STABLE SUPPLY OF MINERAL RESOURCES

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This paper written by Mr Shuhei Kojima is a personal summary on the discussion at the Mineral Resources Policy Platform in Japan. This paper is the first summary on the discussions for the direction of a new mineral policy even though it does not represent the view of the Japanese Government. The writer was responsible for the mineral policy at METI until 12 July 2002. He left the position to serve on a new mission.

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Introduction. Establishment of Mineral Resources Policy

The objective of this paper is to demonstrate the necessity of a stable supply of mineral resources particularly non-ferrous resources to the Japanese economy, and the Japanese Government's aim at securing a stable supply. At the same time, this paper will present the system of policy for attaining the above-mentioned objective and to show specific direction of such policy. The contents of this paper are based on the discussions held at the "Mineral Resources Policy Platform", which was founded with the purpose of establishing mineral resources policy and discussions regarding the Metal Mining Agency of Japan (MMAJ) related to the restructuring of special public institutions in Japan. The personal views of the writer who was responsible for the policy planning are also reflected. As an introduction, I will here briefly explain the general background regarding these discussions before entering the main body of the policy discussion in subsequent chapters.

1 From mining policy to mineral resources policy

After World War II, the mining policy was initiated by the establishment of the Mining Bureau of the Ministry of Commerce and Industry in August 1945. The Japanese Government designated mining as one of the very important industries for reviving the economy of the country. It provided incentives for prospecting new domestic copper, gold and other non-ferrous metal deposits by subsidizing exploration from the latter part of the 1940's to early 1960's. The number of domestic metal mines totaled to over 800 during this period.

The Government founded the Metallic Minerals Financing Agency, the predecessor of the present MMAJ in 1963. The "Three stage domestic exploration" system by MMAJ was established two years later. In the same year, a depletion allowance became effective which is a tax incentive system for promoting domestic mineral exploration. This completed the framework of the mining policy, which supported the post-war high economic growth of Japan. Then from the 1970's, the Government gradually began to apply these policies to overseas mines. The present Japanese mining policy essentially follows this concept and system up to the 1970's with the exception of the introduction of the rare-metal stockpile system in 1983.

However, with the closure of the Kamioka mine in June 2001 after 120 years of active mining, only two metal mines, namely Toyoha and Hishikari mines, are now working in Japan. Now Japan has become the third largest mineral consumer in the world after the United States and China. The country is almost totally dependent on overseas mines for its mineral supply. Together with the progress of metal recycling technology at smelters, the supply mechanism of mineral resources in Japan is gradually changing. The growth of IT and related industries, undoubtedly will become one of the locomotives that powers the Japanese economy in the future, caused the rapid increase of rare metal demand.

It is clear that the environment concerning mineral resources of Japan is changing rapidly in recent years. Therefore, the concept and system of the Japanese mining policy, which was formulated with the view to promote the domestic mining industry, must be reviewed. A policy based on a firm and accurate understanding of reality and genuinely aimed at securing the stable supply of mineral resources for Japan including base metals, rare metals, and also non-metallic resources must be reformulated from base zero. This policy must hold upstream exploration through the middle stream smelting and to further downward industry firmly in view.

From the above understanding, the name of the Government unit in charge of mining policy was changed from the Mining Division of the Ministry of International Trade and Industry to the Mineral and Natural Resources Division of the Ministry of Economy, Trade and Industry (METI) through the restructuring of central government ministries. Thus we will name the policy to be implemented henceforth as the "Mineral Resources Policy" which will be laid out in the following chapters.

2 Mineral Resources Policy Platform

What should be the present mineral resources policy? This is an issue encompassing a wide range of problems and cannot be solved by closed discussions within METI. It is desirable indeed to integrate the wisdom of the informed people of the country for tackling the issue. Thus METI decided in May 2001 to discuss the matter openly and establish the "Mineral Resources Policy Platform" as a forum for the above discussion.

The Mineral Resources Policy Platform is a virtual conference in which many voluntary participants from the industry, academia and government with interest and knowledge in mineral resources policy discuss this issue through the Internet. Remarks of the participants would be carried in the website restricted to the participants http://www.rieti.go.jp/pps/ and be mailed to all participants. It is clearly understood that any remark of the participants represent his/her individual opinion and not that of their affiliated organizations. Consent of the METI is necessary to participate, but anyone with a recommendation of at least one participant can participate without any screening.

The number of participants exceeded 100 after two weeks of opening the platform and attained 200 after three months. The present number is 230. They are; 83 from industry (51 from nonferrous smelting, 9 from trading houses, 9 from resource development consultants, 14 from manufacturers and other fields), 47 from academia (25 from universities, 22 from the National Institute of Advanced Industrial Science and Technology (AIST)) and 100 from government agencies (38 from METI head office, 12 from Bureaus of Economic, Trade and Industry, 31 from MMAJ, 3 from local governments, 16 from public corporations). A list of participants is appended. This includes 15 who are residing overseas and 25 residing in localities outside of Tokyo. These people with a wide variety of experiences and knowledge met and discussed as equals what the mineral resources policy should be on the Internet transcending the restrictions of time and space.

The discussions started from the most basic problem, namely the significance of the objective of the mineral resources policy, securing a stable supply of mineral resources and the government role. On this problem, heated arguments and discussions were carried out among a number of participants with differing views including those who deem the mineral resources policy is unnecessary. Afterwards, problems relating to metal recycling and depletion of aggregates were actively discussed. The period from May to August 2001 was the time of the most heated discussions.

In July 2001, about 60 participants gathered at METI for an "offline conference" with some participants meeting each other for the first time. From August to October, a hearing of individual companies, which many participants proposed, was done at the Mineral and Natural Resources Division, METI. In late August, the activities of the Platform was reported to and authorized by the Mining Subcommittee of the Advisory Committee for Natural Resources and Energy. In September, discussions on large themes were being completed and the pace was settling down. Discussions moved on to individual matters such as effective utilization of "Yen-credit- loans" to the developing countries for mine development, attracting and scientist and engineers in mining and risk communication related to mine development. Presently about 320 presentations by knowledgeable people of various fields have been accumulated on the Mineral Resources Policy Platform, and are available for reference.

From September 2001 to March 2002, a project team consisting of researchers in resources engineering and economics was formed at The Mining and Materials Processing Institute of Japan with the financial support of the AIST. The impact of a supply disruption of major mineral commodities was studied. Further studies on risk communication are planned mainly by the Geological Survey of Japan, AIST.

The results of the Mineral Resources Policy Platform activities, both online and offline, became an invaluable intellectual asset for considering the most desirable mineral resources policy. These results have come into fruition in this paper. However, problems regarding metal recycling and depletion of aggregates will not be considered here as this paper specifically deals with the stable supply of non-ferrous mineral resources. The outline of the discussions relating to these problems is appended.

3 Special public institutions reform and mineral resources organization

In 2001, the special public institutions were reformed. The following basic principle was decided under the strong leadership of the Koizumi Cabinet and whether each project should be continued or not was very strictly examined; namely "all special public institutions will, as a rule, be either abolished or privatized and the exception will become "independent administrative institutions". The special public institution, MMAJ was naturally an object of intensive scrutiny.

Examination was carried out based on several discussions between the Cabinet Headquarters for Administrative Reform and the Mineral and Natural Resources Division of METI between April to December 2001. The discussions regarding the necessity of the projects implemented by the MMAJ have the same significance as discussing the necessity of the on-going mining policy. The reason is because most of the mining policy is now being implemented by the MMAJ. From such a viewpoint, the discussions with the Cabinet Headquarters for Administrative Reform were introduced to the Platform as necessary, and the discussions of the Platform were fed back to the Cabinet Office.

Many decisions including the termination of the "regional geological survey" and "detailed geological survey" the two symbolic projects of the post-war mining policy were made by METI through the close interaction of the Platform participants and administrative offices. In December 2001, it was decided that the MMAJ will be abolished but was permitted to become an independent administrative institute after integrating a part of the functions of the Japan National Oil Corporation. It is expected that the legislation regarding this matter will pass the Diet by the end of July 2002. The independent administrative institute " mineral resources organization " (Official name "Independent Administrative Organization, Sekiyu Tennnenngasu Kinzokukoubutushigen Kikou") will become the main operational organ of the mineral resources policy.

Chapter 1　Significance of Stable Supply of Mineral Resources

As mentioned in the Introduction, the objective of the mineral resources policy is to secure stable supply of mineral resources.　Therefore, the meaning of the term “stable supply of mineral resources” will be examined in this chapter.

1　Why is stable supply of mineral resources necessary?

Why must stable supply of mineral resources be secured?　It is because stable supply of mineral resources is absolutely necessary for maintaining competitiveness of Japanese industry, and will contribute to strengthening the competitiveness of Japanese industry.

In recent years of globalization of industrial activities, the competitiveness of the industries based in Japan is decreasing rapidly.　In the international ranking of 49 countries by IMD （the International Institute for Management Development of Switzerland）published in April 2002, Japan’s position descended to an all-time low of 30th from the top.　Although the Japanese economy has hit the bottom, there still is the danger of entering a deflation spiral.　Under these circumstances, can we avoid the emasculation of industry, particularly the manufacturing industry, and maintain and strengthen the competitiveness of Japanese industry or not: is a matter directly relating to the rise or decline of the Japanese nation.　Therefore, it is the most urgent and the most important policy issue.

In order to maintain and strengthen the competitiveness of Japanese industry, it will be necessary to prepare environments, which would induce stable growth of those manufacturing industries, the locomotive power of Japanese economy.　These industries will be those supplying highly value-added products closely　connected with the most advanced state-of-the-art technology such as the IT and environment-related industries.　For the above matter, strengthening and consolidating industrial technology is an important and necessary policy but it is not sufficient.　To acquire and maintain the overall control of mineral resources indispensable to such leading industries, in other words, to secure stable supply of these resources will greatly contribute to maintaining and strengthening the competitiveness of these industries.　For example; tantalum is indispensable for large-capacity miniature condensers which are the key-parts of mobile phones, indium for liquid-crystal displays, platinum for catalysts of fuel cells, rare earth elements for hydrogen absorbing alloys and copper is indispensable for all electric parts.　Also these metals are very difficult to be replaced by other materials. Therefore, if the technological level is similar, those countries controlling the raw material will be in an overwhelmingly advantageous position.

The above type of argument is more readily applicable to securing stable supply of rare metals, and entirely different argument can be made for stable supply of base metals, namely copper, lead, and zinc. The smelting industry based in Japan is, as will be mentioned later in Chapter 2, is highly competitive in the international market; the quality of its metal products, production capacity, technology, environmental measures and other relevant aspects.　Simultaneously, it is contributing, through the stable supply of metals, to maintaining competitiveness of; electric wire production, copper rolling, electric appliance manufacturing, car production and other downstream industries.　But the high competitiveness of the smelting industry does not have a sound foundation.　The reason is that the Japanese base metal smelters are “custom smelters” relying almost entirely on their raw material supply, namely the metal concentrates from overseas.　Therefore, if the overseas concentrate supply is severed, these smelters will cease to exist.　Consequently, it is prerequisite that raw materials, namely these

concentrates, must constantly be supplied in a stable manner in order to maintain the highly competitive domestic smelting industry.

It can be said from the above that securing stable supply of mineral resources is a matter of national importance, namely maintaining and strengthening the industrial competitiveness is, in other words, an imperative issue for Japanese economic security.

Although the term "mineral resources" would normally include in *sensu lato* ferrous and non-metal mineral resources as well as nonferrous metals such as rare metals and base metals mentioned above, the risk of supply disruption is higher for nonferrous metals than other metals. Therefore the stable supply of these metal resources is of particular importance. Thus the stable supply of nonferrous metals will be considered in the following pages.

2 What is the state of stable supply?

Securing stable supply of mineral resources is an important issue of economic security, but what is the nature of stable supply, which must be secured? Does "stable supply" mean a situation with no fluctuation of prices at all? If not, what is the tolerable limit of price fluctuation for "stable supply"? Or is it "stable supply" if the resources are physically available regardless of high prices? The definition of the term "stable supply" was a theme of the most heated discussions during the early phase of the Mineral Resources Policy Platform. "Stable supply of mineral resources" can be defined in many ways depending on the purpose of securing it.

As mentioned in the previous Section 1, considering the major objective of securing stable supply of mineral resources, which is maintaining and strengthening the industrial competitiveness of Japan, it is deemed appropriate to define stable supply as follows. "A state whereby sustained supply of necessary amount of mineral resources to domestic industry occurs within the range of price fluctuation tolerable to normal economic activity." Also, as this is not an academic exercise, more strict definition is not considered necessary for policy discussions.

The range of price fluctuation should include not only the amount of the difference of price, but also the range of time duration of the price changes. The tolerable range for the price fluctuation for a specific industry decreases with the unpredictability of the fluctuation and dependence of the industry on the mineral commodity. It is necessary for the stable supply to be sustained for the medium to long term for maintaining and strengthening the competitiveness of the industry. If the fluctuation is within the tolerable limit, the increase of price is not necessarily a negative factor for all industries. For example, a normal increase of LME price is not a positive change for copper metal users, but it will result in some increase of TC/RC, which is the revenue of ore processing for the copper smelters.

Thus by defining the stable supply of mineral resources as "a state whereby sustained supply of necessary amount of mineral resources to domestic industry occurs within the range of price fluctuation tolerable to normal economic activity", the "supply disruption" can be considered in the price and quantity aspects. Namely the former indicates a state where the price increases beyond the normal increase and the latter quantity scarcity below the normal decrease.

However, to consider the above two states separately as a different state of supply disruption would be a discussion for the sake of discussion and is not meaningful for considering the mineral resources policy. The reason is that at present, both metals and ores are dealt in some kind of a market, whether perfect or not, and scarcity of quantity is always reflected in immediate price rise as one condition will not occur

without the other. Therefore, the scarcity of quantity and rise of price should be regarded as two aspects of the same phenomena, supply disruption. There could be for a short duration, a most serious situation where total stoppage of supply resulting in an infinite rise of price.

3 Factors causing supply disruption (short-term disruption)

There are many mineral commodities in nonferrous metal resources. There are great differences in the nature of these commodities, for example the ratio of cobalt and tantalum compared to copper for the market size, price, and production would be as follows. For cobalt the market size is 1/30 of copper, the price is 14 times copper, and the production is 1/424 of copper; regarding tantalum the market size is 1/9, the price 1,755 times, and the production 1/6870 of copper. As above, the characteristics of the nonferrous metal resources vary significantly. But the supply structure is generally fragile, and the risks of supply disruption are higher than other resources. This is due to several factors which are mostly common as a whole to all of these nonferrous metal resources. Of these, major short-term factors are the following four.

Firstly, distribution of the nonferrous mineral resources is extremely uneven. For example, 89% of platinum and 73% of chromium resources are concentrated in the Republic of South Africa, 91% of niobium in Brazil, 38% of tungsten and 44% of rare earths in China, and 26% of cobalt resources occur in Democratic Republic of Congo. Since these rare metal resources occur concentrated in Africa, Central and South America and former communist countries where the political system and economic conditions are unstable and the risk of short-term supply disruption is high. This is the reason for the necessity of stockpiling these metals. On the other hand, the base metal resources are relatively dispersed. But still 25% of copper ores are concentrated in Chile and the uneven distribution cannot be said that low. It should be noted that since the unprecedented large-scale multi-terrorist activities in the United States on 11 September 2001, politically stable developed countries are not necessarily safe. It need not be emphasized that natural disasters occur in all countries. In 2000, a large cyclone in Western Australia disrupted roads for the transport of ores causing a marked delay of manganese export during a period of three months.

Secondly, the nonferrous metal resources are susceptible to price fluctuation. This is a characteristic due to the uneven distribution of these resources. Rare metals are particularly susceptible to price fluctuation. Examples are the steep rise of cobalt price caused by the 2nd Shaba incident of Zaire decades ago in 1978, steep rise of molybdenum price due to increase of stainless steel production in 1994, vanadium price rise due to decrease of production in Russia in 1997 and steep rise of tantalum price by the rapid increase of condenser demand recently in 2000. The tantalum price increase was particularly steep exceeding 10 times that of the previous year. These price fluctuations are accompanied by speculation and repeated steep rise and fall occurs often. The unexpected rise of demand caused by progress of science and technology often result in a high price increase, an example is the rare earth metals following the development of rare earth magnets. On the other hand, the price of the base metals does not fluctuate as widely, and the price of copper in recent years is low. However, low-cost copper mines are being aggressively developed and production increasing in Chile, and the some of the operating North American mines were forced to close because of their inability to compete with the Chilean mines. It should be noted as will be discussed later, that oligopolistic process of copper mines by Chile is in progress. Therefore, copper prices in the medium-term future cannot be predicted.

Thirdly, oligopoly of nonferrous metal resources supply is in progress. In addition to the uneven distribution of nonferrous resources, merger of nonferrous major companies are accelerating the oligopoly in recent years as will be described in Chapter 2. As a result, the oligopoly ratio by top five

producers is 64% for copper, 71% for nickel, 99% for platinum, and 100% for tantalum compared to 41% for oil. Although the arbitrary price control of base metals by the suppliers is not evident at present, the risk will increase with an oligopoly.

Fourthly, the substitution of nonferrous metals by other materials is difficult. Most of the nonferrous metals are used on the basis of their individual characteristic properties, and thus they cannot basically be substituted by other commodities. Naturally some commodities may become substitutable by technological innovation, but from the standpoint of maintaining and strengthening industrial technology, it is not desirable to have Japanese firms responding to supply disruption by the development of substituting material. During the period of such substitute development by Japanese firms, foreign firms, which would able to avoid the supply disruption, will surely expand their market shares. Other responses such as substituting copper metals in personal computers and mobile phones by cheap but bulky aluminum is technically possible, but will be producing uncompetitive products. Therefore, in order to prevent forcing Japanese industry to resort to substitution, securing a stable supply of nonferrous metal resources by the mineral resources policy is again important.

4 Factors causing supply disruption (medium- to long-term disruption)

The following three factors cause medium- to long-term supply disruption.

Fifthly, nonferrous metal resources are extremely rare. The abundance of mineral resources underground is 0.0055% copper, 0.0070% zinc, 0.0075% nickel, 0.0025% cobalt, 0.0002% tantalum while iron constitutes 5.6% of the earth's crust. The abundance of the nonferrous metals is better expressed in ppm. Regarding their abundance in the earth's crust, the difference between base metals and rare metals is practically nonexistent in comparison with the difference from the abundance of iron. In other words, it should be noted that the difficulty of obtaining base metals and rare metals is essentially not different in the medium to long term in spite of some differences in concentration among commodities and deposits. This fact is significant that in considering the medium-term and long-term measures in Chapter 3, there is not much meaning in the separate consideration for base metals and rare metals.

Aluminum is an exception among the nonferrous metals and constitutes 8.2% of the earth's crust, and thus it is not necessary to consider securing its stable supply. As will be mentioned in Chapter 3, recycling of nonferrous metal resources is economically limited, and thus the amount used will essentially decrease in a manner similar to other mineral resources. This decreasing nature also increases the risk of medium- to long-term supply disruption occurrence for rare nonferrous metal resources.

Sixthly, the feasibility of investment for nonferrous metal resource development is low. Mine development, compared to other business, needs large-scale investment and has a higher risk, and the period before the recovery of the investment amount is very long. These are; 5~7 years for exploration phase, 2~4 years for development phase, 10~15 years after starting mine operation until the recovery of the investment, with a total of about 20 years or more in normal cases. The development basically starts from easier ore bodies near the surface or in flat areas proceeding to deeper and further interior zones with time. This indicates the fact that investment for mine development increases and the probability of success decreases with time. Therefore, the nonferrous metal resources are rare, and the tendency will be to look for higher-grade ore deposits in the medium to long-term.

Seventhly, the accessibility of investment for nonferrous metal resources development is low. Cases

are not rare where the investors do not have access to mine development and consequently high-quality ore deposits with high economic feasibility are not developed. The Tenke Fungurume copper deposits in Democratic Republic of Congo and the Vasylkovsky gold deposit in the Republic of Kazakhstan are such examples. Many nonferrous metal resources occur in developing countries, in many cases mining legislation and geologic information are inadequate and opposition by the native people to exploration and development is not uncommon. These are cases where the accessibility for exploration investment is low in spite of the confirmed high mineral potential and high economic feasibility. Such low accessibility also increases the risk of medium- to long-term supply disruption.

Last of all, it should be noted that fundamental factor, which causes the above matter to become supply disruption factors in both the short- and medium- to long-term, is that all mineral resources are under the "national property principle". In the Constitution or Article 1 of the Mining Law of almost all resource-possessing countries clearly states that mineral resources belong to the country. This is a fundamental difference between mineral resources and other international commodities. In accordance with this principle, the governments of the resource-possessing countries grant exploration rights to third parties for resources development. This means that there is always a risk of the government of the resource-possessing country intervening in the resources development project from the very early stages of exploration so there is a risk of failure of the project due to political reasons. Also many resource-possessing countries only partially recognize the "mining right guarantee", namely the right of the discoverer of the ore deposit to develop the deposit. Thus there is always the risk of losing the mining concession by changes in the resources policy of the country.

Therefore, the uneven distribution and scarcity of nonferrous metal resources become problems because they are possessed by these countries, and the fact that Japan is almost totally dependent on overseas nonferrous metal resources itself is the basic factor for the short-term and medium- to long-term supply disruption. It should be particularly noted that the Japanese success of mine development in the Central and South America, which is the present main source of base metals for Japan, is an occurrence only within the past ten years. Before this success, political unrest, inflation, resource nationalism, debt crisis, inferiority in keeping peace and order had rendered resources development by private investment impossible. Considering the above factors risks regarding medium- to long-term supply disruption of nonferrous metal resources is not necessarily low.

Furthermore, unlike agriculture and industrial products, mineral resources are in the possession of the country and the stable supply of mineral resources should be secured on the demand-side also by the country.

The four short-term factors and three medium- to long-term factors regarding nonferrous metal resources supply disruption and the principle of national possession of mineral resources brings high risks of supply disruption of nonferrous metal resources. Therefore, it is absolutely necessary for Japan to secure stable supply of mineral resources for both short and medium- to long-term by mineral resources policy in order to maintain and strengthen competitiveness of Japanese industry.

5 Impact of supply disruption

It is not easy to accurately predict the impact of nonferrous metal resource supply disruption to the Japanese economic activity, particularly industrial competitiveness and daily lives of the people. We do, however, have experiences of supply disruption of some rare metals in the past and know their impact. For example, during the supply disruption of vanadium in 1997, difficulty in obtaining the metal continued for a year and resulted in serious problems concerning domestic supply of high tension steel

and the national stockpile was released for the first time. This is the only time the national stockpile was released, while petroleum and food stockpiles have not been released yet. During the tantalum supply disruption in 2000, recovery from disposed tin slag in Southeast Asia and release of US national stockpile were carried out for temporary measures, but Japanese companies were forced to stop shipment of their products. These examples clearly demonstrate that the impact of rare metal supply disruption to the competitiveness of Japanese industry is indeed very serious.

On the other hand regarding base metals, there have been sporadic cases in the past when labor strikes at overseas mines or natural disasters prevented the smooth delivery of concentrates for several months and disturbed operations of smelters, but large-scale disturbances affecting the Japanese industrial competitiveness have not occurred. This, we would like to believe, is the result of the mining policy concerning domestic and overseas base metal mine development. Also as will be discussed in Chapter 2, the types of long-term contracts concluded between foreign mines and domestic smelters in terms of independent development and financing for ore purchase are also considered to have contributed to the stable supply of base metal resources to Japan. It is, naturally impossible to verify the situation where mining policy and/or long-term contracts did not exist.

Thus, the Mineral Resources Policy Platform, reported in the Introduction of this paper, simulated the impact of supply disruption of copper, the representative nonferrous metal, at the Mining and Materials Processing Institute of Japan. First, general balance models describing multilateral demand and supply structure of international market for copper ores (concentrates) and copper metal was prepared (Koji Nomura “multilateral general balance model and resources policy, (in Japanese)”). This model is based on statistical data of 1999 and describes, in detail and realistically to the extent possible, the economic behavior of the top six copper ore exporting countries (Chile, Indonesia, Australia, Canada, Papua New Guinea, Peru) and top five copper ore importing countries (Japan, China, Korea, Germany, USA). It shows in great detail the mechanism of formation of two mutually dependent international markets, namely markets of ores and metals, under the oligopolistic behavior of the ore exporting countries, and the mechanism of simultaneous determination of the international price of ores and metals so that a balance of demand and supply is achieved in the two international markets.

A number of simulations were made on three cases of; decrease of ore production in Chile, expansion of metal consumption in China and decrease of the ore amount purchased under long-term contracts by Japan. The results indicated that a 400 thousand ton decrease (9.5%) of Chilean ores would cause a 72.6% rise of ore price and 57.7% rise of the metal price. A 30% increase of Chinese copper metal consumption would cause a 46.3% rise of ore price and 37.1% rise of the metal price. If the amount of ores imported by Japan under a long-term contract decreased by 50%, the rise of the ore price would be 25.3% and the metal price would rise 20.1%. The above price increases, of course, would affect the whole world, but largest copper ore importing country and the third largest copper metal consuming country, Japan, would be affected most seriously.

In order to analyze the impact of the rise of the above price to other goods, an Input-Output Table for resource analysis was prepared (Tsuyoshi Adachi “Preparation and analysis of “Input-Output Table for analysis on natural resources” by expanding the Japanese Input-Output Table. This table is based on the Input-Output Table 1995 edition (most recent edition as of this day) with an addition of five categories (copper ores, copper metal, copper wire, rolled copper products, copper materials). The price spillover analysis was carried out using this chart. When the Chilean ore production decreased by 400 thousand tones, the price of copper wires rose 14.5%, rolled copper products 10.4%, and heavy electric machinery 1.9%. When the Chinese metal consumption rose 30%, the price increase was 9.3% for copper wires, 6.7% for rolled products, and 1.2% for heavy electric machinery.

The effect of this price increase on the competitiveness of Japanese industry needs to be analyzed. It should be noted that this simulation did not consider a 100% stoppage of copper ore import when the price would not be fixed. For the details of the study by the Mining and Material Processing Institute of Japan, please refer to the following.
http://www.rieti.go.jp/preview/newsite/jp/projects/koubutsu/index.html

Chapter 2 Present State of Mineral Supply and the Role of Mineral Resources Industry

The necessity and definition of stable supply of mineral resources and factors causing supply disruptions and their impact were discussed in Chapter 1. It is our intention to discuss the mineral resources policy for securing stable supply of mineral resources in Chapter 3. Therefore in this chapter, the present state of the supply of mineral resources and role of the mineral resource industry will be considered to enable discussions based on the accurate recognition of the present state.

1. Present state of mineral resources supply (world)

There are eight points, which should be understood as the characteristics of the present state, in comparison to the situation during the late 1960's to early 70's when the mining policy of Japan was firmly established. Of these eight points, those common throughout the world are the following five points.

The first point is the advancing oligopoly by nonferrous majors. Within the term of the past several decades, the pace of M&A among companies called nonferrous majors was not above those of other industries. But this has become very active in recent years, and tendency of oligopolistic control of resources is becoming stronger. Purchase of Asarco (USA) by Grupo Mexico (Mexico) in 1999 to become the second largest copper metal producer is an example. Also in 2001, Teck (Canada) and Cominco (Canada) merged and became the largest producer of zinc ore. Large-scale M&A continued, in the same year, Australia BHP and British Billiton merged, and South African Anglo American purchased De Beers of the same country. This trend is contrary to the resource nationalism of earlier years, and privatization and sales to foreign firms of state mines are continuing. International metal prices generally have been low in recent years. It is highly possible that these trends will continue for some time.

Although the expression "oligopoly" is used, it is quite different from, say, iron ore where three majors control 80% of the world output, or coal and alumina where an oligopoly by several companies control the industry, and different from OPEC for petroleum. The nonferrous majors are not yet in the position to control the international price of base metals. Rather it is also true that the impact of a supplier oligopoly was stronger in the days of resources nationalism. While listening to individual companies on the Mineral Resource Policy Platform, there were few corporations, which actually felt the direct pressure of the oligopoly by nonferrous majors regarding conditions for procuring ores and metals. For mineral resources where an international market is already established, the danger of price control such as those by OPEC in the past, is not likely to occur in the future.

However, the local premium of copper metal is set unilaterally by CODELCO, the Chilean nonferrous

major, and other firms have been following this price for the past several years. This can be said to be a manifestation of oligopoly. Also the study by the Mining and Material Processing Institute reported in the previous chapter, showed that if low-cost copper ore producing countries such as Chile and Indonesia continue to increase production while the price is low, large mines in US and Canada would possibly be forced to close, and it is feared that an oligopoly by Chile and Indonesia would proceed within several years (Nishiyama, Ito, Niikuma "Diversity and stable supply of mineral resources"). For countering such an oligopolistic trend, it is necessary for the Japanese smelting industry to develop their own rights and interests through independent development of overseas mines.

The second point is the rapid increase of Chinese demand for mineral resources. The world demand for copper metal is expected to increase at an annual average of 2.4 ~ 2.6% to 17.63 million tons in 2010. The share of Asia is anticipated to be 37.2%, of which China will use 14.3% a 3.2 point increase over 1998 (Metal Economics Research Institute, JAPAN （ＭＥＲＩ－Ｊ）：Report November 1999 (in Japanese)). The multilateral general balance model reported in the previous chapter indicated that the rapid increase of China's copper metal demand would raise the international copper price considerably. The aggressive open economy policy of the Chinese Government during the past 10 years attained high economic growth exceeding an annual average of 10%. With this high economic growth, China's copper metal demand increased by about 100 thousand tons per year mainly in the infrastructure sector such as electric power, communication and construction. These 100 thousand tons correspond to the level of annual production for a medium-scale copper mine. In 2000, the Chinese copper metal consumption increased 440 thousand tons.

China's production capacity could not cope with such a rapid increase of consumption, and the country is recently becoming increasingly dependent on import of copper metals. The copper metal consumption exceeded production by 310 thousand tons in 1999, 560 thousand tons in 2000 and 780 thousand tons in 2001. As the increasing gap between copper metal consumption and production, it is natural to expect the Chinese to increase the number of copper smelters and their capacity. Actually the Chinese firms are aggressively undertaking independent development of overseas copper mines. For example, China Nonferrous Metal Industry's Foreign Engineering and Construction Corporation (NFC) acquired 85% of the Chambishi copper mine in Zambia. The Chinese Government has shown great interest in the Japanese policy of promoting mineral exploration through MMAJ. It is inevitable that Japan will be competing with China concerning the acquisition of copper ores. But it should be noted that a significant part of China's copper demand is due to the transfer of production facilities of the Japanese electric wire and rolled copper producers. Therefore the mineral resources policy of Japan should not be in the line of a "zero-sum game" such as Japan taking away ores which could feed Chinese industry, but it should aim at securing stable supply to Japan by supporting exploration and development of the Japanese companies.

China, contrary to copper, has zinc production capacity far exceeding her consumption and is the world-largest exporter of zinc metal. China was self-sufficient in zinc ores, but in 2001 imports exceeded exports and China became a net importer of zinc ores. It is anticipated that the competition for zinc ores will also occur between Japan and China in the coming years. Concerning rare metals, China produces 85% of rare earth metals and 79% of tungsten world production. It is not rare for China to take advantage of this oligopolistic position and squeeze, in other words, hold off selling in anticipation of price rise. It is necessary for Japan to deepen the economically interdependent relationship with China in order to prevent such a squeeze.

Another large Asian country, India is imposing high tariff on copper metal with the objective of promoting its domestic copper smelting industry, and its import of copper ores is increasing rapidly in recent years. The tariff for copper ores is 25% as of 2002. We should beware of this nation with a

population of a billion people, which pursues economic growth at a cost of distorting the principle of market economy, as a potentials threat of causing medium to long-term supply disruption.

The third point is the actual risk of terrorism in developed countries. The perception of safety in developed countries underwent a complete change on 11 September 2001. This was such a drastic change of the fundamental framework of thinking that it could even be said to be a shift of paradigm. There was no one in the world except a group of few terrorists who could foresee that such an enormous act of terrorism would occur in the heart of political and economic activity of United States, which was believed to be most secure place in the world. Therefore it is not correct to think that developed countries are more secure than developing countries. This, of course, is not a matter only related to supply of mineral resources, but it is an important issue, which cannot be avoided in considering the problem of mineral supply.

The target of the terror against USA was not directly related to the supply route of mineral resources. But some impact was felt, for example 30 million ounces of silver metal, corresponding to about 30% of the total COMEX stock, was buried under the rubble of WTC Building and could not be recovered for a period of time, and a sense of shortage was widely felt in the silver market. The low impact of the incident on mineral supply this time is no guarantee for the same result in future terrorist activities. Regardless of how much international effort is expended, it is not possible to predict and prevent terrorism completely. For example, if a large-scale terrorism were to occur on the zinc ore route from Australia to Japan, it would seriously disrupt Japan's zinc ore supply as it depends more than half of its zinc ore supply on Australia. Thus the supplier of ore being an advanced country is now no guaranty of stable supply. This has to be recognized clearly.

The fourth point is the very rapid change of demand for specific rare metals associated with the development of IT revolution. For example, miniaturizing mobile phones and personal computers requires; tantalum for electrolytic condensers, rare earth magnets for motors, beryllium for connectors, palladium for contact points and indium for transparent electrodes of liquid crystals. The demand for these metals increased suddenly with the rapid popularization of mobile phones and small personal computers. Also the associated increase is observed for cerium used for abrasives for polishing glass for liquid crystals and zirconium used for containers for baking electronic materials. In the environment protection field, platinum is necessary for catalysts in car exhaust treatment and palladium for fuel cell catalysts and titanium is attracting attention as photocatalyst for decomposing nitrogen oxides and dioxin. Some of these rare metals were not used and regarded as slag ten years ago although they were recovered to be by-products of base metal smelting.

A common expression "dog year" would aptly describe the very fast growth of IT industry, which is on a different dimension with other fields of industry, and consequently the requires rare metal commodity changes extremely rapidly. Thus it is very difficult to foresee the sudden increase of specific commodity within a time span of several years. But for this very reason, the government must carry out an accurate prediction of future demand and to prepare an environment for easily securing a stable metal supply to Japanese industry.

The fifth point is the international acceptance of the concept of "sustainable development" for mine development. "Sustainable development" is a concept on the use of the natural environment by the present generation in a manner not detrimental to future generations. This concept is being discussed in all development fields of activity with the increasing awareness of environment protection in the world. Regarding mining, various concerned organizations including international institutions such as the UN and OECD, intergovernmental organizations such as the World Mine Ministries Forum, the Mine

Ministers of the Americas Conference (CAMMA) and mining organizations such as Global Mining Initiative are carrying out active discussions in order to realize this concept and attain global consensus. Also the interests of the people and society on development, poverty and related problems are becoming increasingly stronger.

Under these circumstances, new mines can only be developed with a maximum consideration of the natural environment and local community. Also the views of stakeholders in mine development can no longer be ignored. “Sustainable development” is undoubtedly a correct concept as a matter of course, but in its realization of mine development, it will be important for the Japanese Government to participate actively and contribute in the above discussions so that they will not become overly radical.

2. Present state of mineral resources supply (Japan)

The following three points should be noted regarding the state of mineral supply within Japan.

The sixth point is the depletion of domestic resources. As mentioned in the Introduction, the number of domestic working mines continued to decrease from the peak of 823 mines in 1951. This is due to the gradual depletion of reserves of ores with sufficient grade to operate at a profit. The Kamioka mine closed in 2001. Now there are only two operating mines with more than 100 employees the Toyoha mine producing mainly zinc and lead ores and Hishikari mine mainly producing gold ores. The Japanese self-sufficiency of zinc was 11.0% for 2000. Regarding copper, kuroko deposits were actively developed from the late 1950’s to the 1970’s, but the reserves are depleted and now there is no copper mine in Japan. Thus the copper ore self-sufficiency of 2000 was 0.1% and dependence on imported copper ores was 99.9%. As for rare metals, with the notable exception of indium with the world’s highest-grade deposit at the Toyoha mine, the Japanese self-sufficiency of all commodities is close to zero.

Through regional and detailed geological survey projects, implemented in accordance with the “three-stage domestic exploration method” of the Japanese Government, 1837 holes in 88 areas were drilled during a period of 37 years by the end of the Fiscal 2001, covering almost all areas with mineral potential in Japan. Therefore with the exception of the unreturned Northern Territories, the possibility of new high-grade ore discovery in areas not surveyed is nil. In other words, Japan will rely forever on mineral resources supply from overseas countries.

The seventh point is that the domestic smelting industry has become the “mineral resources industry”. With the depletion of domestic resources, all Japanese smelters are now, “custom smelters” who process ores imported from overseas mines. Many of these smelters were once operating as smelters at the mines. However, the largest smelter in Japan, the Onahama Smelter was constructed in 1963 in the harbor area specifically for processing imported ores. As mentioned in Chapter 1, custom smelters are destined to disappear when the import of ores is severed, and thus stable supply of ores is a prerequisite. For this reason, the domestic smelters are investing to a differing degree in overseas mines together with buying ores on the spot market where the price fluctuation is large. Long-term stable ore supply comes from these investments in mines. Also it is notable that these smelting companies are not only engaged in smelting, but also in processing metals into electronic materials and actively engaged in environment-related projects such as waste processing and metal recycling by utilizing their smelting facilities.

From the development and management of overseas mines in the upstream zone, through metal production in domestic smelters in the middle stream zone, to the production and environment projects in the downstream zone are carried out consistently by one company. These are the characteristics of

the present state of the mineral resources supply system of Japan. The environment-related projects are concerned with the reproduction of metal from wastes and scrap, thus its position could be described more aptly as in the "countercurrent" to the middle stream phase rather than in the downstream phase.

Under these circumstances, it would be more realistic to consider the above separate industries as belonging to a single integrated industry, rather than separately under standard industry classification, for the purpose of considering the mineral resources policy. Therefore the industry including the upstream, middle stream, downstream and countercurrent phase of the nonferrous metal resources will be called "mineral resources industry" in this paper. In Japan, the present mineral resources industry consists mainly of the following eight companies, Mitsubishi Materials, Mitsui Mining and Smelting, Sumitomo Metal Mining, Nippon Mining and Metals, Dowa Mining, Furukawa, Toho Zinc and Nittetsu Mining. The total 2001 annual sales were 1778.5 billion yen and number of employees is 17,000 people. The upstream and middle stream of this mineral resources industry is inevitably strongly affected by the international metal price and currency exchange rate fluctuations, and the downstream phase is affected by the condition of the IT industry. All the above eight companies' revenue and profit of 2001 decreased significantly over the previous year because of the low international metal price and decline of the IT industry.

The eighth point is the increasingly active merger of operations in the mineral resources industry. The Japanese mineral resources industry is very small compared to nonferrous majors of the world. Although the preconditions of statistics is different and simple comparison is not necessarily adequate, the total revenue of the above eight main companies of Japanese mineral resource industry is far less than that of BHP which was, before the merger, 2.5 trillion yen. This immense difference is similar to that of the Japanese petroleum development companies and petroleum majors. It is not unrelated to the facts that the European and American governments, the home of the nonferrous majors, maintain strong influence to the resources-possessing countries in Central and South Americas and Africa both historically and geographically. They maintain a strong attitude of not hesitating to exert military power in order to safeguard their resources security. This is because, as mentioned in Chapter 1, mineral resources are the possession of nations and the power relationship of the countries greatly affects the operating environment of private enterprises. It is seen, therefore, that the Japanese mineral resource industry bears a large handicap, which is outside of its responsibility.

The largest effect of the difference of scale between the Japanese mineral resource industry and nonferrous majors is most strongly manifested in the exploration capability. For example the total funds expended for exploration by the main eight Japanese mineral resource companies in 1999 was 2.7 billion yen which is nothing compared with that of one company BHP's 13.4 billion yen, and is the same as a medium-scale major like INCO's 2.6 billion yen. This large difference occurs from the fact that larger companies are able to hedge the risk of exploration by implementing a number of exploration projects simultaneously. As a result, the profitability and funding capability of the nonferrous majors inevitably become stronger than those of the Japanese mineral resource industry.

To cope with the above situation and to deal with the difficult economic conditions, there are indications of mergers in activity taken by the Japanese mineral resource industry. For example Nippon Mining and Metals joined forces with Mitsui Mining and Smelting in the sales of electrolytic copper and sulfuric acid in 2000 and copper concentrate purchase in 2001. Furthermore, it was recently announced that these two companies will join in copper metal production in the spring of 2003. When this is realized, it will be the birth of a "Japanese nonferrous major" with copper metal production capacity, second in the world next to CODELCO. Also regarding zinc, Mitsui Mining and Smelting and Sumitomo Metal Mining are planning to cooperate in raw material purchase and product sales in the autumn of 2002.

Policy for securing stable supply of mineral resources must be examined in the light of the present situation regarding the overseas and domestic supply of mineral resources as explained in the previous sections. But before that, the role to be played by the mineral resource industry, which will bear the burden of mineral resource procurement, must be clearly understood. This will be discussed in Sections 3 and 4.

3. Significance of the existence of smelting industry in Japan

As will be mentioned later, rare metals are not produced in Japan with the exception of by-products of base metal smelting. For the sake of convenience, in this paper the term "rare metal" will be used in *sensu lato* indicating the state of the metal after smelting, not only ingots but also intermediate products such as oxides and alloys. Similarly the term "rare metal ores" will indicate rare metal before smelting indicating, not only ore with rare metal as major components but those even with minor content of rare metals in base metal ores when focusing on rare metals.

Regarding base metals, unlike rare metals, which are basically not smelted in Japan, it is necessary to examine whether to aim at securing the stable supply of ores or only of metals as a matter of mineral resources policy. Securing the stable supply of the metals should be sufficient as far as maintaining and strengthening the competitiveness of the Japanese manufacturing industry is directly concerned. Furthermore, copper ores (concentrates) contain 60~70% of unnecessary material, and slags and sulfuric acid which are generated through the smelting process must be treated in order to avoid detrimental impact on the environment, while metals naturally do not produce such byproducts or slags. Why does the mineral resources policy aim at the stable supply of not only clean metals but also of ores? In other words, is it necessary for the government to support securing raw material by the domestic smelters, which are custom smelters? The answer is yes because the existence of smelting industry in Japan has the following significant effects to the industrial competitiveness of Japan.

Firstly, the domestic smelting industry contributes greatly to the stable supply of metals to domestic manufacturing industry. If the smelting industry did not exist in Japan and the manufacturing industry was to be totally dependent on the import of its base metal supply, the base metal supply structure to the domestic manufacturing industry would become significantly more fragile than the present situation. The reason is that in contracts for buying and selling metals, it is the international practice for the supplier to bear the sea freight. For example for Chile and other Latin American countries, their shipping costs are lower for export to North America and Europe because of their closer distances. This means that in the event of a decline of metal production at a Chilean smelter due to an unforeseen accident and other occurrences, the exports to Japan would be the first to stop before North America and Europe. Such cases would be clearly making a bad situation for the Japanese manufacturing industries, which require stable supply of base metals.

Therefore, the existence of a smelting industry in Japan, which in the operating mode of the "mineral resources industry" has secured a stable supply of ores with the 80% coming through long-term contract and will continue to provide stable supply of metal to the domestic manufacturing industry, is extremely significant for the industrial competitiveness of the country. Of course there are "long-term contracts" in case of metal import, but these are an annual commercial contract between an overseas smelter and a domestic manufacturer, and all contract conditions must be negotiated each year. Whereas in the case of ores, a long-term contract is based on the Japanese smelters' investment to overseas mines, thus the deal amount each year is guaranteed and the term of contract is normally for a number of years even extending to ten years is not uncommon. Thus the stability of the long-term contracts for ores and metals are on a different dimension. It is seen that the argument that a "stable supply is sufficient by

importing metal from the market" has no insight and is incorrect.

Secondly, domestic smelters can provide a fine-tuned response to the supply needs of domestic manufacturers. If the smelting industry did not exist in Japan and the supply of all metals were dependent on imports from overseas, it would be difficult to efficiently procure metals of varying forms and blend in small lots. Metals are usually imported in large lots of 1000 to 2000 tons. The major part of the domestic demand for zinc is tailored zinc and the forms are extremely diverse, and it is not possible to respond to these demands by imported zinc. Regarding the quality of the metals, the Japanese electrolytic copper has a very low deviation of impurities and is homogeneous compared to Chilean copper metal produced by the SX-EW method. For the Japanese high-tech industry such as electronic parts, availability of such super-high quality copper metal is a great advantage to overseas manufacturers. Also for example, production of high-purity nickel used for semiconductors and hard disks is one of the fortes of the Japanese smelting industry. It is thus seen that the existence of the smelting industry in Japan and their ability to respond to the needs of the domestic manufacturing industry in supplying diverse and high-level metals is indeed greatly significant.

Thirdly the Japanese smelting industry is the source of supply of high value-added electronic materials. For example, electronic materials with high added values such as electrolytic copper foils and high purity gallium can only be produced through the accumulation of high-level smelting expertise. Actually, Mitsui Mining and Smelting holds 40% of the world share of electrolytic copper foils, Dowa Mining holds 30% and 70% of the world share for high-purity gallium and metal powder magnet material and Toho Zinc holds 60% of the world share regarding high purity electrolytic iron. These companies are the world's top enterprises in the respective fields. Thus the great significance of the existence of the "minerals resources industry" within Japan producing such highly value-added electronic material can be easily understood. It is clearly seen that the existence of the smelting industry in Japan is one of the supporting elements of the competitiveness of the Japanese IT industry.

Fourthly, the domestic smelting industry controls the premium price of metals to Japan. The local premium price of copper metal is unilaterally determined by CODELCO, the state enterprise of Chile. But regarding Japan, copper metal is not necessarily a sellers' market because there are smelters, which provide high-quality copper metals. Thus it is obvious that the Japanese smelting industry contributes to control or suppress the premium price for copper in Japan. Actually the premium price of aluminum in Japan shot up immediately after the aluminum smelting industry closed in 1987 and is still at a higher level than the copper premium price.

Fifthly, domestic smelting industry is a necessity in Japan, as she increasingly becomes a recycling society. No one other than the "mineral resources industry" can process certain types of wastes and recycle metals. Today, shredder dusts of discarded cars and metal recovery from electric appliances are carried out at smelters. But these environmental projects cannot be implemented independently because of the high cost, and they can only be carried out as a side business of the main business of smelting base metals utilizing the plant and technology. Therefore the existence of a strong smelting industry in Japan has great significance in terms of impacting the environment unduly.

Sixthly, the Japanese smelting industry itself is an internationally competitive industry with the highest-level technology. This point needs to be confirmed quantitatively later, but it is inferred from several facts. Smelting industry is one of the typical heavy capital equipment industry. The Japanese smelters invested heavily in modern plants represented by oxygen enrichment process during the 1950's and 60's and consequently depreciation for almost all of these smelting plants have been completed. This is one of the sources of the strength of the Japanese smelting industry. Also regarding copper metals, access conditions to the expected-fast-growth Asian market including China are also another

factor relative to other producing areas such as South America.

The quality of metals and smelting technology has already been mentioned, but particular mention is warranted regarding the Japanese smelting technology. It has taken measures to exceed Japanese environment regulations, which are one of the strictest in the world, and still can compete with the smelters of the environmentally more lenient countries. It is a foreseen trend that the environmental restrictions in the more lenient developing countries and China will be strengthened in the coming years. It is inferred that the Japanese smelting industry would have a continuous advantage with their environmental technology. Such a promising industry with regard to international competition is precious and must continue to operate within the country because without this industry, it would be a great blow to the Japanese economy. It should be noted, however, that this competitiveness is not necessarily on firm ground. As mentioned in Chapter 1, the lifeline of the custom smelters is the stable supply of ores from abroad. The risk of a supply disruption of nonferrous metal resources is high. When the supply ceases for a length of time, the smelting industry will fall.

The existence of the base metal smelting industry in Japan is indispensable for the Japanese economy. Thus the stable supply of ores must be secured by the mineral resources policy. Conversely as long as the smelting industry exists and stable supply of ores is secured, stable supply of high-quality metals to Japanese industry is assured, and thus the necessity of securing the stable supply of metals by policy decreases in a relative sense.

On the other hand, regarding rare metals, the scale of demand is small and changes in demand are frequent, and the merit in importing ores and smelting domestically as custom smelters is small except as by-product of base metal smelting. Therefore, rare metals are smelt abroad at the mine sites. The significance of attempting to securing a stable supply of ores is small. The interest in developing rare metal mines overseas is minimal among the mineral resource companies. Thus the role played by the Japanes trading companies in securing a stable supply of rare metals is expected to be high. At present, these trading companies are showing a strong interest in mine development including mine-site smelting of rare metals in Central Asia including Kazakhstan. For such activities, it will become necessary to consider whether a provision of technical support to these trading firms would be beneficial or not. This will be discussed in detail in Chapter 3.

The Japanese trading companies are actively participating in base metal mine development. For example, Mitsui & Co., is the only Japanese company listed among the 50 top mining companies in the world selected by the Raw Materials Group, the Swedish think tank. These trading companies are particularly strong in resources information gathering and overseas project formulation. In these aspects, they are stronger than the mineral resources industry. From these points, the role to be played by trading companies should be re-recognized in the mineral resources policy.

4 Ore acquisition by the mineral resources industry

It is clear by the discussions in the previous sections that for maintaining and strengthening the competitiveness of Japanese industry, it is of the utmost importance to secure a stable supply of ores to the domestic smelting industry rather than a supply of metals. The acquisition of base metal ores from abroad is done mainly by the smelting industry in the role of the “mineral resources industry”. There are three types of ore acquisition by the mineral resources industry. One is “equity ores” in which the company invests in mine development from the initial exploration stage and acquires ores in accordance with its investment share, the equity. Next is “purchase through financing” where the company provides necessary finance for mine development and secures ore supply by a long-term contract. The

third is “simple purchase” in which the ores are bought on the spot market. For the simple purchase, the price fluctuates considerably and there is no assurance of a long-term procurement of ores. Furthemore, the sources of the ores, namely the mines, should be constant because the variation of the quality of ores such as the impurities and silica content is a negative factor in smelting. It is, thus clear that equity ores and purchase through financing is much more desirable than a simple purchase.

Which is more desirable equity ores or ore purchase through financing? Both are under a long-term contract. Capital gains will be obtained by the independent development with specific rights and interests, but it does not mean that ores can be acquired at lower prices than others (other what?). The conditions for buying the ores are basically the same for the two types. In spite of that, equity ores is much more desirable than ores purchase through financing in terms of securing stable supply of ores.

The reason is that; firstly those with rights and interest in the mines have the guarantee to acquire at least the ores amounting to their share of the interest. In practice, many of the Japanese Mineral Resources Industry Companies are securing more than their equity. The second point, that is; usually the “first refusal right” for ores exceeding the equity in the mine is given to the holders of the mine interest. This is the right to acquire the ores if the same conditions are presented. Therefore the holder of the interest in the mine is assured to be able to purchase ores by at least matching the price of anyone offering high prices. Thirdly, in many cases of unexpected sudden price rise in the spot market, the mine interest holder is given a high priority in allocating ores.

Fourthly, the holder of mine interest has access to an abundant amount of information through participating in the management of the mine. For example information, which is not available to outsiders, can be acquired such as future management plans for the mine, the condition of nonferrous majors who are partners and the situation of the smelters abroad who are trading with the mine. Fifthly, it is possible for the mine interest holder to maintain mining technology through participation in the mine management. Mining technology and skills such as exploration, mining and ore dressing can only be acquired through working at the mines. With the exception of the Toyoha and Hishikari mines, the Japanese mineral resources industry does not have domestic mines, and it is imperative that the next generation of mining engineers of these companies inherits the skills at overseas mines.

With the above advantages, it is very desirable for the Japanese mineral resources industry to hold a major share of the mine and control the management of some overseas mines. For this, it is necessary to participate from the exploration stage of mine development. It will become increasingly expensive to participate as the development proceeds. It is very rare for participants after the exploration stage to acquire a major share of the mine. Therefore, for the Japanese mineral resources industry to acquire major shares in a mine with limited funds, it will be necessary to carry out grass-roots exploration aggressively. On the other hand, in Latin American countries such as Chile, the development of the SX – EW method has increased the number of smelters at the mine sites. This means that the mineral resources industry of Japan should not jeopardize itself by just being complacent as a custom smelting industry.

With the above reasons, the slogan “Japanese smelters return to mineral exploration !!” cannot be overemphasized.

5 Securing the stable supply of ores and metals

It is seen from the above that, what the Japanese mineral resources policy should aim for is to secure a stable supply of base metal ores and rare metals. The mineral resources industry is one of the key

industries contributing to maintaining and strengthening the competitiveness of Japanese industry through a stable supply of base metals.

The Japanese Government designated mining as the important industry for the rehabilitation of the economy immediately after WW II, and under the present recession the Japanese Government should designate the mineral resources industry as the important industry for the economic recovery through maintaining and strengthening industrial competitiveness. The government should commit to a resource policy to the extent possible for supporting the acquisition of ores and stable operation of the mineral resources industry of Japan. For example, these points should be strongly recognized by the Strategic Council on Industrial Competitiveness of METI and Council on Economic and Fiscal Policy (CEFP) of the Cabinet. If their recognition is insufficient, it is our duty to rectify it. This is, of course, a policy to contribute to the whole Japanese economy and not for the promotion of an individual industry. The concrete scheme for this will be mentioned in Chapter 3.

Chapter 3 Mineral Resources Policy for Securing Stable Supply

The reasons why the Japanese Government must exert all its efforts for securing a stable supply of mineral resources are now clear from the discussions in Chapters 1 and 2. In concluding this paper, policies for securing stable supply of mineral resources will be systematized and concrete countermeasures to be taken regarding individual policies will be presented in this chapter.

1 System of stable supply policies

As discussed in Chapter 1, factors regarding the disruption of nonferrous metal resources supply can be largely divided into short-term and medium- to long-term disruptions. Therefore in order to prepare exhaustive plans for securing a stable supply, one must prepare measures with the short-, medium-, and long-term perspectives. For the short-term or an unforeseen sudden disruption, the direct method of stockpiling is most effective. For eliminating the medium-term supply disruption, overseas mining and development should be expanded by promoting exploration and development by the Japanese mineral resources industry. At the same time, considering the fact that mineral commodities are strongly international by nature, it would be important to fully utilize the market functions and increase the degree of supply stability. Regarding further long-term measures, securing exclusive development rights for deep-sea mineral resources represented by manganese nodules should be a significant priority investment.

Of the above four measures, emphasis should be laid on “promotion of exploration and development” and “full utilization of market functions”. These are both primarily stated as measures for medium–term problems, but they are effective also for countering both short- and long-term disruptions. Promotion of exploration and development was also the core of the past mining policy. In the mineral resources policy, these measures should continue to be placed as the most important core with targets entirely on overseas resources. This will be mentioned later. On the contrary, utilization of the market functions was hardly considered in the past mining policy. But in the mineral resources policy, this also should be undertaken as an important measure together with exploration and development.

Thus the two medium-term measures, namely the promotion of exploration and development and full

utilization of the market functions will form the two major pillars. These measures will be supported by the short-term measure of a “stockpile of rare metals” and long-term measure of “deep-sea mineral resources exploration”. These four policy measures will comprise the policy system for responding to all types of stable supply disruption with a complete assurance. The above measures should be the system for securing stable supply of mineral resources of the mineral resources policy. The concrete countermeasures will be discussed in the following sections regarding the promotion of exploration and development, full utilization of market functions, and stockpiling of rare metals: and deep-sea mineral exploration.

As measures for securing the stable supply of mineral resources, lowering the dependence on overseas resources by promoting metal recycling from metal scraps can be considered. For example, used mobile phones, which recently are showing an explosive increase, are sometimes called “city-type mines” because 13 g of copper, 28 mg of gold, 14 mg of palladium can be recovered efficiently from one mobile phone. But the contribution of metal recycling to resources security is limited because metals cannot be recycled without consideration of economic efficiency and its characteristics are that costs rise drastically with the increase of the recovery rate (Nishiyama, Ito, Niikuma “Diversity and stable supply of mineral resources, p.7 (in Japanese)”). From this recognition, technical development and other measures regarding promotion of metal recycling should be categorized within “environmental contributions by the mineral resources industry” rather than a stable supply of resources.

2 Mining policy which should be discontinued

Before discussing the future countermeasures of the stable supply policy in Section 3 and subsequent sections, the policies that should be discontinued must be clearly shown. There are some policies, which have lost their significance and should be discontinued in the viewpoint of the present overseas and domestic situation regarding mineral resources supply. The symbol of post-war mining policy, the “regional geological survey” and “detailed geological survey” of the domestic three-stage exploration system, has already covered almost all of the potential areas of Japan, and it should be assessed that their missions have been accomplished. The budget, personnel and other policy resources for these projects should be allocated for securing overseas mineral resources.

Also there is no longer a viable reason to continue the “loan system for stabilized management on metal mining” now with the domestic mineral resources depleted and essentially only two operating mines.

Other than above, the “stock system for stabilized Import on nonferrous metals” through which low-interest loans are provided for stockpiling copper, lead, zinc and aluminum by the private sector also is another policy, which should not continue in the mineral resources policy. This concept of stockpiling base metals as a measure for short-term supply disruption itself was not viable from the beginning because of the degree of the uneven distribution of base metals is lower than that of rare metals, and the possibility of short-term supply disruption is small. Actually this system has not been used for 19 years since its inception in 1983. It is now time to abandon such impractical policies. However as discussed in Chapter 2, with the rise of the risks for terrorism worldwide, risks of an unexpected supply disruption can occur for base metals from developed countries. It is not a futile exercise to consider a policy for responding to these situations, and this will be discussed in Section 5.

Aside from the above policies, which should be discontinued, there are many on-going policies for which the system or mode of implementation should be amended to a large degree. These will be discussed in Section 3 and later.

3 Promotion of exploration and development (medium-term policy)

One of the strong assertions of this paper, as discussed in Chapter 2, is that the Japanese smelting industry should not be satisfied by being mere custom smelters and must implement mineral exploration abroad. But, mineral exploration is an activity with the highest risk among all activities of an enterprise. Furthermore, the return is not necessarily sufficient under the present low metal prices. No one would invest in a high-risk low-return industry. Unless the exploration risk is lowered to the level commensurate with the return, the exploration and development of mineral resources cannot be carried out commercially. Nonferrous majors with a large operating scale and extremely rich financial connections can implement such projects by themselves, but it is not possible for Japanese industry. Thus the Japanese Government must support the lowering of exploration risks by the companies. For this, there are the following three approaches.

(1) Provision of resources information

This is to lower the exploration risks of the Japanese companies by providing information regarding overseas geology and investment environment.

Information provision from the 10 overseas offices of the MMAJ has been regarded highly by the Japanese industry, but is somewhat not current. Ideal overseas information would provide an understanding of various aspects such as political situation of the resources-holding countries and to issue a warning before the occurrence of supply disruption. For this objective, a system of a close liaison with the Foreign Ministry and Defense Agency is a prerequisite. The satellite image analysis by MMAJ is supposed to be targeted on remote areas, but too remote areas where Japanese companies cannot invest in the medium-term period should not be considered. Also image analysis technology should be constantly improved. The provision of this information should be limited to Japanese companies, and strict information management and control should be enforced so that it will not be leaked to overseas nonferrous majors.

ODA surveys carried out by MMAJ for the mineral-resources-possessing developing countries are a provision of mineral information to the recipient countries. Although these projects are not directly related to the interest of the Japanese industry, one of the countries who benefits greatly from the increase of international mineral resources is a large consumer of mineral resources, Japan. In this sense, the national benefit and global benefit coincides nicely. It is, however, noted that the areas proposed by the developing countries for the cooperative survey often are left-over areas, which are not very promising. A thorough pre-implementation survey is necessary to conserve precious policy resources. Also ODA projects, as a principle, do not pursue compensation, but to conclude agreements to give Japan with a higher priority during a mineral supply disruption is within the natural requests of a donor country.

The above resource information provision must be implemented more strongly by the Independent Administrative Institution, “mineral resources organization” under a full integration with the information acquisition functions of the old Japan National Oil Corporation.

(2) Direct funding support

This is a method of reducing the exploration risk through subsidies, policy loan, tax system and other relevant measures.

The geological structure survey in foreign countries and overseas cooperation for geological structure

survey by MMAJ are the most direct support for overseas exploration to the private sector and should be placed at the core of the exploration and development promotion policy. The mineral resources organization should commit a budget and personnel for the geological structure survey in foreign countries with the completion of domestic geological survey projects. Also the system and mode of implementation should be improved so that it would be easier for Japanese industry to utilize the scheme. Namely, many of the developing countries have wet and dry seasons. The seasons of the southern hemisphere are the opposite from those of Japan. Thus the duration of the project often does not coincide with the Japanese fiscal year. Therefore, carrying over the budget and year-around application for the project from the companies should be made possible. This policy should also be applied to a company if it is a 100% subsidiary of a Japanese company. Also in order to promote exploration by Japanese trading companies, the expenses for F/S by these trading companies should be subsidized by the government and cover their technical weakness. In these cases, however, these trading companies should be obligated to import certain portion of the mine mineral products to Japan in the future.

Regarding the financing for prospecting activity in foreign countries by MMAJ, the conditions for the loan is presently strictly bound by the financial authorities, but it should be left to the discretion of the mineral resources organization after becoming an independent administrative institution. The organization should develop a variety of financial products and services to fit the needs of the industry. Measures regarding taxation are better than subsidies in that there are no restrictions on the financial years and application procedures. The decrement exemption system should not only be continued but expand its application to trading companies.

After the success of exploration, for the mine development phase after the success of exploration, an application of Yen-credit is possible. For this measure, the mine needs not necessarily be a state-operated mine as long as guarantee of the developing country government is obtained. The presentation of various policy packages such as Yen-credit、JBIC financing and trade insurance is an important role of the government.

(3) Preparation of exploration environment
This is to lower the risks involved in exploration of by preparing an environment compatible with mineral exploration activities by the Japanese companies.

The most urgent problem is to educate and train Japanese mining engineers. As most of the domestic mines are no morepermanently closed and localities for on-the-job training is almost non-existent in Japan, the lack of capable mining engineers has already become a serious problem for the mineral resources industry of Japan. The location for on-the-job training for Japanese mining engineers can only be sought abroad. This is also another reason for the government to aggressively support the independent development of overseas mines by Japanese companies. Presently accreditation of tertiary education curriculum by JABEE, a private organization, for all technical fields is now attaining wide recognition in earnest. Regarding mining engineering, the Mining and Materials Processing Institute of Japan is in the trial accreditation stage, and this needs to be firmly established as soon as possible. Also a system of for the continuous training of mining engineers in industry at the International Institute for Mining Technology (MINETEC) and other organizations should be reinforced.

Next is the dissemination of risk communication techniques. Appropriate communication with native people and small-scale mining are important. Since a lack of or poor communication can become a factor hindering the accessibility for exploration investment by the Japanese companies. Such techniques have been studied in fields of the construction of nuclear power stations, chemical plants, waste processing plants, and other construction projects, and this must surely be effective in exploration and mine development. Government should accumulate examples of successes and failures of these

firms, analyze them, and induce general principles from them and make the results available to the Japanese industry. Studies will start in 2002 at the National Institute of Advanced Industrial Science and Technology (AIST), and this should be expanded and developed.

Also the Japanese Government should actively participate in various international activities concerned with "sustainable development" discussed in Chapter 2. It is important for the Government to be involved in formulating international rules regarding mine development and in making rules compatible with exploration and development activities of Japanese companies.

4 Utilization of market functions (medium-term measures)

Mineral resources are international commodities. There is the LME for base metals and international market price for rare metals that is determined by one-on-one negotiation. But as discussed in Chapter 1, there is no guarantee that the necessary amount of mineral resources can be procured from the market at a given time. This is precisely the reason for the necessity of exploration and development promotion scheme discussed in Section 3. However, a policy of securing a stable supply by bringing the international mineral market closer to perfection is another effective policy direction. Promotion of exploration and development and the full utilization of market functions are complementary and inseparable. The full utilization of market functions is approached from three directions as follows.

(1) Preparation of domestic market

The "JME concept" of founding a terminal market in Japan reflecting the rapidly growing base metal demand in Asia was presented in the policy vision of the Agency of Natural Resources and Energy ten years ago. But it has not been discussed since its presentation. The advantage for founding such a market now when the LME price is the absolute international guideline for base metal transactions is small. But for rare metals such as tantalum and cobalt whose Japanese consumption amounts to 20~30% of the world total, JME would be very beneficial. It should also be noted that setting up a LME storehouse in Japan would function as a kind of base metal stockpile in case of an unforeseen supply disruption. In Canada and Australia, there are numerous grass root exploration companies called "juniors". These junior companies exist only in these two countries. The reason for this is the existence of high risk – high return type special markets where these junior companies can obtain financing for exploration. Nonferrous majors are using these junior companies actively, but the Japanese mineral resources industry does not use them very much, perhaps from the difference in business culture. Thus it is worthwhile to set up Japanese junior companies, and the market mechanism of Canada and Australia should be fully examined.

(2) Promotion of area integrationIntegrating markets of geographically close countries and aiming for free and smooth trade within the area would be effective in lowering the risk of a supply disruption of mineral resources. This is clearly demonstrated by the fact that Britain and France discontinued their national stockpile of mineral resources after the EU integration. At the moment, METI is presenting through FTA a concept of "East Asia Free Business Sphere" comprising China, Korea and ASEAN countries forming a huge market consisting of two billion people. This should also be promoted from the standpoint of obtaining a stable supply of mineral resources. Therefore, within the countries of the region, mutual abolition of import duties for copper metal might be contemplated. But as discussed in Chapter 2, Japan must maintain its domestic smelting industry in order to strengthen the industrial competitiveness, a minimum necessary import duty of 3% must be continued and easy compromise at the new WTO Round negotiations will not be permitted.

(3) Information provision to the market

In order to suppress unnecessary price fluctuations in the mineral resource market, it would be effective to provide reliable information regarding medium-term forecast of the demand and supply to the participants. Presently, the demand–supply forecast of base metals is published by the "Metal Economics Research Institute, JAPAN（MERI-J）" and various think tanks of the world, but that of rare metals is inadequate. Therefore, a strong organization accurately surveying and analyzing in detail the production and material flow of rare metals amounting to 30-odd commodities with the ability to provide an accurate supply–demand forecast to the market should be established in Japan. As for its mother organization, mineral resources organization would be most appropriate. Rare metal stockpile (short-term measures)

As discussed in Chapter 2, it should be clearly recognized that since the terror of 11 September 2001, risks of a short-term supply disruption of mineral resources rose dramatically including base metals from developed countries. Therefore, the necessity for stockpiling as short-term measures is much higher than in the past. It was discussed in Section 3 that, if Japan can join a regional integrated organization like EU in the future, the stockpile can be discarded, but for the time being, the on-going rare metal stockpiling needs to be continued.
Regarding commodities for the stockpile, manganese and nickel for special steel should be discontinued and replaced by those directly connected to IT industries and environment industries. In addition, minerals having a very uneven global distribution and strong market price fluctuations in recent years such as tantalum and palladium should be stockpiled. Also the present scheme calls for the procurement of these rare metals for stockpiling through city bank loans now amounting to 30.4 billion yen, and this results in paying 1.5 billion yen interest each year. This scheme with a high running cost should be examined.

Exploration for deep-sea mineral resources (long-term measures)
Mineral resources not occur only on land. The deep sea is a host to an immense amount of rare metal resources such as manganese nodules, cobalt-rich crust deposits, hydrothermal deposits and phosphate deposits. Japan with its domestic land mineral resources depleted, must acquire them from abroad in the medium-term future. The supply from mineral resources within Japan's territory is much more stable than from countries abroad. Therefore securing "domestic resources" on the deep-sea floor is significant in the long term. One of the advantages of an island country, Japan, is the very large Exclusive Economic Zone (EEZ) where Japan has the exclusive right to develop mineral resources. The EEZ for Japan is larger than that for other countries. Also even in international waters, it is possible to acquire exclusive mining concessions under the Law of the Sea by carrying out deep-sea mineral exploration as in the case of manganese nodules.
Deep-sea mineral exploration uses specially equipped vessels. Therefore it will be close to 50 years to obtain a return for the investment. It is not possible for private industry to implement such projects. The government must finance these projects.
The target of deep-sea exploration for the time being is to obtain exclusive mining rights for cobalt-rich crust deposits and hydrothermal deposits in international waters after manganese nodules. For this exploration, it is important to concentrate deep-sea mineral exploration using *No.2 Hakurei Maru* (owned by MMAJ and mineral resources organization) for the next several years and carry out a detailed analysis of the accumulated data before other countries do it. Together with the above measures, the Japanese Government should actively participate in formulating mining codes for the above two types of ore deposits under the Law of the Sea. The code should be sufficiently advantageous for exploration that is carried out using the most advanced deep-sea drilling technology developed by Japan.

Stable Supply of Mineral Resources

Executive Summary

The aim of this paper is to demonstrate the necessity of the stable supply of mineral resources (nonferrous metals) for Japan and urge the Japanese Government to secure a stable supply and present the system and concrete countermeasures of the policy for attaining the above goal.

Introduction. Establishment of mineral resources policy

The past mining policy whose aim was to promote domestic mines must be reconstructed from zero to a new "mineral resources policy" whose aim will be to purely pursue the stable supply of mineral resources in the light of the rapid changes regarding mineral resources in recent years.For this purpose the "Mineral Resources Policy Platform" was founded in 2001, and all aspects of the future policy were very actively discussed. These discussions exerted a very large influence on reforming special public institutions, which was being carried out at the same time. The executive organ of this mineral resources policy will be the newly reformed「*Sekiyu Tennengasu Kinzokukoubutushigen Kikou* (mineral resources organization), Independent Administrative Institution」.

Chapter 1. Significance of stable supply of mineral resources

The stable supply of mineral resources is necessary because this is a prerequisite for maintaining and strengthening the industrial competitiveness of Japan. Therefore this is a requirement for economic security. The stable supply to be secured by the policy is defined as a "situation whereby necessary amount of mineral resources is continuously supplied to domestic industry within the price fluctuation range tolerable in normal economic activities". Two types of supply disruption are considered; namely rise of price and unavailability of necessary quantity, and these two types normally occur together.

The factors which cause supply disruptions of nonferrous mineral resources are; for short-term disruptions ① uneven distribution of resources, ② tendency for the price to fluctuate, ③ progress of a resources oligopoly, ④ difficulty of substitution by other elements; and for long-term disruptions ⑤ rare and diminishing nature of resources, ⑥ low feasibility for resources development investment, ⑦l low accessibility to mineral resources, ⑧ the "state-owned principle" of mineral resources.

Regarding the impact of a supply disruption, the simulation for copper by multilateral general balance models was carried out on the; ① decrease of Chilean ores, ② increase of Chinese metal consumption, ③ decrease of long-term ore contract rate. All of the simulation results indicated a considerable rise in the international price of ores.

Chapter 2. Present state of mineral supply and the role of mineral resources industry

The present state of nonferrous mineral resources supply is characterized in a world-wide perspective; ① increasing the oligopoly of nonferrous majors, ② rapid increase of Chinese mineral resources demand, ③ increasing evidence of terrorism risks in the developed countries, ④ rapid changes of specific rare metal demand due to the progress of the IT revolution, ⑤ world-wide recognition of the concept of "sustainable development" regarding mine development; characteristics concerning Japan are; ⑥ depletion of domestic resources, ⑦ domestic smelting industry becoming the mineral resources industry, ⑧ active cooperation and merger among the mineral resources industry.

"Mineral resources industry" is a form of industry, which deals in every phase of human activity regarding mineral resources, from the development of overseas mines through metal production at domestic smelters and production of electronic materials to finally environmental projects. The existence of the core of the industry, namely the smelters in Japan have great significance. It is significant because it; ① contributes to the stable supply of metals to the domestic manufacturing industry, ② can fine-tune its response to the metal needs of the domestic manufacturing industry, ③ is

the supply source of electronic materials with high-added-values, ④ suppresses the premium price against Japan, ⑤ can carry out metal recycling economically, ⑥ is an industry with the highest-level of international competitiveness. Therefore, regarding base metals, a stable supply of ores, not metals should be secured.
Independent development, neither the purchase nor purchase through financing, is desirable in securing overseas ores for the mineral resources industry. The holders of ownership interests in mines by independent development; ① are assured of the right to purchase ores amounting to its equity, ② are given the first refusal right of ores in excess of their equity, ③ are given priority in allocating ores in times of emergency, ④ have access to abundant and important information, ⑤ can maintain mining engineering technology.

Chapter 3. Mineral resources policy for securing stable supply
The policy for securing a stable supply of mineral resources should consist of; two pillars of ① promotion of exploration and development (medium-term measures) and ② full utilization of market functions (medium-term measures), with the addition of; ③stockpiling rare metals (short-term measures), and ④ exploration of deep-sea mineral resources (long-term measures). The above policy will enable Japan to cope with all types of supply disruption.
Of the measures for promoting exploration and development: ① Regarding provision of information, close liaison with the Foreign Ministry and Defense Agency should be maintained and the information should be strictly controlled. For mineral surveys implemented by ODA, an agreement for a priority supply should be concluded. ② Regarding direct financial support, the mode of operation of the geological structure survey in foreign countries and exploration financing should be more flexible. The application of decrement exemption tax system should be expanded to trading companies. Packages should be presented such as; Yen-credit, JBIC-financing, and trade insurance regarding mine development. ③ On preparation of environment for exploration, training of mining engineers should be considered. Risk communication know-how should be disseminated. Japan should actively participate in the formulation of international rules.
For utilizing market functions: ① regarding Japanese market JME for tantalum and cobalt should be established. An LME warehouse should be invited to Japan. The junior company system of Canada and Australia should be studied and be introduced to Japan. ② "East Asia Business Sphere" should be formulated through FTA. The present import duty of copper metal should be maintained at the New WTO Round. ③ Regarding provision of information to the market, institution which can present a forecast of rare metal supply and demand should be established.

The ongoing rare metal stockpile should be replaced with metal commodities directly related to IT industry. The present scheme of procuring stockpiling metals by loan should be changed.

Regarding deep-sea mineral exploration, survey of cobalt-rich crust deposits and sea-floor hydrothermal deposits should be completed within several years. Japan should be actively involved in the formulation of international mining code.

Discussions of Other Issues at the "Mineral Resources Policy Platform"
(for Reference)

In the Mineral Resources Platform, two large themes, namely "contribution to environment" and "prevention of aggregate crisis", were very actively discussed in addition to those regarding the "stable supply of mineral resources". The outline of the discussions is shown below. The original discussions are always available at http://www.rieti.go.jp/pps/.

1. Contribution to environment

(1) Is there an economic rationale in metal recycling?

Recycling metals, namely recovery of metals from wastes, cannot be implemented commercially in many cases. The metal recovery from shredder dusts of discarded automobiles and discarded electrical appliances is carried out today at smelters together with waste disposal in Japan. This is possible as a side business only because it has an economic rationale due to the high cost of waste disposal in Japan, namely the high reception cost of the final disposal site.

The metal recovery associated with waste disposal is a trade-off relation with the environmental impact by toxic metals and energy consumption. Recycling would be not make sense if it increases the environmental load. Discarded automobiles and electric appliances buried in the final disposal sites are first shredded and metals such as copper and aluminum are recovered and mixed with other unburnable wastes. As high costs and energy are necessary for reprocessing these resources, they are not recycled. Therefore, a thorough classification of collected wastes is important from the standpoint of raising the concentration of these wastes as resources.

(2) How should the smelting industry be understood?

The Japanese nonferrous smelting industry occupies an important position for waste disposal and metal recycling in order to create a circular-style society in Japan. In Japan, the personnel costs for collection, transportation and separation are expensive. Thus metal recycling cannot be done without utilizing the process of primary smelting. Smelters have the technology and space for processing heavy metals and also the market for the recovered metal. Some smelters have the land for final disposal. Therefore, producing metal material from primary raw materials is not the only function of the Japanese smelters now. Even if Japanese smelters could survive by operating overseas, cessation of the domestic operation will cause great difficulty for waste disposal and recycling.

It is clear from the above that construction of a circular style society would be just a dream without a domestic nonferrous smelting industry in Japan. In order to maintain domestic smelters with such important functions, it can be considered that the Japanese Government needs to implement a resources strategy of securing ore concentrates through the support of exploration and other means. This strategy becomes clear by calculating the cost of heavy metal processing by simulating the situation without domestic smelters.

(3) How should the mineral resources policy be?

In order to prevent the undue decrease of the concentration and mixture of unwanted foreign materials in wastes, the Government should expand and strengthen various systems including the recycling law to legally obligate consumers, local governments and manufacturers to classify and collect wastes separately. It is necessary to assist the recycling business through tax reduction and other measures. Wastes should not be recycled without the present economic rationale, but should be stored. Reliable statistics do not exist for wastes at present. The Government should conduct a basic survey and analysis regarding wastes and make a future outlook.

In order to maintain domestic smelters as the key to waste disposal, the Government should support

technical innovation of domestic smelters to strengthen their international competitiveness. As sulfuric acid becomes a serious problem with pyrometallurgy, hydrometallurgy will become the main smelting method in the future. The utilization of by-products such as slags will also become an important factor. Other than technical support, the increase of profitability of waste processing and recycling at smelters by largely upgrading the technical standard of final disposal sites. However, it should be noted that if Japan is alone in pushing the above standards too far, it could become a negative factor to the Japanese economy in comparison with other countries in the future.
In Europe, mining associations are taking firm positions regarding the trend of strengthening the environmental control of mines. They are responding in many ways to enlarge their business opportunities. For mine development in harmony with the environment , the Government needs not only to cope with waste disposal technology, but also to be constantly aware of environmental protection measures in the mine development cycle beginning with exploration and development.
The Government should promote operations of this cycle that always protect the environment. . This will result in the decrease of the country risk of the resources-holding countries and contribute to the stable supply of mineral resources.

2. To avoid aggregates crisis

(1) Will aggregate resources be depleted?

The infrastructure of Japan is based on concrete. Aggregates (coarse aggregates = crushed stones, fine aggregates = natural sand and partly crushed sand) comprise 83% of concrete. Consumption of aggregates increased rapidly since the *Nihon Rettou Kaizouron* (reconstruction of Japanese Archipelago: Prime Minister Tanaka's paper on reconstruction of infrastructure) of 1972 and is now 800 million tons per year. There is no other natural resource, which was consumed, in so great amount in such a short period of time. Concrete structures deteriorate with time and thus must be rebuilt every 60~70 years. In the near future, with the construction of the second wave of concrete building construction, there is no doubt that immense amount of aggregates will be in demand. At present, domestic natural sand (sea sand, mountain sand, and land sand) is near depletion. For example, the sea sand of the Seto Inland Sea, which had met most of the demand of western Japan, cannot be used any more because of the ban on mining by the coastal prefecture governments. The good locations for mountain sands of Chiba Prefecture and land sands of Hokkaido are difficult to secure. Therefore, the demand and supply of aggregates should be recognized as one of the most important issues, which could shake the fundamental basis of the concrete-dependent society of Japan.

(2) Are there substitutes for natural sand?

If the supply of natural sand became tight and the price rose, it is possible to envisage the economic supply of substitutes such as importing sand from neighboring countries such as China, production of crushed sand from crushed stones and recycling discarded concrete in the medium to long term. But possibility of the above scenario is small from the following reasons.
When classifying mineral resources into imported resources and self-supplied resources, the deciding factor of the two is the difference in price. The borderline is considered empirically to be about ¥4,000/ton. Thus the price must rise 2- to 3-fold for sand to become an imported resource. In other words, the infrastructure construction will be about 1/2 to 1/3 of the present scale. The prerequisite of maintaining a concrete-dependent society is the large supply of aggregates at a low cost and thus substitution of domestic sand by imported sand is not practical. Also topographically, high-quality sand usable for aggregates occur most abundantly in island arc areas like Japan and are not as abundant in countries like China and Korea. Also in Asian countries other than China, sands are posing serious problems. The demand in China is anticipated to grow rapidly with the construction of its infrastructure. Thus it is doubtful if a large amount of sand could be imported from neighboring countries for a sustained period of time.

Also sand crushed from stones and recycled from waste concrete can substitute natural sand to a certain extent, but their amount is on a very small scale compared to the whole demand for natural sand. A fairly large investment is necessary for the production of crushed sand. Basic research is presently insufficient for the production of high-quality sand. Recycled aggregates can be used for fill in land reclamation and roadbeds, but their strength is insufficient for concrete. The largest problem with recycled aggregates is the unpredictability of how much and where the waste concrete will be generated. The actual aggregate market is a world bound by complex human relations, conventions, and traditions, where market principles are often not effective. Modernization and normalization of such aggregate market will take a long time. It is necessary for the Government to take action rather than leave it to the market principles.

(3) How should mineral resources policy be?

If natural sand for aggregates is near depletion and practical substitutes are available in the distant future, central and local governments should aggressively secure areas for sand and gravel mining simultaneously giving due consideration to the environment. For this measure, the distribution of high-quality aggregate resources should be surveyed. Also it should analyze the future outlook on the limit of domestic resources, the rise of price and thus prevent undue confusion. Formulation of the understanding and agreement on aggregate supply by the local residents and strong supervision regarding quarries will be necessary. Promoting the construction of quarries that will not disturb the scenery will be important. Guidance should be provided to the medium to small operators on quarrying in harmony with the environment based on future plans. Also the Government should concern itself with environmental problems related to former sites of reckless quarrying.