$4 billion in the smelting and refining phase. 11/ Shipments of refined metal peaked at $5.7 billion in 1979 and have since declined. 12/

In 1982, U.S. copper mining and refining were the sole source of primary domestic arsenic, selenium, tellurium, platinum, and palladium--all of which have critical uses. The industry also yielded about 20 percent of U.S. primary gold output, 27 percent of the silver, and nearly 40 percent of the molybdenum. 13/

As of the mid-1970s, the United States consumed around 1.2 tons of copper per million dollars of GNP, or less than 2 cents worth per dollar. Because of generally declining intensity of materials use in the U.S. economy and losses to competing materials, the ratio of copper use to GNP continues to decline, but the rate of decline is probably decelerating. 14/ Most of the losses to aluminum have already occurred, as have the gains of copper use over steel (galvanized iron) in plumbing. Copper faces additional competitive losses to glass fibers in telephones and other telecommunications, but because of copper's price advantage, the rate of substitution is likely to be slow.

Uses and Substitutes

About 80 percent of net new copper supply (primary metal plus copper recovered from old scrap) entered U.S. consumption in 1982 as refined metal. Three-quarters of this went into wire products and the rest into other shapes and forms. The Bureau of Mines estimates that 54 percent of the copper ended up in electrical applications, 20 percent in construction, 13

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11. U.S. Department of Commerce, Census of Manufactures (1977).

12. U.S. Deparment of Commerce, U.S. Industrial Outlook, 1982, p. 159.

13. U.S. Bureau of Mines, Mineral Commodity Summaries, 1983.

14. L.L. Fischman, et al., World Mineral Trends, pp. 106, 186-7. Also S.V. Radcliffe, et al., Materials Requirements and Economic Growth: A Comparison of Consumption Patterns in Industrialized Countries, U.S. Bureau of Mines (December 1981), pp. 72, 256.

percent in industrial machinery, and 8 percent in transportation equipment. 15/

The most critical uses occur in power generation and distribution, communications, and electronics. Copper will retain importance in power generation for some time to come, but if necessary, substitution of aluminum could be accelerated in the distribution phase, including building wiring. The use of optical fibers could be accelerated in communications, and the communications burden could be shifted in greater degree to radio, laser links, and satellites. In construction, aluminum, galvanized iron, and plastics could serve, in part, as alternatives to copper. In the most critical electronic applications, copper content has now become almost incidental relative to total value. This use can, therefore, readily absorb any cost increases necessary to divert copper from other applications.

Sources of Supply

The United States has been the world's leading copper producer almost every year since 1883 and until recent decades was a net exporter. A significant portion of past imports was used not for domestic consumption, but was smelted and refined in coastal processing plants for reexport. Even today, copper is one of the few metals in which the United States is nearly self-sufficient. Net imports have fluctuated from year to year, in the range of zero to 20 percent of net copper consumption. Table 8 presents sources of gross copper imports in 1981.

In general—the recent recession was an exception--the proportion of imports arriving as refined metal has been increasing. Over the years 1978-1981, Chile was on average responsible for 32 percent of copper imports, Canada for 22 percent, Peru for 14 percent, and Zambia for 11 percent. 16/ Chile has regained the relative dominance in U.S. import supply which it enjoyed prior to the nationalization of U.S.-owned mines in 1971. Canada, Zambia, and the Philippines are all growing producers. Thus, including U.S., Mexican, and Panamanian production, the overwhelming bulk of U.S. copper supply will continue to originate in the Western Hemisphere.

Self-sufficiency in copper could be re-achieved in a relatively short time, if necessary. Substantial price increases would be required, however,

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15. U.S. Bureau of Mines, Mineral Commodity Summaries, 1983.

16. Ibid.

TABLE 8. SOURCES OF U.S. COPPER IMPORTS FOR 1981

Country	Percent of Imports a/
Chile	32.1
Canada	25.3
Peru	12.1
Zambia	10.3
Zaire	5.7
Mexico	5.5
Philippines	4.7
Other	4.3

SOURCE: U.S. Bureau of Mines, Minerals Yearbook, 1981.

a. Based on copper content of gross imports of ore and concentrates, matte, blister, refined copper, and scrap. Refined copper accounted for 77 percent of the total.

because of the comparatively high production costs and the financial incentives needed to induce major domestic investment in a highly volatile, and thus rather risky, industry.

Nature of the Risks

The principal problem plaguing the U.S. copper industry has been the recent recession and accompanying low prices. Current copper prices of about 75 cents per pound are down 60 cents from their early 1980 peak and not much above their mid-1970s average. Meanwhile, operating costs have increased, substantial investments have had to be made in pollution control and new smelting processes, and debt-to-equity ratios have risen to historically high levels. Some major mines and smelters have been closed, inventories have continued to build up, and the industry is operating well under capacity—about two-thirds of capacity in the mining sector. The copper industry's problems are exacerbated by the industry's geographical concentration in the Southwest, which localizes the effects of industry downturns in one region. Arizona alone produces 65 percent of both mine and refinery output. Thirteen out of the country's fifteen primary smelters are located in Arizona, Utah, New Mexico, and Montana. 17/

Most of the industry's problems would be rapidly solved by renewed economic growth and consequent rising prices. Even at their current high levels, industry inventories are only about three months of normal consumption, and less than half the amount is in the hands of producers. 18/ A number of the closed mines will not be reopened because they are essentially depleted, and some smelting capacity will not be reactivated because it is obsolescent and too difficult to retrofit to meet new pollution standards. At the same time, new smelting capacity, utilizing more economical, less polluting, modern technology has been added. The industry has also been moving in part toward "electrowinning" technology that bypasses the smelting stage altogether and may be combined with leaching mining methods and the reworking of old ores.

The copper stockpile goal is equivalent to about five months of normal consumption. Even counting some copper in brass or below specifications, it is only about 3 percent filled.

Conclusions

There is very little security risk attendant upon U.S. copper supply. The largest interruptions in the past have come from labor strikes, both in the United States and abroad, and these will probably continue to be the principal problem. The overwhelming bulk of copper supply is domestic, and most of the rest originates in the Western Hemisphere, much of it in Canada. Domestic capacity is substantial at all stages of production, from mining through refining and fabricating. There is a large secondary copper industry which usually generates a surplus of scrap copper for export and could supply additional copper in an emergency.

The largest single risk is that of sharp price runups in time of general economic boom. Because of the great volatility of copper prices, recessions cause major financial losses and stifle the capital investment needed to maintain a steady pace of modernization, expansion, and fulfillment of pollution-abatement requirements. This problem has been partially

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17. U.S. Bureau of Mines, Mineral Commodity Summaries, 1983; Commerce Department, U.S. Industrial Outlook, 1982.

18. Ibid; and U.S. Bureau of Mines release, "1982 Raw Nonfuel Mineral Production" (January 19, 1983), p. 3.

alleviated by the larger reservoir of funds available to the many firms after their aquisition by oil firms.

Despite the adherence of major LDC copper producers to the Intergovernmental Council of Copper Exporting Countries (CIPEC), a copper exporting organization antedating the International Bauxite Association, there is scant risk of effective cartel action except in times when demand-supply pressures would run up prices anyway. Control over supply is precluded by the dominant position of the United States as a producer, the large number of other producers, and the need for most of them to maintain the employment and flow of foreign exchange associated with copper production.

Fulfilling the stockpile goal, at present depressed prices, would cost about $1.4 billion.

LEAD

Lead is another metal of ancient use. The Romans fashioned it into pipes for water supply, and contributed its Latin name (plumbum) to what is now called plumbing. Today, it is suspected that the Romans who used this piped water were slowly poisoned, much as are poor children who ingest lead-based paint in old buildings. Discoveries like this have rapidly changed the character of lead's applications. The 20th century saw a shift from lead to galvanized iron and then to copper for piping. Lead has been eliminated from most paints and has been phased out of much gasoline. Health concerns have also resulted in the imposition of pollution-control standards that have become a heavy burden on the lead smelting industry.

A distinctive characteristic of the lead industry is the very large role played by secondary recovery. This is because of the heavy proportion of total consumption that goes into automotive batteries, the relatively short life of such batteries, and the well-established system for recycling batteries for lead recovery and re-use. Lead in batteries could be counted as an inventory of metal in circulation, rather than metal that was being consumed. In any case, the development of long-life and maintenance-free batteries is beginning to modify the established cycle. Longer-life batteries are increasing the amount of recyclable lead in current use. Maintenance-free batteries have increased the requirement for pure lead in contrast to the predominantly antimonial lead that battery recyclers have been equipped to recover. Recovery of pure lead is a more difficult process, requiring smelting.

Role in the U.S. Economy

Because nearly all lead is recovered from ores that also contain zinc, economic data on the mining phase of these two metals are generally combined. According to the 1977 Minerals Census, gross receipts for lead-zinc mining were $1.85 billion, slightly more than receipts for copper mining. Somewhat over half these revenues may be ascribed to lead. The number of lead and zinc mines (130) and total employment (32,000) were each about 50 percent higher than the corresponding figures for copper. Domestic lead mining is overwhelmingly concentrated in one state--Missouri--and the bulk of lead smelting and refining is also centered there. 19/

At their peak in 1979, receipts of primary lead smelters-refineries reached $1.4 billion, but they declined by around 40 percent before beginning to recover in 1982. 20/ Although smelting and refining are distinct processing operations, they are mostly integrated within the same companies, if not the same plants. Data on secondary lead production are not readily available, but the quantities of such lead exceed those of primary lead. 21/ Since secondary lead is produced mostly as antimonial lead, and antimony is more expensive, the difference in value of output between primary and secondary is even greater. Employment in lead scrap collection and secondary lead recovery probably far exceeds the 3,000 persons engaged in the primary smelting and refining industry. 22/

As of the mid-1970s, the United States consumed around a ton of lead per million dollars of GNP. This is only about four cents worth per dollar of GNP, including both primary and secondary lead, and the cost is declining. 23/

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19. U.S. Bureau of Mines, Mineral Facts and Problems, 1980 ed., preprint, p. 2.

20. U.S. Department of Commerce, U.S. Industrial Outlook, 1982, p. 160; U.S. Bureau of Mines, Mineral Commodity Summaries, 1983.

21. U.S. Bureau of Mines, Mineral Commodity Summaries, 1983.

22. Primary employment from U.S. Industrial Outlook, 1982, p. 160.

23. L.L. Fischman, et al., World Mineral Trends and U.S. Supply Problems, pp. 119, 197-8.

Uses and Substitutes

About 60 percent of total lead use (primary and secondary combined) is in one application--storage batteries. The great bulk of these are used in automotive transportation. With about 10 to 15 percent of lead consumption used in anti-knock additives and additional amounts in such applications as bearings and radiator solder, nearly three-quarters of all lead use is bound up with transportation. 24/

Residual use of lead in paints and pigments, primarily for lead oxide in rustproofing, accounts for less than 8 percent of lead consumption in recent years, and other uses are still smaller. Lead is still used in construction for caulking, some piping, and soundproofing, and in construction and equipment for radiation shielding. Its use in cable covering is being replaced by plastics. While its military use for ammunition is important, this application consumes a very small part of total supply. The once critical need for lead in aviation gasoline has been significantly reduced by the advent of jet engines.

Given the continuing elimination of lead from gasoline and as a solder in high-technology electronics and its replaceability in most forms of caulking and sheathing, the remaining critical use will be in batteries. Though there are substitutes for lead-acid batteries, there are none of comparable cheapness. As discussed above, maintenance-free batteries require pure lead, which now has to be supplied mainly from primary lead. The secondary recovery industry is, however, adapting to the production of pure instead of antimonial lead, so this supply problem will eventually be eliminated. Another current difficulty is the scarcity of battery scrap, occasioned by the longer-lived maintenance-free batteries and the slowing in growth of numbers of automobiles, but this is a passing phenomenon.

Sources of Supply

Despite the current zero or even negative net U.S. reliance on lead imports, gross imports are still about 10 percent of consumption. Refined metal constitutes about 80 percent of the total import dependence. The rest consists of ore, concentrates, and semi-processed lead. Over the period 1978-1981, Canada and Mexico accounted for 39 percent and 37 percent of finished imports, respectively, while Peru and Honduras accounted for 32

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24. U.S. Bureau of Mines, Mineral Commodity Summaries, 1981-1983; Mineral Facts and Problems, 1980; U.S. Department of Commerce, U.S. Industrial Outlook, 1982.

percent and 27 percent, respectively, of ore and intermediate forms.25/ Sources of U.S. lead imports for 1981 are summarized in Table 9.

TABLE 9. SOURCES OF U.S. LEAD IMPORTS FOR 1981

Country	Percent of Imports a/
Canada	41.9
Mexico	27.0
Honduras	8.9
Australia	7.4
Peru	7.0
Other	7.8

SOURCE: U.S. Bureau of Mines, Minerals Yearbook, 1981.

a. Based on lead content of gross imports of ores, flue dust, and residues; base bullion; pigs and bars; sheet, pipe, and shot; and reclaimed scrap. Pigs and bars (refined lead) accounted for 76 percent of total imports.

Nature of the Risks

As with the other nonferrous metal industries, the principal problems facing the lead industry are low prices and the costly need to meet environmental standards. In addition, since lead poses high risks to human health, the industry has been required to give special attention to minimizing exposure hazards in the workplace.

There is no resource problem in lead. Large new discoveries have recently been made in Missouri and the resulting new capacity will well outweigh losses from the closing of older, less economic mining operations. In total, the United States has the largest lead resources of any country in the world and is at least comparable with the USSR in resources that could be produced at current prices.

The stockpile goal for lead, which had once been reduced to zero, is now set at 1.1 million tons. It is 55 percent filled, and there are no evident

25. U.S. Bureau of Mines, Mineral Commodity Summaries, 1983 and earlier years.

plans for near-term additional procurement. Completion of the goal would cost about $200 million at current prices.

The lead industry is unusually depressed, because it is tied to automobile output through its major use in automotive batteries. Lead prices have been very low, even in comparison with the other nonferrous metals; at the end of 1982 at a little over 20 cents per pound, they were less than half of their 1979 average and the lowest since 1976. In early 1983, however, lead prices showed signs of an upturn. Even if U.S. automobile production does not regain earlier levels, it should improve enough to give a decided upward boost to primary lead sales. The attendant increased scrappage of old automobiles will provide increased scrap for the secondary lead industry. Stocks of lead have remained low and are now down to about a month and a half of normal consumption, about evenly divided between primary smelters, and secondary smelters and consumers in the form of batteries. The secondary industry ran at only about 50 percent of capacity in 1982, but the primary industry exceeded 80 percent.

Conclusions

The future health of the lead industry is not a serious problem, except for continuing cyclical instability. Its recovery is tied to the U.S. automobile industry. Lead demand should increase despite the progressive loss of one of lead's principal markets, gasoline additives. New U.S. lead mines are quite competitive. The primary smelting industry has by now made most of the required adaptation to pollution abatement and workplace health safeguards. The secondary industry may experience some further shakeout, but appears able to adapt both to pollution abatement requirements and to changing battery specifications.

There is no security problem with regard to lead supply. The United States is essentially self-sufficient and could at most times either readily replace the limited flows of lead concentrates and metal from foreign countries or, if necessary, eliminate outward flows, especially of lead scrap. The great bulk of imports is from adjacent countries, and most of the balance from elsewhere in the Western Hemisphere. The most serious risk seems to be the possibility of prolonged labor strikes. These have caused supply slowdowns in the past (for example, in 1981), but could be controlled in a mobilization emergency.

ZINC

The United States consumed 1.2 million tons of zinc in 1981. About 64 percent was imported, at a cost of $680 million. Zinc's principal distinction among the nonferrous metals is the relatively small and unusual role of "old" scrap in the total supply. Only about 20 percent of all processed zinc-containing scrap is old scrap--that is, obtained from finished goods. Of this amount, nearly half is the zinc content in brass and bronze. Nearly all the latter goes right back into brass and bronze, which is the single form into which well over half of all scrap zinc, old and new combined, is recycled. 26/

Two-thirds of zinc scrap is so-called "new" scrap--that is, industrial process scrap, recovered from the tanks and furnaces of galvanizers, die casters, chemical plants, and other users. The largest portion of this becomes a direct input into chemical products, which are also produced directly from ore as well as from slab zinc. A smaller portion ends up as zinc dust, incorporated into paints, especially for the automotive industry. A generally declining portion is redistilled into slab zinc. 27/

About two-thirds of U.S. mine production of zinc is from primarily zinc ores; more than half originates in Tennessee. Roughly 25 percent is extracted from zinc ores in the Middle Atlantic states of New York, New Jersey, and Pennsylvania. Another 20 percent is derived in combination with lead mining, overwhelmingly from the ores in Missouri. 28/

Role in the U.S. Economy

As noted earlier, lead and zinc mining in combination earned about $1.85 billion in 1977; zinc receipts accounted for somewhat less than half of this. Judging by the relative volume of ore processed, it probably also accounted for less than half the combined 32,000 employees. Primary slab zinc output was valued at roughly $500 million in 1981, down modestly from a 1979 peak of over $570 million. 29/ It then dropped sharply to $255 million in 1982. 30/ As of the mid-1970s, the United States consumed only

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26. U.S. Bureau of Mines, Minerals Yearbook, 1980, vol. I.

27. Ibid.

28. Ibid.

29. Department of Commerce, U.S. Industrial Outlook, 1982.

30. U.S. Bureau of Mines, Mineral Commodity Summaries, 1983.

about three-quarters of a ton of zinc per million dollars of GNP. This ratio had been declining and may be expected to decline further. Because of the use of zinc in galvanized steel, automobile hardware, and various machinery parts, there is a close correlation between zinc consumption and that of steel. The ratios have been fairly steady at 9 to 10 kilograms of zinc per metric ton of steel (0.9 to 1.0 percent). At recent prices, the amounts of zinc consumed in the United States amount to about 6 cents per dollar of GNP, slightly higher than the corresponding value for lead.

Uses and Substitutes

About 70 percent of total zinc consumption is as slab zinc, nine-tenths of which is produced from virgin origin. Slab zinc is used in making alloys for automobile parts. While a small amount of zinc enters into chemicals directly from ore, the bulk comes from secondary zinc recycled from brass and other alloys. 31/ Apart from the recirculating alloy stock and some secondary zinc used in chemicals and paints, almost half of all zinc goes into galvanizing, close to 30 percent into zinc-base alloys, and 10 to 15 percent into brass and bronze production. Of these processed forms of zinc, about 40 percent is used in construction, 20 percent in transportation equipment (principally automobiles), and 20 percent or more in other machinery and equipment, both electrical and nonelectrical. 32/

The principal use of zinc in the United States is as an anticorrosive coating for steel, as is found in galvanized sheet and strip steel for automobile bodies. Because of its special applications in one-sided galvanizing and improvements in steel production, zinc holds a strongly competitive position against displacement by either aluminum or plastic. In another major automotive use--die-cast trim, parts, and hardware--zinc has already been substantially displaced by aluminum, magnesium, and plastics. But the development of economical, thin-walled castings seems to have arrested the decline in consumption in this area.

Another large share of galvanized sheet goes into construction--for roofing, siding, guttering, and conduits. Here, aluminum and copper, among other materials, are important substitutes and competitors. Copper has taken over part of the piping function from galvanized iron, and both metals are giving way to some extent to plastic piping. Galvanized nails, wire, and

31. U.S. Bureau of Mines, Minerals Yearbook, 1980, pp. 899-900.

32. Ibid.; and Mineral Commodity Summaries, 1981-1983.

fencing remain important and resilient markets for zinc, as do galvanized structural shapes.

Zinc, in the form of brass, is used in automobile radiators, where it remains resistant, though not impervious, to replacement by aluminum. Other brass applications, such as those for electrical devices, seem to be diminishing; this is probably due more to declining metal content of the devices than to replacement of brass by other metals. The principal substitute for brass or bronze screws is zinc-plated screws, but screws in general may be yielding ground to other modes of joining and fastening.

One of the more minor forms of zinc—rolled zinc—heretofore used largely in dry-cell batteries, had a boost in use starting in 1982, when the government substituted zinc for most of the copper in pennies. The new penny is 98 percent zinc with a 2 percent copper coating; the old one was 95 percent copper and 5 percent zinc. This use could eventually consume as much zinc each year as now goes into galvanized piping.

Sources of Supply

Overall import dependence for zinc shows a decline from a peak of 66 percent in 1978 to an estimated 53 percent in 1982. 33/ The shift occurred in 1982, when the cumulation of permanent and temporary zinc smelter closings, along with a sharp drop in total consumption, converted the United States from a heavy net importer of zinc ore and concentrates to a net exporter.

Some 70 to 90 percent of U.S. zinc imports in recent years have been in the form of slab zinc, with the remaining 10 to 30 percent arriving as ore or concentrates. Over the 1978-1981 period, Canada was responsible for 59 percent of the crude mineral imports and Peru for 17 percent. Canada was also the source of more than half the slab zinc. 34/ Table 10 summarizes the source of gross imports of unmanufactured zinc in 1981.

Nature of the Risks

The closing of the Bunker Hill smelter at the end of 1981 was the latest in a series of closures dating from 1972 in response to low real prices

33. U.S. Bureau of Mines, Mineral Commodity Summaries, 1983.

34. Ibid.

TABLE 10. SOURCES OF U.S. ZINC IMPORTS FOR 1981

Country	Percent of Imports a/
Canada	56.9
Peru	8.4
Mexico	4.2
Germany	3.7
Finland	3.4
Zaire	3.3
Spain	3.3
Australia	3.2
Other	13.6

SOURCE: U.S. Bureau of Mines, Minerals Yearbook, 1981.

a. Based on zinc content of ores and concentrates, blocks, pigs and slabs. Slab zinc (refined zinc) accounted for 71 percent of the total.

and the difficulties of complying with environmental standards. In 1970, the United States had been essentially self-sufficient in slab zinc, with a smelter capacity of 1.38 million tons and slightly lower consumption. By 1978, active capacity had fallen to about 850,000 tons and since then it has dropped to about 400,000 tons. Late 1982 production rates were little more than half of that capacity. 35/ Major smelter closings occurred in 1979, 1980, and 1981. 36/ Not all of these closings are permanent, however, and one completely new smelter was opened in 1978 as a joint venture of New Jersey Zinc and Belgium's Union Miniere.

Mine closings have more or less kept pace with smelter closings. Despite these closings, there was a surplus in zinc concentrates in 1982. These resulted from the decreased demand during the recession and the near absence of the labor strikes that had lowered production in earlier years. 37/

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35. U.S. Bureau of Mines release, "Zinc Industry in November and Smelter Production in December 1982" (February 8, 1983).

36. U.S. Department of Commerce, U.S. Industrial Outlook, 1982.

37. U.S. Bureau of Mines release, "1982 Raw Nonfuel Mineral Production."

Stocks of slab zinc are not high either by past standards or in relation to normal consumption. Producer and consumer stocks combined would suffice for only about a month's consumption, and merchant stocks add less than a month more. The national stockpile contains enough zinc for about four months of normal consumption, even though its goal is only about one-fourth met.

As with lead, zinc consumption prospects should improve considerably with the revival of the domestic automobile industry. It will also get a boost from a resurgence in construction. Over the long run, there is the possibility that zinc, rather than lead, will reap the benefit of electric automobiles or use of storage batteries for electric-utility load leveling, given its potential superior capacity-weight relationships.

Conclusions

The U.S. zinc industry has recently undergone a cyclical decline. Economic recovery should reabsorb excess smelter capacity and cause some mines to be reopened. Over the longer run, it is likely that smelter capacity will be expanded somewhat, but not at the same rate as trend increases in zinc consumption. Thus, import reliance is likely to revert to, then increase beyond, previous levels. Vulnerability will not materially increase, however. Canada has the largest economic or near-economic zinc reserves in the world, and Canada and the United States jointly have two-thirds the world total. 38/ Thus, 80 to 90 percent of U.S. supply will continue to originate either in Canada or the United States. Much of the remainder will come from Peru and Mexico. Judging by the record, the greatest supply risk is from labor strikes. Under the circumstances, there seems little justification for fulfilling the stockpile goal. To do so at present producer prices would cost some $800 million.

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38. U.S. Bureau of Mines, Mineral Commodity Summaries, 1983.

CHAPTER V. POLICY OPTIONS

The United States has a considerable range of policy options to reduce its dependence on imported nonfuel minerals and limit the impact of any shortages that might result from such dependence. From a budgetary perspective, the least costly option would rely completely on the private sector to purchase the most economical supplies and to maintain appropriate inventory levels, irrespective of whether the source was domestic or foreign. But that option could impose a high cost on the economy if a serious shortage were to occur, either as a result of a national defense emergency or other events affecting access to foreign sources of supply.

As the preceding chapters have illustrated, the conditions surrounding the supplies of individual minerals vary widely. Significant differences exist concerning the nature and extent of risk involved in relying on imported supplies, the potential damage that might result from a contingency, and the ease with which the private market might adjust by resorting to consumption or supply alternatives. Five of these eight minerals--aluminum, chromium, cobalt, manganese, and the platinum group--share some risk of supply disruption from political instability, logistical difficulties, or attempts at price manipulation. The risk is particularly significant for those minerals produced principally in South Africa and the Soviet Union. While a variety of limiting circumstances would make disruption of these supplies less devastating than the oil shortages of the 1970s, any such disruption could exact real economic costs through losses of output and employment in industries that depend on foreign minerals.

This chapter examines the following options to mitigate such costs:

- Increase the National Defense Stockpile;
- Build economic stockpiles;
- Subsidize domestic production;
- Diversify sources of supply;
- Encourage exploration and development on public lands;
- Intensify metals and materials research and development; and
- Utilize foreign policy initiatives.

Since many of these policy options have, in fact, been employed in the past, previous experience provides some guide to their effectiveness and cost. The following discussion of each option evaluates the factors likely to determine cost and effectiveness, as well as some difficulties of implementation and management.

STOCKPILES

Stockpiles are named for their purposes. A defense stockpile is one intended for use only during time of war. An economic stockpile is a buffer stock, intended to smooth out shortages and sudden price runups arising from localized interruptions of individual minerals. For example, the Strategic Petroleum Reserve would presumably be made available at public auction under circumstances well short of warfare and thus could be considered an economic stockpile. Under current policy, the United States has a National Defense Stockpile of minerals and materials, intended to support defense production and essential civilian needs in time of national emergency. It does not have an economic stockpile that would bridge market shortages during other disruptions, such as the interruption of mineral production in one nation or region.

The National Defense Stockpile

The National Defense Stockpile is both the first and the most widely and repeatedly endorsed measure to minimize vulnerability to a wartime shortage of imported raw materials. The stockpile was initiated under the 1939 Strategic Minerals Act. Endorsed as the most cost-effective option by the Materials Policy (Paley) Commission and subseqent panels, it has been virtually immune from criticism in principle. Many claim, however, that it has not been managed well or used properly.

In principle, a stockpile could be built up during periods of low economic activity and accompanying low raw materials prices. Stockpiled materials would be released only during a national emergency, presumably when market demand and prices would be much higher. Depending on the time interval, profits from sales would offset part or all of the costs of management and storage as well as interest on government borrowing to finance purchases. The very existence of the stockpile should discourage potential aggressors who might hope to defeat the United States in a conventional war by cutting off its supplies of vital raw materials and thus its defense production capabilities. But, in practice, several issues have been raised regarding the defense stockpile.

Should Stockpile Goals Be Filled? As discussed in Chapter II, the minerals stockpile targets are developed by the Federal Emergency Management Agency. In an elaborate interagency process, the stockpile goals are determined based on assumptions about mineral demands during a three-year mobilization for war. This paper does not attempt to critique the 140 or so policy assumptions used to calculate the goals. The validity of the goals depends on the validity of these assumptions, however. Among the critical ones are the needs of the U.S. economy--both civilian and military--under mobilization conditions; probable increases in production in the United States, Canada, Mexico, and other secure sources; and levels of minerals consumption in other industrial nations.

About $11 billion in new appropriations would be required to meet all current goals at early 1982 prices, of which about $4 billion could be obtained by selling excess inventories. But the $11 billion figure includes purchases of minerals whose security risk is low. At current cash market prices, about $1.4 billion would be needed to meet the goal for copper, $600 million for nickel, $800 million for zinc, and $200 million for lead. The vulnerability of the United States to serious shortages of these metals, even in the event of a national emergency, can be questioned, given the extent to which U.S. needs are met from North American supply sources and the possibility for expanding North American production rapidly. The extent of vulnerability in a national emergency for these and other minerals obtained from nearby sources of supply is a matter of judgment, as is the decision to pay fairly high insurance premiums for protection against low probability risks.

In addition, the stockpile targets are premised on requirements for a three-year mobilization. The probability of a military contingency requiring such an extended effort may be low. If the one-year goal set by President Nixon in 1973 were reinstituted, the sale of excess inventories could be sufficient to finance stockpile goals for all materials on the list. Alternatively, stockpile procurement could be accelerated for those specific minerals for which substitutes would be difficult to find in an emergency and which are imported from relatively insecure sources--specifically, South Africa, Zaire, and the Soviet Union.

Whatever goals may be deemed essential, any procurement would be most advantageous before economic recovery drives up raw material prices. Given the volatility of raw materials prices and the traditional movement of minerals prices over the business cycle, the cost of meeting defense stockpile goals could well increase by 50 percent or more if procurement is delayed until the international economy has reached its next cyclical peak.

Should Stockpile Levels Over Goals Be Sold? The only stockpiled materials that have been used for military purposes since the Korean War are nickel, copper, and quinine, released during the Vietnam War. About 35 percent or more of the inventory has, for 20 years or more, consisted of materials in excess of stockpile goals. The authorization of sales of excess inventories, however, has been hampered by fears and charges of market disruption made by domestic and foreign producers. Nevertheless, substantial sales were made out of the stockpile inventory during the 1960s and early 1970s. These sales yielded some $6.8 billion by disposing of materials whose acquisition cost was only $4 billion. Assuming that the sold materials remained in the stockpile for 15 years on average, the profits yielded an average annual return of 3.6 percent, less than interest, storage, and management costs.

Assuming that existing excess inventories could be sold at current market prices, they would yield $4 billion. The threat of such stockpile releases was used in the 1960s and again in the early 1970s to discourage domestic metal producers from raising their prices. Some consider that inventories were determined to be excessive in order to help balance budget deficits. Stockpile disposal legislation sent to the Congress in April 1973 was accompanied by a Presidential message that pointed out its potential value in the current fight against rising prices. 1/ The message went on to state that the nation had greater capability to find substitutes than it had at the time the three-year goal was set and concluded that "twelve months would give us sufficient time to mobilize so that we could sustain our defense effort as long as necessary."

Silver inventories in particular have long been considered excessive. However, the large quantities sold between 1967 and 1970 at $1.29 per ounce continue to be noted by opponents of legislation to authorize additional disposals. (Prices have centered between $10 to $12 per ounce since mid-1981.) Stockpile disposals of silver were not authorized in 1980 when the price of silver exceeded $40 per ounce. This price, however, resulted from massive speculative demand and alleged improper conduct by selected silver traders. Thus, it is unlikely that silver prices will return to these abnormally high levels. Surplus silver sales could raise about $1 billion at current prices. These revenues could be used to purchase minerals whose contribution to national security would be far greater than that of silver.

The demand for other minerals is more procyclical, and current markets are depressed and prices abnormally low. For these, it might be desirable to delay sales until substantial world-wide economic recovery has occurred and raw materials prices have recovered. At that time, sales could yield perhaps 50 percent more to the U.S. Treasury and also exert a dampening effect on inflationary pressures.

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1. Presidential Documents: Richard Nixon, 1973, vol. 9, no. 6.

Are The Right Quality Materials Stored? The stockpile has also been criticized because existing inventories purchased in the 1950s no longer meet current physical or chemical requirements. For example, the platinum-group inventory consists of bars, plate, and sheet while current specifications call for sponge. The Inspector General of the General Services Administration (GSA) has audited the stockpile six times over the past decade and has issued critical reports on each occasion. He has charged that materials have been stolen or otherwise disappeared and has claimed to have found major billing errors. The GSA Office of Property Management is responsible for the storage, inspection, maintenance, and security of the stockpiled materials. It lacks funds to undertake a detailed inventory of more than a very few materials each year. Whatever the validity of or explanation for each of the foregoing pieces of evidence, it seems clear that government purchase, storage, and sale of stockpiled raw materials operate under severe institutional handicaps. Appropriating funds for a comprehensive audit of the stockpile would allow GSA to perform its functions with improved efficiency.

Economic Stockpiles

While the strategic stockpile for national defense emergencies has long been an instrument of U.S. government policy, the events of the 1970s evoked concerns about contingencies with other origins--local wars or disturbances in major foreign supply areas, embargoes, cartels, or insufficient investment in foreign production capacity to accommodate demand surges. In 1976, the National Commission on Supplies and Shortages suggested formation of an economic stockpile to cope with such contingencies. Part of the strategic stockpile might be set aside for that pupose, or a separate stockpile could be created. In either event, the economic stockpile would be used only to meet severe supply disruptions, not to influence market prices in the absence of a clearly defined disruption.

The history of the strategic stockpile in the 1960s and the 1970s produced strong opposition to a new policy instrument that might be used by the federal government to influence the market. Metals users prefer that the government not engage in purchases that would tend to raise their costs at a time when the markets for their products are likely to be weak. Mining and metal producing companies, on the whole, expect their prices and their profits to be cyclical and volatile. They are not eager to have the government engage in sales that would shave off the peak prices that provide a substantial part of their profits over a period of years. Both groups tend to prefer to take their chances on the market rather than be subject to government intervention. Thus, very little support for a government economic stockpile exists within the mining and metal producing community, whether foreign or domestic.

Several foreign countries do have economic stockpiles. In Sweden, peacetime stockpiles of chromium, manganese, cobalt, and vanadium are maintained in addition to a wartime stockpile. The peacetime stockpile is for use in the event that supply lines are disrupted in a circumstance short of war. Switzerland offers minerals importers low interest rates and tax rebates to maintain stocks corresponding to about a normal 12-month supply. Japan provides interest rate subsidies and loan guarantees to three private metal stockpiling associations. Stockpiles of nine critical nonferrous metals are maintained to stabilize the supply of key minerals, contribute to national security, and, incidentally, to assist those developing countries that depend on earnings from exporting such materials to Japan.

Some of the problems encountered with the management of the National Defense Stockpile might be overcome by creating an independent, publicly owned corporation that would operate with its own capital, either borrowed directly from the U.S. Treasury or from the private market with government guarantees. 2/ The potential advantage of such a corporation is that it could be charged with purchasing minerals on a more selective basis than that of the National Defense Stockpile. On the other hand, such a corporation might not be more efficient than its existing counterpart.

Under another alternative, the federal government would provide financial incentives to encourage private companies to hold larger inventories of specified materials than is their "normal" commercial practice. 3/ Normal could be defined in terms of ratios of inventories to consumption. Among the incentives that have been suggested are: a tax credit for materials inventories held in excess of normal levels; interest and carrying cost rebates paid directly by the federal government for a percentage of the costs of above-normal inventories; purchase cost rebate contracts; and tax-free interest on bonds floated by user industries to finance inventories in excess of normal levels.

The advantage of private stockpiling is that user companies would tailor their inventories to their evolving requirements. Fresh inventories would be maintained through frequent turnover and the government would

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2. Former Senator Harrison H. Schmitt suggested the establishment of a Strategic Stockpile Commission that would function as an independent federal agency to manage the National Defense Stockpile, using the Stockpile Transaction Fund.

3. See J.H. Holt and T.W. Stanley, Alternative Nonmineral Stockpiling Policies: Private Stockpiling (International Economic Studies Institute, forthcoming).