire the rights to control the management of the operation into the exploitation stage.

Support for the exploration and exploitation of mines, based on the growing trend of domestic mine closures and the immediate need to secure sources of ore supply, must be promoted by combining in a well-balanced way the supporting measures at the exploration and exploitation stages.

Collection and provision of information

By posting its staff in 13 foreign countries, the Metal Mining Agency of Japan (MMAJ) has been able to collect and analyse information from those countries. Now that much mining information has been shared by the parties concerned, the Agency, as a governmental agency, must independently analyze and provide value-added information in cooperation with outside research institutes.

From now on, not only grass-root exploration but also exploitation in a form different from that of conventional methods may be possible; this includes the acquisition of rights and controlling interests at the exploitation stage, the acquisition of producing mines, and exploitation based on the SX-EW method. Therefore, the MMAJ must increase its assistance to exploration as well as the collection of basic information which will supplement business activities.

Moreover, from the viewpoint of strengthening relationships with resource rich countries, it is also necessary to hold various conferences for the exchange of information and views in the area of resource development, and to provide information which is useful for the planning and promotion of policies for resources development in developing countries.

Basic geological survey

To support Japanese companies in finding new exploration projects, there are two methods which will lead to corporate surveys, by the conducting of basic surveys prior to full-scale exploration. One is the "Overseas Geological Survey" which the MMAJ carries out and is paid for by the corporation with a government subsidy. The other is the "Joint Overseas Geological Survey" in which a grant is offered by the Government for a geological survey to be conducted by a Japanese corporation jointly with a foreign corporation.

The Joint Overseas Geological Survey has advantages in that it may lead to a future joint venture with a major foreign corporation at both the exploration and exploitation stages and result in an exchange of technology.

Therefore, it is desirable for the MMAJ to promote projects abroad by utilizing its overseas staff and preliminary survey systems. The Agency must also be able to cope with diverse methods of conducting exploration by expanding the Joint Overseas Geological Surveys and their application to overseas subsidiaries of Japanese corporations concerned.

Investment and finance systems for overseas exploration

The overseas exploration of copper, lead and zinc is covered by a finance system of the MMAJ. However, although a considerable amount of exploration was financed between 1965 to 1984, only a small amount has been financed recently.

This may be attributed to the recent unexpectedly high risks in overseas exploration.

However, now that the number of domestic mines is decreasing year by year, resulting in greater dependence upon overseas ores, it is a pressing task for the Japanese nonferrous metal industry to explore for copper, lead and zinc abroad, and to re-exam support measures.

As a specific measure towards this purpose, in order to provide an incentive to the nonferrous metal mining companies to conduct exploration abroad, the existing finance system with low interest rates should be improved by adding to the MMAJs financial assistance scheme, a system which exempts these companies from the payment of loan interest when exploration for copper, lead and zinc fails.

For these countries which are in transition to a market economy, such as Central Asia and Mongolia which have large potential resources, a measure may be cooperation in resource exploitation as a part of ODA. In the future, however, investment should be made by the private sector for exploration and exploitation. To this end, an additional support system for the exploration of copper, lead, zinc and gold should be considered.

The application of investment systems to overseas exploration by the MMAJ is limited to projects jointly undertaken by nonferrous metal firms. However, in view of the fact that such projects have diversified recently, the system should be reviewed so that it can be further utilized.

Taxation systems to support overseas exploration and exploitation

The taxation systems currently applied to exploration and exploitation abroad include an income deduction for mineral resource depletion and a reserve fund for losses from overseas investment. The accelerated depreciation method needs to consider lowering the amounts borne by the acquisition of an interest in overseas mines as well as the cost of possessing such mines.

Improvement of exploration and exploitation technology

Recent Japanese exploration technology is related to the exploration of domestic epithermal gold deposits in which Japan has acquired advanced technological expertise. However, in order to promote the exploration of various types of ores abroad, it is necessary to cope with diversified geological environments and various types of deposits. Therefore, exploration technology must be further improved.

To improve exploration technology, in addition to corporate efforts, governmental organizations, including the MMAJ, must promote the development of fundamental new technology. An increase in affiliation with governmental research institutes and mining companies abroad is a subject for further study.

Moreover, in view of the decreasing number of domestic mines, efforts to maintain mining technologies by increasing the opportunities for engineers to train overseas should the exercised.

Supporting measures concerning funds for mine exploitation

The following policies to be provided at the exploitation stage of mines are basically aimed at supporting those projects in which feasibility has been clarified to some extent:

The Export-Import Bank of Japan offers loans to large-scale projects to secure the nationwide supply of ores, in order to promote economic exchanges, mainly in trade, between Japan and foreign countries.

The finance system for general cases under the Overseas Economic Cooperation Fund (OECF) covers projects in which it is difficult for the Export-Import Bank of Japan or private financial institutions to offer loans. Even if such projects are not directly connected to foreign trade, so long as they contribute to the industrial advancement of developing countries as well as Japan's economic exchange with other countries, finance is extended. In addition, this investment system has a principle in which it must receive requests from developing countries before offering loans to them.

To ensure sound development of foreign trade or other transactions with other countries, the trade insurance system covers risks caused by reasons which may not be the responsibility of the other party, such as wars, revolutions, compulsory expropriation, import and exchange restrictions which may occur in other countries (emergency risk), as well as risks caused by insolvency of the other party in a contract (credit risk).

In particular, both the overseas investment insurance and the insurance for financing overseas activities are applicable to overseas investment in mine exploitation projects including the purchase of ores.

This system guarantees liabilities related to loans required for such overseas activities as mining metal ores and subsequent refining and smelting.

Although the above systems are all based on governmental subsidies, they may not be applicable to all cases of mine exploitation because of limits in their financial resources. Moreover, depending on the details of the relevant project, such subsidy systems may not be suitable in some cases. Therefore, in order that the above financial support systems may be effectively and properly applied for mine exploitation, continuous efforts are required to review the requirements for the use of such systems so that they may meet the actual demand for funds. Specifically, the following examples may be listed: increasing the limits of foreign currency loans by the Export-Import Bank of Japan, the establishment of preferential loan interest rates, the more flexible application of project finance, and the improvement of requirements for liability guarantee by the MMAJ based on the actual status of overseas exploitation.

Economic cooperation

In supporting corporations engaged in exploration and exploitation abroad, direct supporting policies for exploration and exploitation must be improved and maintained. However, in view of the fact that many of the resource producing countries in the world are developing countries and that new opportunities for investment are offered mainly in those countries as stated above, it is necessary to re-examine the future direction of Japan's technical cooperation to develop mineral resources abroad.

The promotion of exploitation of new mines of nonferrous metal resources in developing countries is productive in securing worldwide reserves and economic development in such countries. For this purpose, "Technical Cooperation for Mineral Exploration" has been undertaken by the Japan International Cooperation Agency (JICA) and the MMAJ. In response to future changes in circumstances, the contents of this undertaking should be expanded.

The "Technical Cooperation for Mineral Exploration" often ends before reaching the mining stage, as either promising deposits are not discovered during the survey or because the economic feasibility of the discovered deposits is not favorable for various reasons. In this case, although the transfer of technology, including the method of resource exploration, may be carried out, the ultimate objective of the economic progress of developing countries through mine exploitation cannot be realized. Therefore, in conducting "Technical Cooperation for Mineral Exploration", emphasis should be placed on the realization of actual mine exploitation throughout the entire process, including the selection of a project and the subsequent carrying out of the survey.

Depending on the situation of individual countries, many developing countries have limited capability to develop potential projects. Therefore, it is important for Japan not just to wait for a request by such countries, but through daily contact with the governmental institutions of such developing countries, to make efforts in forming plans for the development of specific potential projects.

While areal balance should be considered in selecting projects, priority should be given to projects in areas which have a good prospect of direct investment at a future exploitation stage. As a result, such selection may promote the economy of a developing country to some desirable level.

To be specific, it is necessary to select an area with high potential by taking into full consideration the state of the infrastructure developed in the surrounding districts, the state of adjacent districts with their possible demands, and the regulations within the mining industry and with foreign investment in the selected area.

In this respect, Central and South America, with potentially large resources and a positive attitude towards the introduction of foreign investment, as well as Asia, which has prospects for supply shortages, should be regarded as areas most suitable for exploration and exploitation. It is also important to find projects which will contribute to the stable supply of other metals.

In conducting technical cooperation for exploration in virgin areas, as possibilities of subsequent exploitation may not be foreseen, it is difficult to work out in advance a plan to be carried out after completion of such mineral exploration cooperation.

Basically, the Government of the developing country has to decide whether to conduct subsequent exploitation and by which method in the event that it is to be carried out. However, through continuous discussion with that government, various means of cooperation may be utilized toward the exploitation stage. These means are, for example, a feasibility study to examine the economic efficiency of mine exploitation based on a development study by JICA, acceptance of trainees and the dispatching of specialists, technical cooperation and research cooperation.

As to the financial aspect, measures to promote mineral exploitation should be examined in a comprehensive way, including the utilization of yen credit, loans by the Export-Import Bank of Japan, and facility improvement projects through development loans and investments by JICA for the development of infrastructure necessary for mine exploitation, such as electric power, water supply, roads, railroads and ports.

In the case where favourable results are obtained from technical cooperation for mineral exploration, in order to support the smooth advancement to the exploitation stage, the measures stated above must be improved so that Japanese firms which plan to participate in the exploitation, while respecting the independency of that country, can put into effect the loan system of the Export-Import Bank of Japan and the trade insurance.

Support transition to market economy

Among the countries which are in transit to a market economy, it is important for Central Asia, Mongolia and other nations, aiming at the reconstruction of their sluggish economies by activating metal mining, to start technical cooperation for mineral exploration. Although these countries have abundant resource potential, they are unable to evaluate the economic value of their mines due to a lack of knowhow in assessing the economic value of such mines under the market economy system, and this may disturb in some respects the promotion of investment by nonferrous metal companies in Western countries. Therefore, it is necessary to found a scheme of technical cooperation for mineral exploration which re-evaluates the existing geological information by the standards required by companies in Western countries prior to their investment.

In particular, owing to the present necessity for acquiring foreign currency, these countries are targeting economic development based on their abundant mineral resources. Therefore, for future technical cooperation with these countries, it should be considered to extend ODA placing emphasis on their mineral resource industry and the preparation of the related infrastructure.

As for Russia which has abundant resources, although if is not covered by ODA at present, a proper policy should be examined regarding future cooperation.

Environmental cooperation

Like the operation of smelters, the exploitation and operation of mines may possibly cause serious pollution. It is necessary to actively promote cooperation for environmental protection measures. Consequently, in the exploitation and operation of overseas mines, it is desirable to urge the developing country concerned to promote its approach to environmental protection.

Moreover, in the provision of ODA undertakings for exploration and exploitation, it is important to give careful consideration to possible environmental influences, and, in the case of a developing country requesting Japan to assist in taking measures for environmental protection of existing mines, to positively respond such a request by utilizing various ODA schemes. ■