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A CRISIS IN CRITICAL COMMODITIES

by

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A Crisis in Critical Commodities

Twenty years ago the United States was confronted with a report that warned that it was becoming dangerously dependent on imports from insecure foreign sources for supplies of a number of critical commodities. The President's Materials Policy Commission, better known as the Paley Commission, predicted that before long the nation would be faced with serious shortages of domestically produced fuels and other minerals.[1/]

This pessimistic forecast was soon demonstrated to be in error. Consumption of minerals boomed, but the United States continued for several years to supply a large part of its own requirements from its own production. Timely discoveries of new reserves, changes in consumption patterns and technological progress in both mining and smelting helped to keep domestic output growing more rapidly than the Paley Commission had anticipated. The role of imports in meeting U. S. requirements for fuel and metallic minerals increased over the next two decades, but the rate of growth of dependence on imports was relatively slow. This permitted a smooth adjustment. New foreign supplies were developed, and costs did not soar unreasonably over the long run.

1/ The President's Materials Policy Commission (Paley Commission) "Resources for Freedom" in 4 volumes, 1952.

But beginning in the mid-1960's a change appeared in this pattern. Domestic production of important minerals has since then lagged further behind the growing demand and the share of imports in the total U. S. supply has been rising at an accelerated rate. Competition among industrial nations for mineral resources has sharply intensified. Now predictions like those of the Paley Commission are being heard from numerous official and private sources. The possibility of serious shortages of electricity, petroleum, and natural gas looms on the horizon. This could mean steeply rising fuel prices, and rapidly increasing dependence upon fuel imports, beginning in the second half of this decade.[2/] Similar forecasts are being made with regard to many non-fuel minerals.

A general awareness seems to be emerging that the era of basic self-sufficiency in minerals and easy supply conditions is almost over, with a new era of high import-dependency, high costs, and greater uncertainty about supplies about to begin. If the current projections prove correct, and recent trends in the Supply and demand for fuels and other minerals persist, we must expect a serious impact both on the U. S. economy and on our external economic relations.

2/ U. S. Congress "Fuels and Energy Crisis," Government Printing Office, 1972.

This study will focus attention on some of the principal factors behind this change in the U. S. minerals position and on the main features of the new era. A look at the Paley Commission's projections and the reasons for their failure to materialize fully will help illuminate the unique aspects of the present situation, and will provide a better perspective from which to judge the current forecasts of future supply and demand for the various minerals.

I. The "Energy Crisis"

The most sophisticated forecasts of the Paley Commission Report were in the energy field. Even so, its projections of the growth of demestic supply and demand of fuels between 1950 and 1970 have proved to be very much on the low side. Demand projections were based on the assumption of a 3 per cent annual growth rate of GNP, constant prices, and an unchanged mix of energy sources. Actually, real GNP increased at a rate of about 4 per cent, while prices of major fuels, coal and petroleum declined (the average real price of electricity declined 40 per cent between 1950 and 1970), and the relative shares of different energy sources in total consumption changed greatly. (See Table I.) Energy consumption increased much faster than anticipated by the Paley Commission. The level of natural gas consumption projected for 1975 was actually reached in 1965, and the projected level of petroleum consumption

for the same year was reached in 1969. Only the projected level of coal consumption has not yet been achieved, and probably will not be until the early 1980's. The share of coal in total U. S. energy consumption dropped from about 40 per cent in 1950 to 20 per cent in 1970.

The Paley Commission's predictions of shortages in the domestic supply of petroleum, and of increased dependence on oil imports, have proved equally wrong. Domestic oil production was able to meet the demand, which was even larger than projected. Although the volume of oil imports doubled between 1950 and 1965, the share of imports in the total supply of oil remained virtually the same, viz. 12.5 per cent in 1950 and 13.6 per cent in 1965. Natural gas imports in 1965 accounted for only 2 per cent of total consumption, and the nation has remained a major exporter of coal. Basic self-sufficiency in the energy field thus persisted into the mid-1960's.

Since then, however, the situation has radically changed. There has been a sharp acceleration in the growth of energy consumption. Up to 1960, gross energy consumption in this country grew at an annual rate of less than 3 per cent. The rate of growth increased to 3.6 per cent between 1960 and 1965, but since then it has jumped to 5.0 per cent. It is expected to remain at this unprecedented level, or even to increase during the rest of this decade. The Department of the Interior forecasts a gradual slowdown

in the 1980's and afterwards, with an average annual growth rate of energy consumption of about 3.5 per cent between now and the year 2000, i.e., a three-fold increase.[3/] Even these projections may prove to be too conservative, for they are based on the assumption of a constant ratio of energy consumption to real GNP. This ratio had been continuously declining ever since the 1920's, but since 1967 the ratio has been moving up sharply, implying a declining efficiency in energy utilization in this country.

Demand for oil and natural gas has grown even faster since 1965 than total energy demand. The demand for oil has increased at an annual rate of 5.4 per cent while the demand for natural gas has increased at a rate of over 6 per cent annually. In 1970 more than 75 per cent of our energy requirements were met by oil and natural gas. While the proportion is expected to decline to 65 per cent by 1985 (see Table I), the Department of the Interior's projections indicate that there will be an 80 per cent increase in oil demand between now and 1980, and a 50 per cent increase in the demand for natural gas.[4/]

These estimates lead to predictions of an early "energy crisis" because it is widely believed that future increases in energy

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3/ U. S. Department of the Interior "United States Energy, a Summary Review", January 1972, p.v.
4/ Statement of H.M. Dole, Assistant Secretary of Interior, Hearing before the Joint Committee on Defense Production, U. S. Congress, August 2, 1971.

demand of this magnitude cannot be met from domestic fuel resources--at least not until the mid-1980's when nuclear power generation, coal liquefication and gasification, and the use of oil shales are expected to become commercially practical. Projected petroleum requirements through 1985 exceed presently known reserves 2.5 times, and natural gas requirements exceed known reserves 1.5 times. (See Table II.) Potential reserves, although, are believed to be considerably larger than projected requirements. The rate of their discovery in recent years, however, has fallen below the growth rate in consumption. This has already resulted in the reduction of known reserves, especially reserves of natural gas. Unless this trend is reversed, domestic production of oil and natural gas will soon begin to decline.

Between 1965 and 1970, domestic production of petroleum increased at a slower rate (4.3 per cent annually) than petroleum demand (5.4 per cent). As a result, petroleum imports sharply increased. The share of petroleum imports in total supply rose from 13.6 per cent in 1965 to almost 24.0 per cent in 1970. Even assuming that the Alaskan North Slope oil comes into full production and that production in the other States remains near its present level, oil imports are expected to more than double by 1980, and more than triple by 1985. This would bring the share of imports in total oil supply to 45.0 per cent by 1985.[5/]

5/ Statement of John Ricca, Acting Director Office of Oil and Gas, Department of the Interior, Hearing before the Joint Committee on Defense Productions, U. S. Congress, August 2, 1971.

Oil industry sources, however, expect a 30 per cent decline in domestic oil production between 1970 and 1985, and therefore predict that by 1985 more than 60 per cent of U. S. demand for petroleum will have to be met with imports.6/

A recent study released by the Federal Power Commission points out that the available supplies of natural gas in both the United States, and Canada are insufficient to meet the rapidly growing demand. The cumulative demand for gas over the next 10 years is expected to total approximately 275 trillion cubic feet, while proven reserves of natural gas as of the end of 1970 were 291 trillion cubic feet, and annual additions to reserves in recent years have been only 17 trillion cubic feet. From now on, gas consumption will have to be rationed in order to stretch the existing reserves. Imports of liquefied natural gas (LNG) were initiated in 1968, and are expected to account for at least 40 per cent of total gas consumption in this country by 1990.7/

6/ M. A. Wright, Chairman of the Board, Humble Oil and Refining Company, "U. S. Energy Crisis and What Can be Done About it" printed in "Selected Readings on the Fuels and Energy Crisis" 92nd Congress, January 1972. p. 268.

7/ Federal Power Commission "Natural Gas Supply and Demand, 1971-1990", Staff Report No. 2, Washington, D.C., February 1972.

II. Import-Dependency in Non-Fuel Minerals

The Paley Commission's forecasts of future demand-supply relationships in the field of metallic and non-metallic minerals have missed the mark less than its forecasts for fuels. During the past 20 years, domestic consumption of most non-fuel minerals has grown at about the rate which had been projected by the Commission, at a slower rate in the 1950's, but then at a higher rate in the 1960's. (See Table III.) The Commission's prediction of increased U. S. dependence upon imports has also turned out to be true for most minerals, although there have been some notable exceptions. (See Table IV.)

In 1950, the United States was already almost totally dependent upon imports of such strategically important minerals as chromium, cobalt, columbium, manganese, sheet mica, platinum group metals and tin. The past 20 years have not changed this situation. Known and potential domestic reserves of these minerals are of so low a grade that no amount of technological progress in the foreseeable future can make their exploitation economically feasible. During the past 20 years, there has also been a strong shift away from basic self-sufficiency in such important minerals as aluminum (bauxite). antimony, fluorspar, iron ore, tungsten and zinc.

One of the most notable failures of the Paley Commission's projections was in regard to lead. It predicted a 50 per cent decline in domestic production of lead by 1975, shortages of lead and sharp price increases.[8/] Dependence upon lead imports was also expected

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8/ "Resources for Freedom," Vol. II, op. cit., pp. 39-44.

to increase sharply. None of these predictions materialized. The explanation largely lies in the Commission's assumption of virtually static technology in exploration, extraction, and use of lead, which proved to be incorrect. Introduction of new lead substitutes had resulted in the stagnation of lead consumption in this country, at least through mid-1960's. The discovery of new lead deposits and advances in the technology of lead extraction, at the same time, prevented all but a slight decline in domestic lead production.

A similar error was made with respect to copper. Contrary to expectations, substantial technological progress has taken place in the copper industry during the past two decades, as well as in many copper-using industries. This resulted in the reduction of imports' share in primary copper supplies from almost 40 per cent in 1950 to a mere 9 per cent in 1969. However, this probably overstates the decline, since there was a world-wide shortage of copper in 1969, and U. S. prices were held below world market levels. Import-dependency has also declined for silver and mercury. (See Table IV.)

Despite a major increase in import-dependency in many non-fuel minerals during the past two decades, the United States still enjoys a basic self-sufficiency in a number of important minerals, and primary domestic production still meets a substantial portion of demand for many others. The extent of import-dependency in most of these minerals, however, may sharply increase in the coming years.

The demand for most minerals is expected to grow at a faster rate during the next two-three decades than in the past. (See Table III.) At the same time domestic mining and processing industries are being increasingly threatened by a decline in American mining technology and research, and by a rise in production costs.

Until the end of the first post-war decade, the United States had occupied a dominant position in virtually all aspects of mineral science and technology. In the past, technological progress was sufficient not only to offset rising labor and capital costs, but also to allow work on deposits of decreasing quality at constant and even declining cost. Contrary to the expectations of the Paley Commission, this continued to be the case with respect to a number of important minerals in the first post-war decade. However, the U. S. position in mining research and technology has now deteriorated. One measure of this decline has been the drop in the number of departments of mining engineering in American universities from 26 in 1962 to 17 in 1967, and in the number of graduates in the minerals field from 500 annually prior to 1962 to only 138 in 1967.[9/] The decline has apparently continued since then.

Most new discoveries and developments in mining technology are now being made abroad, except in the petroleum field, where the U. S. still maintains the lead. Because new mining technology is

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9/ National Academy of Sciences "Mineral Science and Technology, Needs, Challenges and Opportunities," Washington, D. C. 1969, p. 16.

often being developed for particular deposits, the application of foreign technology in U. S. mines is somewhat limited. Normally, mineral facilities require about 5 to 10 years of lead time to develop. The decline in minerals research and technology, therefore, has not yet seriously impaired the competitiveness of the U. S. mining industry. But, the effect will inevitably be felt in the near future.

Together with the threat of technological stagnation, the United States faces rising costs of production of minerals and metals, especially at the processing stage. In recent years costs have been pushed by both the growing costs of labor and capital, and by the added costs of environmental protection. Metal smelting, particularly in the non-ferrous field, is by its very nature a highly pollutant industry, and the costs of pollution-control are normally quite high. Recent anti-pollution legislation has already forced a number of smaller smelting companies out of business, and a reduction of production even at some large enterprises. A dramatic example is provided by the copper-smelting industry. Added anti-pollution costs forced this industry to reduce smelting capacity by 15 per cent in 1970 alone. Unprocessed U. S. copper ore had to be exported for treatment in foreign smelters, and imports of refined copper had to be increased accordingly.10/

10/ U. S. Department of the Interior "Control of Sulfur Oxide Emissions in Copper Smelting", July 1971.

Recent pollution-control legislation and public pressures have placed considerable obstacles in the way of the expansion of existing processing facilities and the setting up of new ones. The combined effect of cost increases and technological stagnation will inevitably be a decline in domestic production of primary and secondary metals. The share of domestic smelter production in total supply of a number of important metals is already declining as the following table shows. Imports of refined metals will thus

Per cent of U.S. primary demand met by domestic smelters

	1956-60	1961-65	1966-70
Aluminum	92	83	78
Copper	92	92	83
Zinc	84	81	70
Tin	20	7	5
Antimony	91	82	66
Nickel	10	9	9

Source: "Defense Production Act, Progress Report - No. 50, Potential Shortages of ores, metals, minerals, and energy resources, Government Printing Office, 1971, p. 65.

have to increase sharply to fill the ever-widening gap between expanding demand and domestic production.

The problem of scarcity of domestic mineral resources is to a large extent economic. The United States still has large known and potential reserves of fuel and many non-fuel minerals. However, the quality and accessibility of the remaining resources is

progressively declining, and the costs of their exploration, development and exploitation are increasing. The cost differential between domestic and foreign mineral supplies has been widening.

Until the early 1960's, when the cost differentials between domestic and imported minerals were much smaller than today, various governmental subsidies to the mining industry and restrictions on oil imports were sufficient to stimulate expansion of domestic production and progress in mining technology. Special protective measures, thus played an important role in prolonging basic U. S. self-sufficiency in fuels and some non-fuel minerals, and in slowing down the growth of import-dependency in many other minerals. It has been suggested, for example, that domestic production of petroleum would fall by over 70 per cent in the absence of import controls.[11/] Higher costs of fuels and raw materials used by American industry, however, may have contributed to the declining competitiveness of U. S. products in the world markets.

As the cost-differential between domestically produced and imported minerals widened, the existing level of protection offered to the U. S. mining industry became increasingly insufficient.

11/ Kaj Areskoug "U. S. Oil Import Quotas and National Income," Southern Economic Journal, January 1971.

The government has chosen not to raise this level. In response to shortages of domestic fuel supplies in recent years, oil import quotas have been increased. With completion of the stockpiling program in the early 1960's, the level of subsidies to many mining companies was reduced. However, government loans are still available for exploration of a large number of metallic and non-metallic minerals, up to 50-75 per cent of total costs. The policy of limiting the level of protection opens the way for an accelerated growth in U. S. import-dependency in fuels and other minerals.

III. U. S. Trade in Minerals

The problem of increasing dependence upon imported fuels and other minerals is further compounded by changes in the composition and the geographical origin of U. S. mineral imports. In 1970, imports of minerals (fuels, ores, metals and non-metals) amounted to more than $8 billion, or more than 20 per cent of total U. S. imports. At the same time, the U. S. was also a major exporter of minerals: coking coal, nonferrous metals, and non-metals, to the tune of about $5 billion, or almost 12 per cent of total U. S. exports. The largest portion of the resulting deficit in mineral trade was on account of fuels and lubricants. In recent years this country has been a net exporter only in non-metals, with the surplus usually amounting to about $50 million annually. The following table, although omitting the trade in non-metals, reveals some general trends in the U. S. mineral trade as it has evolved over the past 20 years.

U. S. Net Exports (+) or Net Imports (-) of Minerals, Iron and Steel

	Annual averages in $1 million				
	1951-55	1956-60	1961-65	1966-68	1970
Mineral Fuels & Lubricants	+380.8	-293.0	-1060.4	-1284.6	-1486.7
Materials for Steel-making	-283.4	-263.6	- 520.4	- 416.3	
Iron and Steel	+661.4	+678.8	+ 71.8	- 256.6	- 804.9
Nonferrous Ores and Metals	-834.4	-611.0	- 427.6	- 806.3	
Total: Deficit	- 75.6	-904.0	-1588.0	-2764.8	-3148.1

Sources: Data for 1951-68 from U. S. Department of Commerce, "U. S. Exports and Imports Classified by OBE End-Use Commodity Categories, 1923-1968" 1970, Table 5 and Data for 1970 from U. S. Department of Commerce, "U. S. Exports," FT410, and "U. S. Imports" FT135, December 1970.

After a very rapid growth during the early 1960's, imports of materials for steelmaking (iron ore, pig iron, iron and steel scrap, manganese, etc.) declined rather substantially during the second half of the 1960's. Net imports of iron and steel, on the other hand, sharply increased in the late 1960's. This suggests that the growing U. S. demand for iron and steel is being increasingly met with imports of the processed or semi-processed products, rather than through increased domestic production using imported inputs. A similar trend, as has been already noted above, is also emerging in the nonferrous metals and petroleum fields. Environmental concerns are raising costs

of domestic refining and processing, and are preventing the establishment of new facilities. The level of spare refining capacity in the U. S. is declining, and it is expected to be fully exhausted within two or three years. Incremental quantities of oil imports will then have to be entirely in the form of petroleum products rather than crude oil.

The emerging shift from imports of crude, unprocessed minerals to imports of the already processed, refined products would add greatly to the import bill. With tripling the volume of oil imports between now and 1980, and shift from crude to product imports, total value of oil imports is expected to increase 6-7 times the present level, reaching between $12-$15 billion in 1980.[12/]

In 1970, 80 per cent of crude petroleum imports, almost 90 per cent of petroleum products imports, and with few exceptions more than 90 per cent of the bulkiest metallic minerals and scrap, originated in Canada, Latin America and the Caribbean area. (See Table V.) Proximity of these producing areas to the U. S. markets, U. S. control or a major participation in their mining companies, and basic political stability of most of these areas, have provided for lower costs and general dependability of our mineral imports from them. The United States has enjoyed a considerable advantage over

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12/ Projections by the National Petroleum Council quoted by Wall Street Journal, April 27, 1972, p. 14.

other industrial nations in competing for the mineral resources of the Western Hemisphere.

There are clear indications that in the future an increasing portion of our mineral imports will have to come from other regions. Due to natural limitations as well as to impediments to effective explorations, petroleum production in the Western Hemisphere is growing at a slower rate than the U. S. demand for imported oil. Demand for oil at the same time is growing at a rapid pace in the producing and neighboring countries of the region, reducing potential exports to the United States. Limited expansion of present import levels therefore can be expected from the region. While in 1970 only 4 per cent of our oil imports originated in the Middle East, by 1985 this share is expected to rise to 23 per cent.[13/]

Likewise, rapidly growing manufacturing industries in Canada, Mexico, Brazil and some other countries in the Western Hemisphere claim an ever-increasing share of their mineral output. In the future, the United States will have to import a larger portion of its needed metallic and non-metallic minerals from Africa, Asia, Australia, and possibly some Communist countries. Supplies from these

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13/ Statement of W.A. Radlinski, Acting Director, Geological Survey in "Defense Production Act Progress Report - No. 50, Potential Shortages of ores, metals, minerals, and energy resources," 1971, p. 35.

areas are expected to be more expansive on account of higher shipping costs, and, with exception of Australia, less secure. The United States will enjoy no special advantages over its competitors in any of these areas.

IV. International Trade in Minerals

Table VI shows the relative share of various regions and countries in the total world production of some metallic minerals, while Table VII indicates the direction of trade flows between these regions and countries in major mineral commodity groups. Industrial non-Communist nations as a group are the principal importer of fuel and non-fuel minerals. The import dependence of Western Europe and Japan in virtually all minerals is already much higher than is true for the United States, and their consumption of minerals is growing much faster than is the U. S. consumption, as the following table shows.

Annual Consumption Growth Rates for Major Minerals in Selected Countries (1964-69)

	USA	France	Italy	W. Germany	U.K.	Japan
Petroleum	5.0	11.1	9.7	11.6	7.6	17.4
Copper	3.0	2.5	3.7	3.4	-	12.0
Lead	5.0	2.9	11.8	5.0	-	3.2
Zinc	2.5	3.3	6.4	-	-	9.5
Nickel	-	9.2	13.8	7.4	-	17.5
Aluminum	7.5	8.0	13.8	10.8	2.0	22.5
Steel	3.3	5.3	11.6	3.9	0.8	14.5
Real GNP	4.6	5.5	5.4	4.7=	2.3	10.9

Source: Japan's Ministry of International Trade and Industry (MITI) "White Paper on Prospect of Natural Resources Problems in Japan" in Trade and Industry of Japan-Economic Reports, No. 167, 1972, Table 1, p. 35.

The growth of minerals consumption in Japan has been particularly rapid. Japan has emerged as the second largest consumer of raw materials in the non-Communist world (after the United States) and by far the biggest importer of such resources. In 1970, Japan's share in the world's trade in natural resources was 12 per cent, but according to growth projections it should reach at least 30 per cent by 1980.

This means that in expanding its imports of fuels and other minerals the United States will face an ever-increasing competition from other developed countries. Preparation of new deposits for mining and expansion of existing mining operations is a very costly undertaking. This is so not only because new deposits are usually located in less accessible regions, but also because the grade of ores mined is generally decreasing, requiring a substantial beneficiation on the spot before shipment. This necessity of large preliminary investment by prospective consumers puts a high premium on access to mineral deposits in politically-stable regions.

Mineral resources of Canada, Australia, and South Africa are and will continue to be the primary object of competition between the United States and other deficit non-Communist industrial nations. It should be obvious, however, that the available mineral exports from these countries will not be sufficient to satisfy the needs of the deficit countries. (See Table VII.) An ever-growing portion of these needs will have to be met with imports from the less-developed and some Communist countries.

The less-developed countries (LDCs) contribute only a small portion of the total world production of various metallic and non-metallic minerals. (See Table VI.) However, because of their own low consumption, they contribute a major portion of the available world exports. In 1968, for example, the LDCs as a group accounted for 46 per cent of total net exports of metal ores and scrap, and for 61 per cent of total net exports of non-ferrous metals. (See Table VII.) In the same year, the LDCs accounted for more than 80 per cent of total net exports of mineral fuels.

The LDCs' share in world mineral exports will further increase in years to come if for no other reason than because their potential for major new mineral discoveries, expansion of existing mining operations, and for establishing processing facilities, is so much greater than that of the already industrialized countries. On the other hand, the LDCs as a group are increasing their consumption of minerals at even faster rate than the developed countries. Not only are some among them developing their own manufacturing industries at a rapid pace, but virtually all of them experience a much higher population growth rate than the developed countries. The growth of their mineral exports, therefore, can be expected to decelerate in years to come.

Access to mineral deposits in the more politically-stable LDCs will be the primary object of competition between the developed non-Communist countries. Competition for oil and other mineral deposits of above average quality, however, will be increasingly joined by the Communist countries as well. The principle that an industrial nation can lose its international competitiveness unless it secures an access to the cheapest sources of fuels and other minerals at any given time, applies equally to the non-Communist and the Communist countries.

In the past the Soviet-led Comecon has hardly been a factor in the international trade of non-fuel minerals. During the past decade the bloc as a whole was a marginal net exporter of iron and steel, nonferrous metals and some non-metallic minerals, and a minor net importer of metallic ores and scrap. Only in fuels was the bloc (mainly the USSR) a major net exporter. This situation was the result of a deliberate policy of maximum reliance on its own mineral resources, regardless of costs. So far, of course, the USSR has been able to meet not only its own needs, but also most of the mineral requirements of Eastern Europe, and even have a small surplus for export to the hard-currency areas. This policy and pattern of the intra-bloc trade are changing, which can be of considerable consequence for the international trade in minerals.

Most Soviet mineral exports originate in the long-exploited deposits located in the European regions of the country and in the Urals. Because of the increasing costs of production and growing Soviet need for hard currency, deficit countries of Eastern Europe are under pressure tofind new sources of imports in the friendly LDCs.

Most Soviet industries are located in the European regions, but an ever-growing portion of their fuel and other mineral inputs is shipped at a very high cost from the far-off Eastern regions. Major new deposits have been discovered in the Central and Northern Siberia. Their development, for which the USSR seeks Western capital and know-how, will be a long and costly process. The USSR will continue to serve as a major supplier of fuels, mainly natural gas, and as a marginal supplier of some other minerals (chrome, manganese, asbestos) to the countries outside the bloc. Sometime in the earlier 1980's it will probably become the principal world producer, and maybe exporter, of a number of important minerals.

Meanwhile, the USSR is growing increasingly restive about the wide cost differential between the industrial inputs it uses and the inputs that the industrial non-Communist countries import from the LDCs. Unlike in the past, the USSR now has sufficient means, both economic and non-economic, to secure a substantial flow of cheaper mineral imports from certain friendly LDCs. There are indications that it intends to use those means, chiefly in order to gain an exclusive access for itself and other bloc countries to deposits of exceptional quality. Emergence of the Comecon Bloc as a major net importer of minerals would further aggravate international competition for mineral resources of the LDCs.

V. Changing Patterns of International Trade in Minerals

Contrary to earlier gloomy predictions, including those by

the Paley Commission, a situation of almost continuous oversupply of most mineral resources has prevailed in the world during the past two decades. Only a short time ago it appeared that there would be no limit to the growth in demand for mineral inputs by major industrial nations of the world, or to the industrialization efforts of the LDCs. Indeed, the known world reserves of virtually all mineral substances have been growing faster or at least as fast as the demand for them. A rapid advance in exploration and mining technology resulted not only in the discovery of large new deposits in many parts of the world, but it also allowed work on deposits of ever-decreasing grade while at the same time continually lowering the unit cost of output, or at least maintaining it at the same level.

Unhappily, conditions appear to be changing. The past experience of an increasing or at least stable reserves-consumption ratio has not been repeated for a large number of important minerals in recent years. Both producers and consumers of mineral resources, therefore, are becoming increasingly conscious of the fact that the total stock of various substances in the world that can be economically mined is finite, and can soon be exhausted if the exponential growth of their consumption continues much longer. Cumulative consumption of iron ore in the 1970's is expected to increase by at least 50 per cent over that in the 1960's. Consumption of nonferrous metals in the world is expected to increase 80 per cent and consumption of petroleum about 120 per cent.14/

14/ "White Paper on Prospect of Natural Resources Problems in Japan" in Trade and Industry in Japan, No. 167, 1972, p. 44.

Total cumulative world consumption of natural resources in the 1970's is expected to double over the level of the 1960's. In order to maintain the reserves-consumption ratio at the end of the 1970's on a par with that at the end of the 1960's, the reserves would have to increase in the 1970's twice as much as they did in the 1960's. There is no assurance, and indeed a considerable doubt, that such a volume of new reserves can be found at all. This applies particularly to fossil fuels, but it also applies to metallic minerals.

Although iron and aluminum are relatively abundant metals, most other important metallic minerals are either already in short supply (mercury and tungsten among them), or threaten to become scarce in the not too distant future (copper, cobalt, chromium, manganese, nickel and many others). Aluminum is a cheap and adequate substitute for copper in many of its uses. Many other metallic minerals, however, do not have satisfactory substitutes, unless price is not a consideration.

The awareness that the world is entering a new age in respect to mineral resources is affecting the behavior of both suppliers and consumers, and accelerating changes in the pattern of international trade in minerals. Mineral deposits are "quick assets" of the country that possesses them, and it naturally wants to achieve a lasting economic improvement before the deposits are exhausted. In the case of minerals that are already scarce, have no satisfactory substitutes, or consumption of which is growing faster than their total world reserves, major producers increasingly tend to form a

cartel in order to extract the maximum price from the consumers.

The price of mercury, for example, has been already for some time determined by the cartel action of major producers in Spain and Italy, rather than by the costs per unit of output.15/ The Organization of Petroleum Exporting Countries (OPEC), formed in 1961, was finally able to extract from the international oil companies a major increase in revenues in 1971. As a result, the price of the Middle Eastern crude jumped more than 20 per cent in that year. Members of OPEC now push not only for further increases in revenues, but also for a direct control over production and distribution of oil, including a possible acquisition of their own tanker fleet. In 1970, Chile, Zambia, Peru and Zaire, which together control over 33 per cent of world's copper production, formed the Intergovernmental Council of Copper Exporting Countries (CIPEC), apparently hoping to employ OPEC's successful tactics in dealing with consumers. Formation of consortiums by producers of various minerals can be expected to become an increasingly important factor in the international trade in minerals in coming years.

Despite inevitable year-to-year fluctuations, prices of most minerals generally remained quite stable during the first two decades after World War II. Price increases were over-all commensurate to the increases in production costs. Only in recent years have prices of some important minerals begun advancing more rapidly than the costs

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15/ Consumption of mercury in the U.S. alone almost doubled during the past two decades, but the price of mercury meanwhile increased by more than 500 per cent. See: Thomas S. Lovering "Mineral Resources from the Land" in the National Academy of Sciences "Resources and Man," 1969, pp. 125-28.

of their production. This is largely attributed to the faster growth in demand than in supply. Supply of some minerals has apparently become less price elastic. As the trend toward cartelization becomes stronger, the advance in prices of many minerals may further accelerate.

Industrial nations, the consumers, seem to be in the inherently weaker bargaining position than the less-developed countries, the producers, especially the oil-producing countries with large foreign exchange reserves. A temporary suspension of revenues may cause difficulties for the government of the less-developed mineral producing country, but it is unlikely to disrupt its economic life. On the other hand, even a temporary suspension of the flow of vitally important industrial inputs can cause a chaos in the more developed industrial economy. Starting work on domestic deposits that otherwise are non-economic is not a practical alternative, for this would require much time and capital investment. Switching to other foreign sources of supply, even if they are available, may sometimes also prove difficult, mainly because the advanced processing facilities of the consumer country are frequently designed to process the output with definite specifications coming from a particular deposit.

Countries of Western Europe and Japan that are highly dependent upon imports of fuels and minerals try to reduce their vulnerability by diversifying sources of supply. Considerable effort also goes into making special commercial and non-commercial arrangements with the producing countries that help to secure access to their mineral deposits

and maintain the flow of supplies. The size of the capital investments that are presently required for mineral exploration, deposit development, construction of some beneficiation facilities and transportation lines, encourages long-range sales arrangements between consumer and the producer countries.

Indeed, international trade in minerals is increasingly assuming the nature of financing for future supplies. Dr. K. P. Wang of the Bureau of Mines notes that short-term spot trading in minerals is rapidly disappearing from the scene, giving way to long-term, large tonnage arrangements. He also notes that unlike most U.S. mining companies that invest overseas mainly for profit unconcerned who gets the output, most European and Japanese companies invest in mining in order to secure the future flow of supplies to their home countries.16/

Governments of consumer nations are being increasingly called upon to assist their national as well as multinational mining companies in securing access to the desired mineral deposits of the LDCs, and to assure necessary conditions for smooth mining operations. This assistance may include a provision of some form of economic aid to the host country, granting of bilateral trade preferences to it, as well as purposeful cultivation of good will and close working contacts with economic and other agencies of the host government. Availability of capital alone is not sufficient to guarantee access to mineral resources of the LDCs.

16/ Dr. K. P. Wang "Minerals and Metals in International Trade," lecture delivered at the U.N. Inter-Regional Seminar on Mineral Economics, Ankara, Turkey, October 1970.

In the coming years, international competition for the mineral resources of the LDCs will take not only commercial, market-type forms, but increasingly non-commercial, institutional forms as well. For one thing, only a few among the mineral-rich LDCs remain committed to some form of market-type economic arrangement. A number of these countries have switched to non-market, socialist-type economic systems. Some of the countries that possess resources of strategic importance to the industrialized Western nations are ruled by radical regimes for whom economic considerations are frequently subordinated to political consierations. The emergence of the Soviet Bloc as an important minerals exporter and importer will enhance non-commercial aspects of the international competition for mineral resources. The allocation of mineral resources of the LDCs among various consumers is not going to be determined by market forces alone, but increasingly by special arrangements between consumers and producers. Development of effective working relations with the non-market economic institutions that are becoming dominant in the LDCs is an increasing challenge to all developed Western nations, and especially to the United States.

VI. Some Implications for the United States

Growing uncertainty of future mineral imports, increasing competition with other major industrial powers for the limited mineral resources of the world, and the need to adapt to the far-reaching changes in the patterns of international mineral trade, are important elements in the new situation confronting the United States. As the United States

becomes increasingly dependent upon imports of fuels and other vital elements, these new parameters of the international natural resources scene will have a growing impact upon the U.S. economy and the balance of payments.

In the past, the U.S. economy has been well-assured of the availability of needed mineral imports. Not only was the competition weak and essentially commercial in nature, but there were other factors as well that strengthened that assurance.

Direct investments by U.S. companies in mining industries of various LDCs was probably most important among them. Even though most U.S. mining companies were investing for profit unconcerned with the allocation of the output, still their control over mining operations was enough to assure supplies to U.S. consumers. Investments of this type turned out to be a particularly vulnerable target for nationalization. In recent years U.S. mining or other mineral operations have been nationalized in Peru, Bolivia, Chile, Guyana, Libya, Iraq and Zambia.

U.S. leadership in minerals research and technology in the past has provided American mining companies with a special advantage in competition for access to mineral deposits in various parts of the world. Except in the petroleum field, that special advantage has recently passed to our competitors.

Until recently, the United States owned or controlled a substantial portion of world processing facilities, which also assured us

of the flow of crude and semi-crude minerals from the producing countries. The United States no longer enjoys predominance in this field either. There is a marked trend toward increasingly advanced processing near the site of mining or at least within the borders of the producing country. This is due not only to the growing transportation costs, but also to the desire of producers to have a greater control over their resources, and a greater share in revenues.

With an ever larger portion of our mineral imports coming from other than traditional and at the same time more distant sources, existing processing facilities in the United States become less useful and competitive. The environmental concerns further reduce their competitiveness, while making it ever more difficult to set up new processing facilities. If recent trends continue, the United States will be increasingly importing totally refined products, thus losing an edge in competition for resources.

Finally, in the past the United States enjoyed an unprecedented political and economic influence in many parts of the less-developed world. This was sufficient to provide us with access to their mineral resources, and to prevent our competitors from gaining an exclusive control over particularly valuable deposits. As our influence has been slipping in more recent years, and our foreign aid has been on decline, access to desired resources grows less certain.

One of the most obvious implications of the emerging discontinuity in the U.S. minerals position is the necessity to increase exports drastically in order to pay for rapidly growing volume of vital

fuel and other raw materials imports. One projection suggests that the nation will have to increase exports to $60 billion a year by 1974 (as compared to $44 billion in 1971), and to $125 billion by 1980.17/

The volume of our trade with the less-developed countries will also rise steeply, as we become increasingly dependent upon imports of fuel and non-fuel minerals. In 1970, only a third of U.S. total exports went to the LDCs, and our imports from them accounted for slightly more than 26 per cent of total imports. Our exports to all countries of Africa taken together, for example, were less than our exports to Belgium alone, and imports from Africa were less than imports from France alone. In the coming years, the share of LDCs will greatly increase, especially on the import scale.

Development of stable economic and political relations, on private as well as government-to-government level, with the less-developed countries will become a matter of vital importance to the economic welfare of this nation. The U.S. Government will apparently be called upon to play an ever increasing role in securing access to foreign mineral resources, and assuring their uninterrupted flow to the U.S. industries.

The American response to these trends is still unclear, although awareness of the seriousness of the problem is growing. In a recent speech, Mr. John B. M. Place, President of the Anaconda Mining Company emphasized that many decisions that affect our mineral supplies "are being made for the wrong reasons, often out of ill-considered

17/ M. Van Gessel, Acting Director of the Commerce Department of International Commerce, quoted by Washington Post, May 22, 1972, p. D11.

and unnecessary emotionalism." Mr. Place said: "It is time the United State States realizes the consequences of the path it is taking to get the minerals and energy that sustain American's high standard of living.18/

The problem of assuring adequate mineral supplies impinges not only on domestic environmental concerns but upon our foreign relations and our traditional attitudes toward trade and investment policy.

Some of the questions raised in the international area are these:

1. Can we rely on free market competition to insure adequate supplies of mineral imports, or must we follow the practice of some other countries in entering into long-term contracts to assure supplies?
2. Is it desirable that we continue to employ large amounts of our scarce capital resources to develop mineral supplies abroad for use in third countries?
3. In view of prospective supply scarcities and the trend toward cartelization of minerals by producing countries, how can essential mineral supplies be distributed in ways that will avoid economic disruption and ill-feeling among major industrial nations?
4. Are we doing enough to protect our access to essential mineral supplies in countries where access may be jeopardized by political or military developments?

It is not too early for serious thought to be applied to these and other questions raised by the changed outlook for mineral supplies.

18/ Speech before the Rocky Mountain Mineral Law Foundation reported in The New York Times, August 6, 1972.

Table I: United States Demand for Energy Resources and Structure of Energy Inputs by Major Sources

	Actual 1950	Paley Comm. Proj. 1975	Actual 1970	Dept. of Interior Projections 1975	1985	2000
Petroleum (mil.barrels)	2,375	5,000	5,367	6,550	8,600	12,000
Share in gross energy inputs	34.3[1947]		43.0	40.8	35.6	34.6
Natural Gas (bil.cubic feet)	6,000	15,000	21,847	27,800	38,200	49,000
Share in gross energy inputs	15.0[1948]		32.8	32.4	29.5	26.0
Coal (Thous.sh. tons)	493,000	751,000	526,650	615,000	850,000	1,000,000
Share in gross energy inputs	50.0[1948]		20.1	18.2	16.7	13.7
Nuclear Power (bil.KW hours)			19.3	462	1,982	5,441
Share in gross energy inputs			0.3	5.4	15.6	22.7
Hydropower Share in gross energy inputs			3.8	3.2	2.6	2.6

Sources: The President's Materials Policy Commission (Paley Commission) "Resources for Freedom" Vol. II "The Outlook for Key Commodities," pp. 129-30;
U. S. Department of the Interior "United States Energy, A Summary Review" January 1972, p. 20, Table 2;
U. S. Department of the Interior, Bureau of Mines "Mineral Facts and Problems" 1970 Edition.

Table II: United States Fuel Mineral Requirements and Resources
1970-1985 Cumulative in Btu's 10^{18}

Commodity	Requirement	Reserves known	Reserves Potential	Submarginal Resources
Petroleum	0.65	0.26	2.7	14.0
Natural Gas	0.45	0.30	2.1	4.5
Coal	0.27	4.8	3.0	25.0
Uranium	0.20	0.17	0.43	475.0
Oil Shale				80.0

Note: Known Reserves include proved or explored reserves.

Potential Reserves include potential unexplored reserves, future potential and inferred reserves that can reasonably be expected to be found and recovered commercially using present technologies and prices.

Submarginal resources include geologic estimates of known or potential resources not now commercially recoverable with present technologies and prices.

Source: U.S. Department of the Interior "United States Energy, a Summary Review" January 1972, Table 3, p. 23.

Table III: Actual and Projected Rates of Growth of U.S. Consumption of Major Minerals
(Compound annual rates in per cent)

	Paley Comm. Proj. 1950-75	Actual 1947-65	Actual 1959-69	Dept. of Interior Projection 1970-2000
Aluminum	6.2	7.4	6.5	6.7
Antimony	2.3	-1.5	2.9	
Asbestos	1.4		0.4	4.1
Beryllium	7.1		0.3	5.1
Cadmium	3.7		2.8	
Chromite	2.9	4.0	0.5	2.7
Cobalt	6.2		4.5	1.5
Columbium				4.7
Copper	1.5	1.0	2.6	4.0
Fluorspar			8.6	4.1
Iron Ore	1.7	0.8	4.1	0.2
Lead	1.9	0.0	2.5	
Manganese	1.7	1.9	3.1	1.8
Mercury	1.1	3.4	3.7	1.7
Mica				
Molybdenum			3.2	4.4
Nickel	2.9		2.3	
Platinum Group		6.9	4.2	4.2
Rutile				4.1
Selenium				0.4
Silver			3.5	
Tin	0.9	0.4	0.4	
Tungsten	3.8	3.6	2.8	5.0
Vanadium			11.8	5.0
Zinc	1.3	1.3	3.5	

Sources: Projections for 1950-75 from the President's Materials Policy Commission (Paley Commission) "Resources for Freedom" Vol. II "The Outlook for Key Commodities" 1952;
Actual for 1947-65 from U.S. Dept. of Interior, Bureau of Mines "Mineral Yearbook, 1969"
Actual for 1959-69 from "Mineral Yearbook, 1960" and "Mineral Yearbook, 1969";
Projections for 1970-2000 from U.S. Department of Interior, Bureau of Mines "Commodity Data Summaries" January 1972.

Table IV: U. S. Import-Dependence and Share in World Production and Consumption of Major Minerals

(in percents)

	(1) Share of Imports in Primary Min. Supply		(2) Imports as Percent of Consumpt.	(3) Share of Scrap in Gr.Supply	(4) US Ore Product. as Percent of World Total		(5) US Share in World Metal Consumption
	1950	1969	1970	1969	1955	1969	1965-69 Av.
Aluminum (Bauxite)	65.5	90.2	91.0	4.0	11.0	4.0	50.4
Antimony	63.4	89.3	94.0	54.0	1.0	1.0	26.5
Asbestos	100.0	100.0	83.0				
Beryllium	81.7		51.0				
Cadmium	50.5	67.5	53.0		54.0	34.0	42.3
Chromium	99.0	100.0	100.0		4.0	0.0	27.2
Cobalt	90.2	94.7	93.0		6.0	0.0	31.6
Columbium	100.0	100.0	100.0		6.		
Copper	39.9	8.9	6.0	23.0	29.0	23.0	32.0
Fluorspar*	57.0*	86.0*	78.0				
Iron Ore*	14.0*	31.0*	33.0		28.0	12.0	20.5
Lead	38.3	41.7	38.0	36.0	14.0	14.0	40.5
Manganese	76.9	92.9	99.0		2.0	0.0	12.5
Mercury	90.4	58.0	38.0	18.0	10.0	10.3	28.2
Mica	99.0	100.0	100.0				
Molybdenum	0.0	0.0	0.0				
Nickel	99.1	89.6	87.0	11.0	2.0	3.2	33.4
Platinum Gr.	93.1	97.2	98.0	23.0	2.0	0.6	43.3
Rutile			100.0				
Selenium			29.0				
Silver	68.5	57.5	27.0				
Tantalum	100.0	100.0	100.0				
Tellurium			20.0.				
Tin	99.0	99.0	100.0	29.0	0.8	0.0	22.0
Tungsten	39.9	52.2			20.0	13.0	21.3
Vanadium	0.9	26.2	22.0				
Zinc	39.7	63.2	59.0	6.0	16.0	9.5	27.9

Sources: (1) U.S. Department of the Interior Data in "Defense Production Act Progress Report-No.50, Potential Shortages of Ores, Metals, Minerals, and Energy Resources" Government Printing Office, 1971, pp. 275-277.
(2) Statement of H.L. Moffet, Director of Office of Minerals and Solid Fuels, Dept. of the Interior, in the "Defense Production Act Progress Report-No.50," p.57.
(3) U.S. Dept. of the Interior, Bureau of Mines "Mineral Yearbook, 1969"
(4) Same as above.
(5) Same as above.

Note: (*) Data for 1950 represents share of imports in gross supply in 1955 while data for 1969 represents share of imports in gross supply in 1969.

Table V: Percentage Distribution of Mineral Imports by Area of Origin, 1970

Commodity	North America	South America	Europe	Asia	Africa	Oceania	Soviet Bloc
Bauxite	72	28					
Aluminum Scrap	82		15	1			2
Antimony	18	36			46		
Chrome Ores			23	19	15		43
Columbium Ores	15	56	6	3	20		
Copper Ores	20	28		50		2	
Copper Scrap	92	2	6				
Fluorspar	69	1	29		1		
Iron Ore	62	32			4	2	
Iron & Steel Crap	99		1				
Lead Ore	57	25				18	
Lead Scrap	97		3				
Manganese	3	34	2	4	53	4	
Mica		29	2	60	9		
Magnesium Scrap	41		40	10	7	2	
Mercury	83		17				
Nickel Scrap	80		20				
Platinum Group M.	28	4	29	23	7	9	
Thorium Ores				41		59	
Tin Ores		100					
Tin Scrap	92			2		6	
Titanium Ores	2				7	91	
Tungsten Ores	95	5					
Zinc Ores	83	13	2		1	1	
Zinc Scrap	100						
Zirconium Ores	3		5		4	88	
Petroleum Crude	52	28	1	12	7		
Petroleum Products	47	42	9	1			
Natural Gas	98	1			1		

Source: U. S. Department of Commerce, Bureau of the Census, "U.S. Imports," FT 135, December 1970, Table 2.

Table VI: Regional Shares in World Production of Principal Metallic Ores
(Percentages of total world production)

	Bauxite	Antimony	Chromium	Cobalt	Copper	Iron Ore	Lead	Manganese
Developed Countries	32.0	34.9	26.6	22.4	39.1	42.9	51.0	17.9
U.S.	3.5	1.3		1.0	22.7	12.5	12.0	
Canada		0.5	2.7	11.9	9.7	5.6	9.8	
Western Europe(1)	13.4	5.3		9.5	3.1	18.2	14.4	0.5
Australia & Pacific(2)	15.1		0.5		1.2	5.4	13.0	5.2
South Africa		27.8	23.4		2.4	1.2	1.8	12.2
Less-Developed Countries	53.2	34.0	33.5	76.8	42.5	22.7	21.5	34.2
Latin America	41.8	26.5	0.3		17.4	10.7	13.8	11.8
Africa	6.0	2.2	8.4	76.8	19.7	6.7	4.7	13.0
Asia	5.4	5.3	24.8		5.4	5.3	3.0	9.4
Communist Countries(3)	14.8	21.1	39.9	0.8	17.4	34.4	27.5	47.9
Percentage of World Production actually entering internat'l.trade (4)	45.5				11.1	34.5	19.6	47.2

(1) including U.K. and Yugoslavia;
(2) including Japan, New Zealand and Oceania;
(3) including both European and non-European communist countries.
(4) From K.P. Wang "Minerals and Metals in International Trade" Table 1, Lecture delivered at the U.N. Inter-Regional Seminar on Mineral Economics, Ankara, Turkey, October 1970.

Data for bauxite, antimony, chromium, iron ore and manganese is for 1969 only; data for cobalt is for 1970; data for copper and lead is an average of 1965-1970.

Table VI: (cont.) Regional Shares in World Production of Principal Metallic Ores
(Percentages of total world production)

	Mercury	Nickel	Platinum Gr.	Tin	Tungsten	Zinc
Developed Countries	63.9	67.2	37.0	5.6	23.9	53.8
U.S.	10.2	2.9	0.6		13.0	11.1
Canada	7.0	40.0	7.8		0.8	21.4
Western Europe	44.8	1.9	0.2	1.0	4.2	14.2
Australia & Pacific	1.9	21.0		3.8	5.9	7.1
South Africa		1.4	28.4	0.8		
Less-Developed Countries	11.2	3.2	0.8	72.5	21.2	26.2
Latin America	9.3	0.2	0.8	14.8	11.7	12.9
Africa		1.6		8.1	0.8	6.0
Asia	2.9	1.4		49.6	8.7	3.0
Communist Countries	24.9	29.6	62.2	21.9	54.9	27.5
Percentage of World Production Actually Entering International Trade		70.0		73.9	40.6	38.8

Source: Data for bauxite, antimony, chromium, iron ore, manganese, mercury, nickel, platinum group metals, tin, and tungsten from "Mineral Yearbook, 1969" Vol. I-II, U. S. Department of the Interior, Bureau of Mines, 1971.

Data for copper, lead and zinc from various issues of "Yearbook of the American Bureau of Metal Statistics"

Data for cobalt from Engineering and Mining Journal, March 1971, McGraw-Hill.

Data for zinc is an average of 1965-1970; data for manganese, mercury, nickel, platinum group metals, tin and tungsten is for 1969 only.

Table VII: Direction of Trade Flows in Major Mineral Commodity Groups, 1968
(in $1 million)

(+) net exports
(-) net imports

	Metal Ores, concentrates, scrap	Iron & Steel	Nonferr. Metals	Non-Metals	Mineral fuels
U. S.	- 390	-1,450	-1,250	+ 60	-1,430
Canada	+1,005	- 10	+1,025	+220	- 90
Western Europe	-1,540	+ 900	-1,740	-460	-7,500
Japan	-1,170	+1,545	- 450	n.r.	-2,339
Latin America	+ 683	- 415	+ 855	n.r.	+2,090
Africa	+ 369	n.r.	+1,211	+173	+2,290
Near East	n.r.	n.r.	n.r.	n.r.	+6,925
Asia	+ 349	- 635	+ 40	n.r.	+ 240
Australia & N.Z.	n.r.	- 55	+ 130	n.r.	+ 160
Not Reported	+ 624	+ 375	- 78	- 38	-1,497
Communist Europe	- 30	+ 20	+ 180	+ 45	+1,220
Communist Asia	n.r.	- 175	- 79	n.r.	- 69

Source: United States Department of the Interior "Minerals Yearbook" Vol. IV, Area Reports: International, 1969; U.S. Government Printing Office, 1971, p. 27.

n.r. - not reported.