PB97-120703

1990 SECRETARY'S ANNUAL REPORT

ANNUAL REPORT OF THE SECRETARY OF THE INTERIOR - 1990

U.S. Bureau of Mines

Office of Special Projects

PREPARED PURSUANT TO THE MINING AND MINERALS POLICY ACT OF 1970
(PUBLIC LAW 91-631)

In response to the Mining and Minerals Policy Act of 1970, this report analyzes significant trends in the performance and short-term outlook of the domestic nonfuel minerals and materials sectors in 1989 and 1990 and discusses key issues facing the industry for these years.

I am pleased to report that the domestic nonferrous metal industry became more internationally competitive in 1989 and 1990. Production for most major U.S. nonferrous metals increased for the fourth consecutive year in 1990. In the near term, the industry should continue to be competitive in the world marketplace.

The Department of the Interior, in keeping with the Administration's stewardship principles, will continue to work with industry, Congress, other Government agencies and the public to resolve issues of concern to the domestic mineral and materials industries and to effectively meet the national objective of multiple use of Federal lands in an environmentally sound manner.

T S ARY
Director, U.S. Bureau of Mines
September 1992

PREFACE

Section 2 of the Mining and Minerals Policy Act of 1970 (Public Law 91-631) specifies " . . . it is the continuing policy of the Federal Government in the national interest to foster and encourage private enterprise in (1) the development of economically sound and stable domestic mining, minerals, metal and mineral reclamation industries . . . the Secretary of the Interior shall include in his annual report to the Congress a report on the state of the domestic mining, minerals, and mineral reclamation industries . . . together with such recommendations for legislative programs as may be necessary to implement the policy of this Act."

In direct response to the Congressional mandate, this report highlights significant trends in the performance of selected nonfuels minerals and materials sectors in 1989 and 1990 and some of the major issues facing these sectors.

CONTENTS

ILLUSTRATIONS

Preceding page blank

TABLES

EXECUTIVE SUMMARY

The U.S. nonfuel minerals and materials industry enters the 1990's after undergoing dramatic changes during the past 10 years in response to the 1981-82 recession, intense foreign competition, and increasing Government regulation. To ensure viability, metal producers have shut down uneconomic facilities, invested in new technology, and cut costs. As the 1980's came to a close, profitability returned to metal and nonmetallic mineral producers. This report, which responds to Section 2 of the Mining and Minerals Policy Act of 1970, reviews the performance of selected domestic minerals sectors during 1989 and 1990 and presents their short-term outlook. The performance of the plastics and advanced materials industries is also presented because of the increasing importance of these sectors as competitors with traditional minerals.

OVERALL INDUSTRY PERFORMANCE

In 1989 and 1990, the nonferrous metals industry turned in by far the best overall performance of the domestic nonfuel mineral industries (e.g., ferrous metals industry, nonferrous metals industry, and industrial minerals industry). U.S. production of most major nonferrous metals increased for the fourth consecutive year in 1990, owing primarily to mine openings and capacity expansions. Domestic gold production hit record levels; the United States became a significant net exporter of lead concentrates for the first time; production of refined copper increased to its highest levels since 1981; and most aluminum processing plants operated at or above their annual rated capacity levels. Although consumption and prices for some metals such as aluminum declined in 1989 and 1990, nonferrous metal prices generally remained high by historical standards. In the near term, the nonferrous metals industry is expected to continue to be the best overall performer of the domestic nonfuel mineral industries.

ISSUES OF CONCERN

Despite its improved performance in 1989 and 1990, issues of concern to the domestic minerals and materials industry remain. Those discussed in this report are broadly related to accessibility to minerals located on public lands, the costs of regulatory compliance, and the impact of regulation and international agreements on the recycling of metal products.

Access to Minerals on Public Lands

Efforts to protect lands perceived to have special values can result in regulations that restrict access to Federal lands for mineral exploration and development purposes. Restriction of mineral access, in turn, can mean lost jobs and lower public and private sector revenues. To deal with this issue the Department has begun, on a case-by-case basis, to prepare quantitative estimates of the mineral potential and the economic impacts of Federal lands proposed for withdrawal which are known or believed to be highly mineralized. An analysis of various proposals regarding the California Desert Conservation Area (CDCA) is presented in this report as an illustration of this Departmental initiative.

Cost of Regulatory Compliance

A regulatory program to control and manage mineral industry wastes is now being developed by the Environmental Protection Agency (EPA) under the provisions of the Resource Conservation and Recovery Act (RCRA). Mine and mineral-processing waste regulations implemented under such a program could add significantly to the environmental compliance costs of major sectors of the domestic minerals industry. Compliance costs which are incurred by the domestic industry, but not by its foreign competitors, reduce the competitive position of the U.S. minerals industry. Additionally, required compliance expenditures reduce capital funds available for investment in new technology and research and development. An important aspect of this regulatory process and a major determinant of regulatory compliance costs is the identification of those wastes that are hazardous and must, therefore, be regulated largely at the Federal level (Subtitle C), and those that are nonhazardous and can be regulated at the State level (Subtitle D).

In May 1990, the EPA released its "Recommendations for a Regulatory Program for Mining Waste and Materials Under Subtitle D of the Resource Conservation and Recovery Act," commonly known as Strawman II. In order to gauge the potential cost impact of Strawman II on a major sector of the domestic minerals industry, the Department of the Interior (DOI), through the Bureau of Mines, estimated the potential compliance cost for 10 copper mining operations at 4 possible levels of regulation under the Strawman proposal.

Throughout the remainder of the mine waste rulemaking process, the Department remains available to provide technical assistance to the EPA in their efforts to develop a cost-effective program that protects human health and the environment as well as our Nation's ability to produce needed minerals.

Another regulatory issue facing the minerals industry is the proposal by the Occupational Safety and Health Administration (OSHA) to regulate certain nonasbestiform minerals (AT&A) as asbestos.

Because AT&A are common in nature and occur in conjunction with other mineral deposits, such as construction aggregates and talc, the regulation of AT&A would also affect these industries. According to a Bureau of Mines (BOM) analysis, the economic impact of the OSHA regulation would be greatest on the aggregates industry. The Bureau has recommended to OSHA that AT&A should not be regulated as asbestos unless medical data clearly indicate that these minerals present a significant health risk which would be reduced through regulation.

The Impact of Regulation on the Recycling of Metal Products

Recycling has been endorsed nationally as an important element of our environmental policy. Hazardous waste regulations promulgated under RCRA have, however, in some cases, produced unintended economic and environmental consequences by discouraging the recycling of specific mineral products. Spent aluminum potliner and spent lead-acid batteries are two examples of waste products that presently are experiencing recycling difficulties because of such regulations, even in those applications which have been shown to be environmentally safe. Regulations that may pose a barrier to the environmentally safe recycling of mineral products with economic value should be reviewed carefully.

Concerns continue to be expressed that the added economic costs attendant to the implementation of the Basel Convention through bilateral and multilateral agreements could result in major economic disincentives to the export of metal scrap and metal waste products and would therefore interfere with the promotion of domestic recycling activity. Given these concerns the Department of the Interior will remain actively involved in negotiations concerning the implementation of the Basel Convention with the Organization for Economic Cooperation and Development nations, the European Community nations, and with the United Nations. The continued participation by the Department in these negotiations is essential in order to assure that the agreements reached both discourage the dumping of hazardous wastes as well as promote U.S. goals of encouraging recycling and a competitive market for recyclable metals.

INTRODUCTION

The U.S. nonfuel minerals and materials industry entered the 1990's after undergoing a dramatic change in the last 10 years. The 1981-82 recession, intense foreign competition, and increasing Government regulation had major consequences for the industry. Metal producers, in particular, were affected significantly, and almost the entire domestic metal industry operated at recession levels from 1982 through 1986.

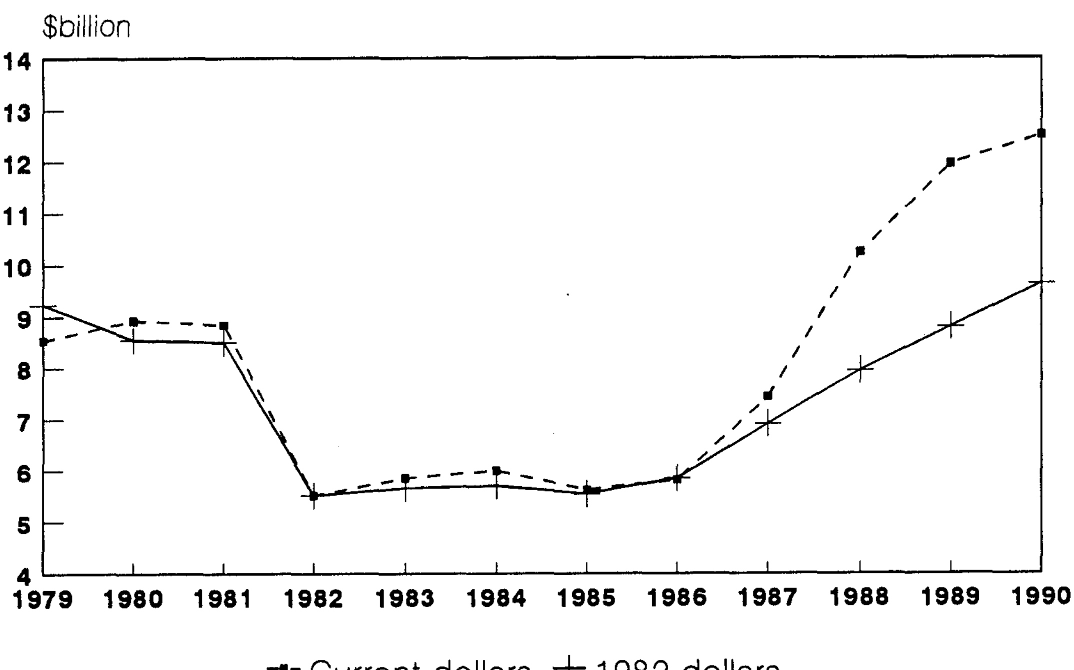
To ensure viability, metal producers shut down uneconomic facilities, invested in new technology, and cut costs. As a result, U.S. employment in metal mining declined by 44,000 jobs between 1980 and 1989, a 44% decline from a total of 100,000 in 1980. But as the decade came to a close, higher mineral prices and technological advances brought profitability to both metal and nonmetallic minerals producers, and new producing mines came on line. By 1990 the value of total domestic nonfuel minerals production stood at $33 billion, with metals accounting for about $13 billion of this total (figs. I-1 and I-3). After 1987, total physical production surpassed levels reached prior to the 1981-1982 recession (figs. I-2 and I-4). A smaller, but more efficient industry appears to be on its way to achieving even higher production levels in the near term. The total value of U.S. nonfuel mineral production seems rather modest when compared directly to contributions of other sectors of the economy. For example, if the 1989 total of $32 billion is compared to the 1989 value of shipments for all manufacturing of $2,779.2 billion, nonfuel mining would account for only 1% of the total. Moreover, the direct contribution of nonfuel mining to the Nation's gross national product (GNP) is only about 0.2%. Hence, nonfuel mining may seem relatively unimportant in an economy whose GNP, adjusted for inflation, averaged $4 trillion from 1986 to 1990.

Such comparisons, however, are misleading. Many important sectors of our economy are highly dependent on minerals, particularly those involved in manufacturing durable goods and those involved in construction activity. Even during the difficult period that metal mining experienced from 1982 to 1986, the percentage of GNP directly originating in the manufacturing of fabricated metal products, machinery, and equipment averaged 9%, and these industries presently contribute about 10% to GNP. The products of mining, then, are critical inputs to these sectors, making it possible for major sectors of the economy to operate and, in turn, for the rest of the economy to function and grow.

This report, which highlights significant trends and issues facing the domestic nonfuel minerals and materials industries during 1989 and 1990, is in direct response to the mandate of Section 2 of the Mining and Minerals Policy Act of 1970.

Chapter 1 presents and briefly analyzes significant trends and events that affected the performance of the domestic nonferrous, ferrous, and industrial minerals sectors in 1989 and

Figure 1-1. Value of U.S. Production - nonfuel metal mining.



U.S. Bureau of Mines. Constant dollars computed from producer price indexes for nonferrous metals and iron and steel.

early 1990. A discussion of plastics and advanced materials, including advanced metals, is included, because these sectors are increasingly important as competitors with traditional minerals in some end uses. Although there are more than 100 mineral and materials industries, only those that are most important for economic or strategic reasons are highlighted.

Chapter 2 of this report briefly discusses a number of current and emerging issues, which could influence the future performance of the domestic minerals industry. The issues include the economic impact of proposed legislation affecting mining activity in the California desert; the impact of selected environmental and health and safety statutes and proposed regulations; and the implementation of the Basel Convention.

This report was prepared by the Office of Special Projects in the Bureau of Mines.

CHAPTER 1. — SIGNIFICANT TRENDS AND EVENTS

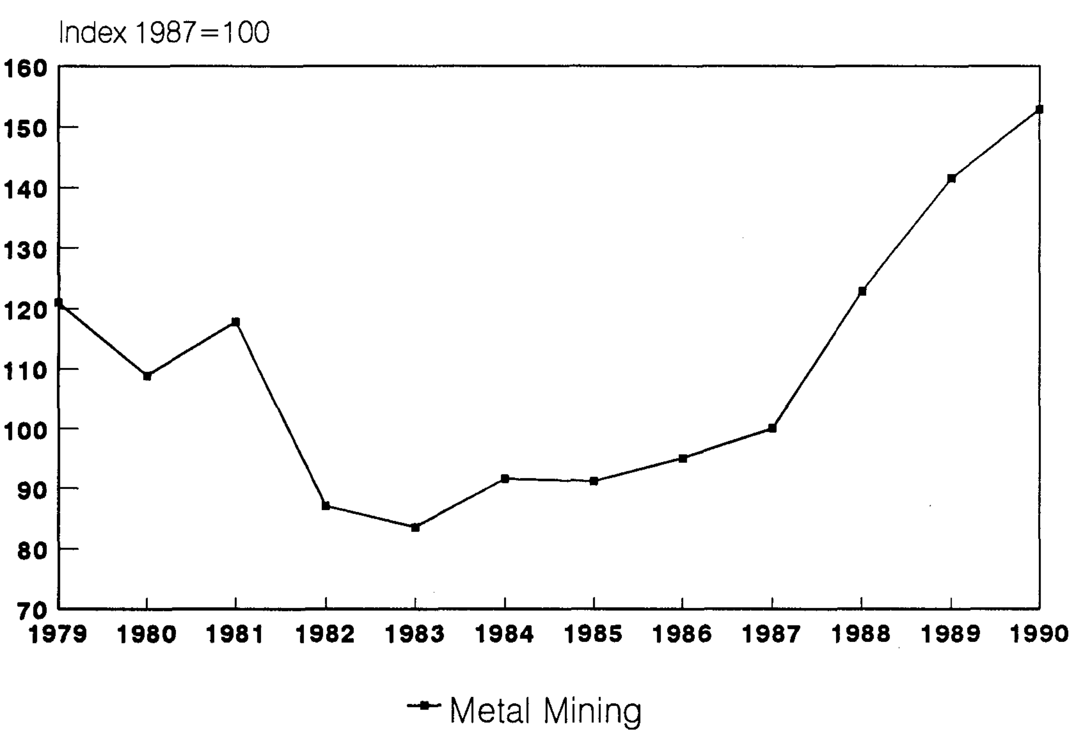
NONFERROUS METALS INDUSTRY

The nonferrous metals industry turned in the best overall performance of the domestic nonfuel mineral industries (e.g., ferrous metals industry, nonferrous metals industry, and industrial minerals industry) in 1989 and 1990. Domestic production of most major nonferrous metals increased in 1990 for the fourth consecutive year, due primarily to mine openings and capacity expansions (tables 1-1 and 1-2). Although consumption and prices for some metals such as aluminum declined in 1989 and 1990 in response to the softening economy, nonferrous metal prices generally remained high by historical standards.

Aluminum

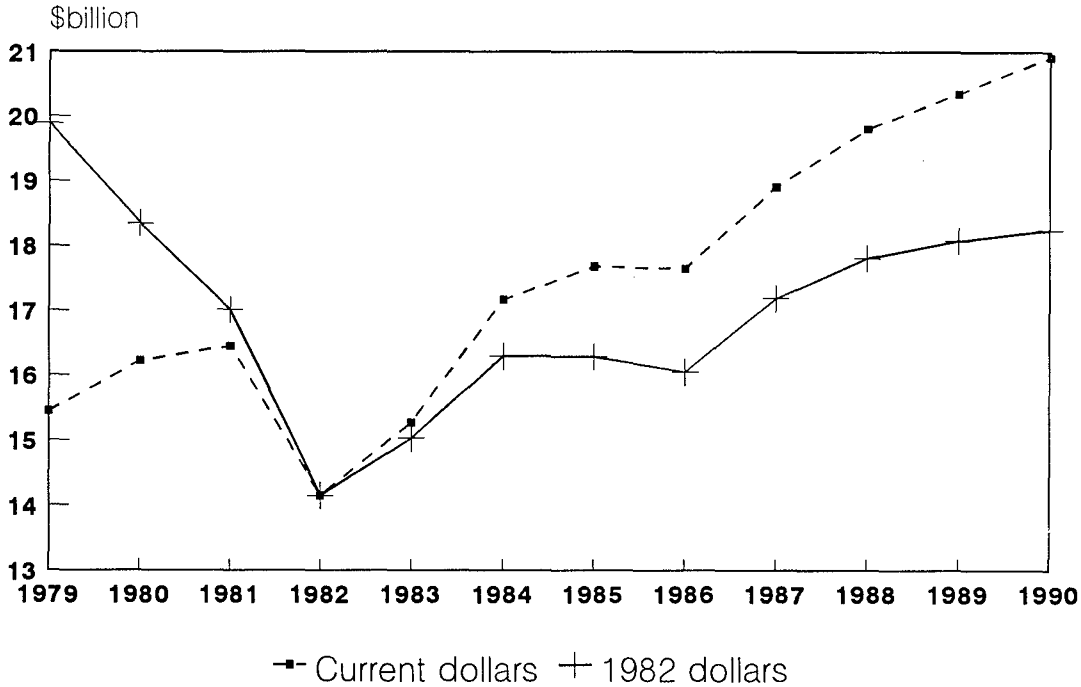
Domestic production of primary aluminum in 1989 increased about 2% over 1988 to a total of just over 4.0 million metric tons (mt) and remained approximately at that level in 1990. These production levels were the highest since 1984. World production also increased 2% since 1988. These increases resulted in increased demand and higher prices for bauxite and alumina, major ingredients for producing primary aluminum, and, in turn, have increased the costs of producing aluminum. While primary aluminum production increased, production of recycled aluminum from old scrap, which accounts for about 20% of total primary and second-

Figure 1-2. Changes in physical production - metal mining.



Board of Governors Federal Reserve System.

Figure 1-3. Value of U.S. production - industrial minerals (except fuels).



U.S. Bureau of Mines. Constant dollars computed from producer price indexes for nonmetallic mineral products.

ary production, declined slightly. By the end of 1989, only 23 primary aluminum reduction plants were operating in the United States, compared to 33 operating plants in 1980. Most of these plants, as well as those throughout the world, operated at or near their annual rated capacity levels in 1989 and 1990. The resulting worldwide production increase, coupled with a decline in domestic aluminum consumption of almost 8% from 1988 to 1989, led to a reduction of the average U.S. spot market price of aluminum ingot by 20% from its 1988 level. This was the first year since 1985 that the price for ingot decreased, but the average price of 87.8 cents per pound was still the second highest of the last 10 years.

The United States was a net exporter of aluminum in 1989 and 1990. U.S. exports of aluminum ingot, mill products, and scrap increased 29% over 1988 to 1.6 million mt in 1989 and increased again slightly in 1990 to 1.7 million mt, the highest level since 1980, largely because of the competitive advantages resulting from the decline in the value of the dollar and because of expanding demand in Europe, Japan, and other Pacific Rim nations. In contrast, U.S. imports of these products declined 9% in 1989 and increased only slightly in 1990.

Preliminary data for 1990 showed that domestic consumption of aluminum declined slightly from 1989. Aluminum demand in the United States for the near term is expected to remain sluggish because of continuing weakness in the transportation and building and construction sectors. Packaging and containers will remain the dominant end uses.

Table 1-1. — U.S. production and product value of selected nonferrous metals, 1988–90

(Thousand metric tons and million dollars, except as noted)

	Production			
	1988	1989	% change	1990e
Aluminum, primary	3,944.0	4,030.0	2.2	4,000.0
Copper, mine	1,417.0	1,497.0	5.6	1,550.0
Gold, mine, mt	200.9	265.5	32.2	300.0
Lead, mine	394.0	419.0	6.3	495.0
Platinum-group, mt	5.0	6.3	26.0	7.0
Silver, mine, mt	1,661.0	2,007.0	20.8	2,000.0
Zinc, mine	244.0	276.0	13.1	530.0

	Product Value		
	1988	1989	1990e
Aluminum, primary	$9,573	$7,801	$6,700
Copper, mine	3,764	4,321	4,203
Gold, mine	2,831	3,266	3,700
Lead, mine	315	356	477
Platinum-group	W	85	47
Silver, mine	349	355	310
Zinc, mine	324	499	837

W Withheld to avoid disclosing company proprietary data.
e Estimated.

Source: Bureau of Mines, Minerals Yearbook, v. I, 1989, and Mineral Commodity Summaries, 1991.

Table 1-2.—U.S. apparent consumption[1] of selected nonferrous metals, 1988–90
(Thousand metric tons, except as noted)

	1988	1989	% change	1990[e]
Aluminum	5,373	4,959	–7.7	4,800
Copper	2,212	2,182	–1.4	2,200
Gold,[2] mt	185	326	76.2	230
Lead	1,226	1,249	1.9	1,220
Platinum-group, mt	103	101	–2.0	99
Silver,[2] mt	4,142	5,085	22.8	4,300
Zinc	1,345	1,314	–2.3	1,270

[e] Estimated.
[1] Defined as production + (imports - exports) + adjustments for Government and industry stock changes.
[2] Defined as refinery production from primary materials + refinery production from old scrap + net imports of bullion.

Source: Bureau of Mines. Mineral Commodity Summaries, 1991.

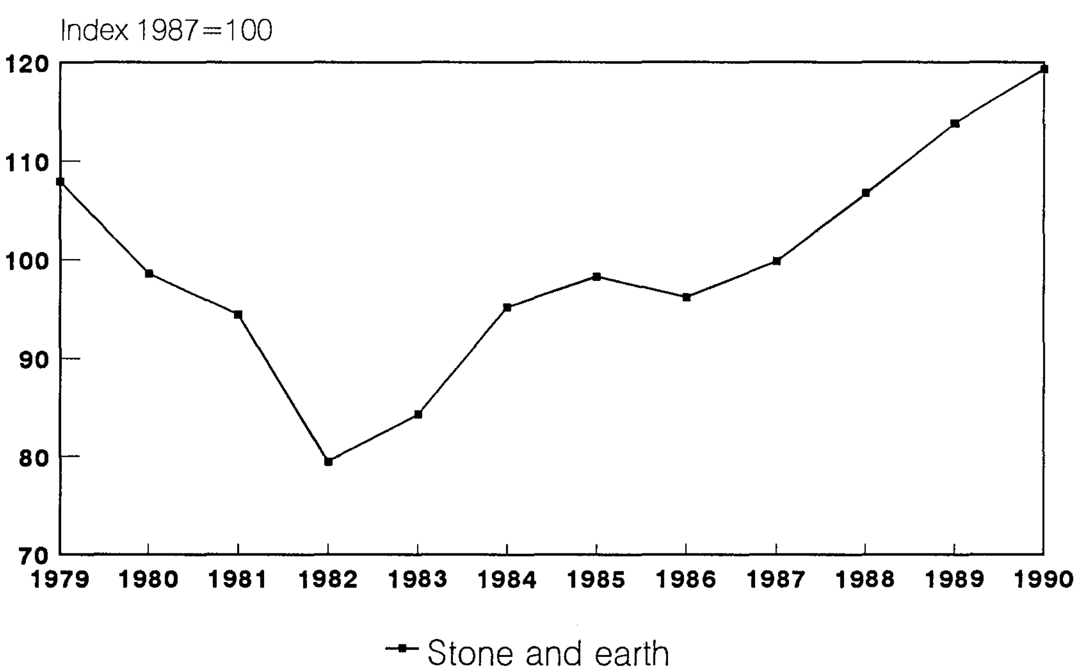
To strengthen their economic position, domestic aluminum companies are engaging in major sales efforts and have diversified into the production of other goods, such as waxed paper and plastic wraps, aerospace and industrial products, and composite materials. Some of this diversification was made possible by research and development conducted by the aluminum companies themselves. Alcoa, for example in 1989, increased its research and development expenditures for the development of electronic products and composites by 9% over 1988.

Copper

In 1989, domestic production of refined copper increased to its highest level since 1981, with production totaling almost 2.0 million mt, a 6% increase from 1988. U.S. mine production of primary copper totaled almost 1.5 million mt, again a 6% increase from 1988. Preliminary data for 1990 indicated that both U.S. refined copper production and mine production were continuing to increase and were likely to exceed the 1989 production levels. Operations in Arizona accounted for about 60% of total U.S. copper mine production and about 10% of the world total. About 72% of all copper consumed in the United States is used in electrical and electronic goods.

Higher copper prices in 1989 and 1990 not only prompted interest in reopening several long-closed U.S. copper mines, but also encouraged copper producers to announce plans for further expansion of capacity by utilizing solvent-extraction electrowinning (SX-EW) technology, which produces copper by leaching low-grade oxide ores. In mid-1990, for instance, ASARCO Incorporated announced that it will spend $54 million to build a new SX-EW plant at its Silver Bell operation, near Tucson, Arizona. In 1989, SX-EW technology accounted for about 21% of domestic primary refined production, as compared with about 12% in 1986. Copper from old scrap also continued to be a major source of supply for the United States, providing about 25% of apparent consumption in 1989 and 1990. With increased primary refined production, a decline in refined imports from 332,000 mt in 1988 to approximately 300,000 mt in 1989 and 1990,

Figure 1-4. Changes in physical production - stone and earth (industrial) minerals.



Board of Governors Federal Reserve System.

and a solid increase in refined copper exports from 58,000 mt in 1988 to 180,000 mt in 1990, net import reliance as a percent of domestic apparent consumption of copper declined from 13% in 1988 to 5% in 1990, its lowest level since the 1% level reported for 1982.

The Bureau of the Census reported that in 1989 the United States exported more than 721,000 tons of ore, concentrates, blister, refined, and alloyed and unalloyed copper scrap, making it an overall net exporter of copper for the second year in a row. In recent years, increases in world copper consumption have been most notable in Southeast Asia because of increased industrialization, while the more mature industrial countries, such as the United States and Japan, and western Europe, have experienced only modest growth.

Chile is continuing to expand its mine production, and production increases over the long run are also expected from Mexico, Indonesia, Portugal, Peru, and Australia. Although this bodes well for world mine production, concerns have been raised that the trade policies of several countries, particularly Japan, have so affected the copper concentrate market that it may no longer be economic to invest in new smelter capacity in unprotected markets.[1]

Preliminary data for 1990 indicated that U.S. copper consumption increased only slightly from 1989. Because of projected slow growth in the construction and electrical products sectors, the U.S. Department of Commerce estimates that this trend is likely to continue in the near term.

Gold

Gold was a stellar performer in the nonferrous metals industry during the 1980's, with U.S. production increasing each year since 1979 because of high world prices relative to production costs. Domestic gold production reached record levels in 1989, aided by the opening of two dozen new gold mines and capacity expansion of many others. The vast majority of new operations brought into production over the past several years utilize open pit, bulk haulage methods, and heap leaching, a technology which is helping to keep production costs well below selling prices. Domestic mine production of gold is estimated to be at least 300 mt in 1990. Over one-half of the gold produced in the United States is mined in the State of Nevada. In 1990, Nevada contributed an estimated 185 mt of the total domestic mine production of gold.

Despite recent successes, domestic gold producers continued to face challenges in addition to the economic impact of fluctuating gold prices. In 1989, for example, voters in Nevada overwhelmingly approved an amendment to the State constitution which increased taxes on net proceeds from mineral production, although a proposal for additional mining severance taxes was defeated. In California, opposition to new mining permits continued to affect gold mining operations throughout the State.

Although interest in gold as an investment softened in Europe and North America in 1989, overall consumer, investor, and government demand for gold remained strong in the free world, and a consumer market for gold began to emerge in nations with centrally planned economies. Interest in gold increased in Japan, where demand was buoyed by partial removal of a ban on gold investments by certain professional fund managers, the removal of restrictions on gold marketing, and a reduction in the tax on coins and jewelry. Moreover, the use of gold for jewelry continued to buttress world demand.

The longer term outlook for gold, however, is uncertain and depends on world supply, demand from fabricators and investor expectations regarding inflation, interest rates, and political uncertainties. Other factors which will influence future demand for gold are the growth in the eastern European markets and a possible monetary role for gold produced in the former republics of the Soviet Union, for which exact production and reserve figures are unknown.

Lead

In 1989, the United States became a significant net exporter of lead concentrates and virtually all exports were shipped to Canada for further processing. This change was due largely to the opening of the Greens Creek Mine in Alaska. This trend should continue with U.S. mine production and exports increasing significantly during the 1990's as another new mine in Alaska, the Red Dog, moves to full production. Missouri was the Nation's largest lead mining State in 1989, accounting for almost 90% of domestic mine production.

Almost 70% of refined lead in the United States was produced from lead scrap at secondary smelter-refineries. Secondary production totaled a record 868,000 mt in 1989 and accounted for 67% of all U.S. refined production, 20 percentage points more than in 1970. Lead-acid batteries accounted for 87% of the scrap consumed by secondary smelters and refiners. Primary lead plants produced 396,500 mt of lead in 1989 and 395,000 mt of lead in 1990. Total output declined over the past 10 years because the old and inefficient primary plants, which were shut down, were not replaced by new smelters.

Although its production and use have been affected by environmental and health regulations, lead still remains a critical material in great demand throughout the world. World consumption has risen by 83% over the past 30 years, but mine production (in terms of metal content) has risen by only 28%, making recycling a key factor in supply.[2] Increased demand is occurring largely because of a world-

[1] Lesemann, Robert H. Is There a Copper Smelter Bottleneck Developing?, Resource Strategies, Inc., June 1990. Japan, which is now a large producer of smelted copper, decided to meet its copper needs by importing copper concentrates and producing its own processed copper rather than importing processed copper. To secure the huge amount of concentrates it would need, while discouraging Japanese users from importing processed copper, Japan made it uneconomic for mining companies outside of Japan to sell refined copper to Japan. Japan did this by imposing a high import tariff on refined copper, but none on concentrates. This helps Japanese producers have lower selling prices for processed copper compared to the selling prices for processed copper of mining companies with integrated smelters outside of Japan. Korea and Brazil have followed the Japanese model in developing their smelting capacity.

[2] Nurse, Milton. Secondary lead becomes a primary need. Metal Bulletin Monthly, June 1990.

wide increase in the number of motor vehicles, which have lead-acid storage batteries, and a need for lead in backup stationary emergency power systems. In 1989, for instance, batteries accounted for 79% of total lead consumed in the United States, compared with 44% in 1970 and 60% in 1980. U.S. manufacturers of storage batteries consumed a record 1,012,155 mt of lead in 1989.

Although overall domestic demand for lead grew at an average annual rate of 2.5% from 1985 to 1989, this rate of growth is not expected to be sustained over the next decade. Some domestic end uses of lead will be phased down or eliminated. The end uses most likely to be affected are in the nongrowth lead markets such as lead solders; paints and coatings (already eliminated in interior house paints); ceramics; gasoline additives; containers or other packaging, including inks or dyes, especially where food is concerned; and cosmetics. The Bureau of Mines estimates that U.S. annual growth in lead demand will average 0.5% to 1.0% per year over the next decade. The world growth rate is forecast at 1.5% per year over the same period.

Platinum-Group Metals

The platinum-group metals include platinum, palladium, rhodium, ruthenium, iridium and osmium. The United States depended on imports for 90% of its platinum group metal (PGM) consumption requirements in 1989 and 88% in 1990. In 1990, 54% of the direct requirements were supplied by South Africa and 12% of the direct requirements were from the former U.S.S.R.

One of the PGM, rhodium, is a very scarce metal which is essential in the production of automobile catalytic converters. Supply sources for rhodium are more limited than for the other PGM. South Africa and the Soviet Union are the only significant rhodium suppliers; in 1990, they provided 65% of direct U.S. imports. While prices for most of the PGM remained stable throughout 1989 and into 1990, rhodium experienced a substantial price increase, rising from approximately $2,000 per ounce at the end of 1989 to a record high of more than $7,000 per ounce in June 1990 and then settling down to about $5,000 per ounce in July 1990. Speculative buying by automobile manufacturers in the United States, Japan, and Europe and rhodium refinery production problems in South Africa reportedly contributed to the price rise.

The Stillwater Mine in Montana, the Nation's only producer of PGM, provided about 46,000 (troy) ounces of platinum, 156,000 ounces of palladium, and 1,000 ounces of rhodium, equivalent to 8% of U.S. platinum, palladium, and rhodium consumption in 1989. The partners in the Stillwater Mining Company, Chevron Corporation, and Manville Corporation, completed the construction of a $6 million PGM smelter in mid-1990. The smelter is at Columbus, Montana, about 40 miles from the Stillwater Mine. However, final refining of the precious metal matte is still done in Belgium. As a result, most of the Stillwater PGM's are consumed by European manufacturers because they are in closer proximity to the final processing site.

World demand for PGM, especially rhodium, is expected to remain strong over the next 5 years. Barring any disruption in world supplies, estimated available supplies of platinum and palladium should be adequate to meet anticipated demand. Rhodium recycling is not extensive; it provides only about 10% of domestic consumption requirements. Further, growth in rhodium recycling will be slow in the near term. This is because the more stringent nitrous oxide emission standards have only been in effect in the United States since 1983, and the average lifetime of an automobile is 8 to 12 years. As emission control requirements continue to be put in place in Western Europe and other countries, further increases in the demand for rhodium could again move its price well above the 1990 average dealer price of $3,565 per ounce.

Zinc

Continuing the trend begun in 1987, domestic mine production of recoverable zinc ores in 1989, aided by the startup of three new and reopened mines, increased 13% over 1988 production to 276,000 mt, with a refined metal value of about $500 million. Refined metal production also increased in 1989 to 358,000 mt, 8.5% higher than in 1988. The increase in output was due to increased recovery from scrap recycling and to a stimulation of activity resulting from higher prices for high-grade zinc. In 1989, prices reached record levels because of strong worldwide demand and a tightness in worldwide supply resulting from strikes and production problems at several foreign facilities.

U.S. zinc output increased approximately 87% in 1990 to 515,000 mt because of the added initial output of Alaska's Red Dog Mine. Two additional mines, one in Idaho and one in Nevada, also opened during 1990. The Red Dog Mine is expected to produce about 525,000 mt of zinc concentrate, 110,000 mt of lead concentrate, and 45,000 mt of bulk lead-zinc concentrate annually when it is in full production by 1992. This will make Alaska the leading zinc-producing State. None of the production is scheduled to be processed in the United States, but will go to Canada, Japan, South Korea, and Europe for processing. Despite the significant increase in mine production, the United States is expected to remain the world's largest importer of zinc metal during the next decade, primarily because of a lack of sufficient domestic primary smelter capacity.

U.S. slab zinc consumption decreased by about 3% in 1989 and by about 7% in 1990 to 990,000 mt because of reduced demand in the transportation and construction sectors. World consumption of zinc also declined slightly in 1989 and 1990. The International Lead and Zinc Study Group estimated that Western world refined zinc consumption was slightly more than 5.2 million mt in 1989, about 1% less than in 1988, and was slightly less than 5.2 million mt in 1990 primarily because of the slowdown in the world economy in the second half of the year.

FERROUS METALS INDUSTRY

Despite a good year by the domestic iron ore industry, the ferrous metals industry, which is composed of producers of iron and steel as well as ferrous foundries and supplier industries such as iron ore, ferroalloys, and ferrous scrap, performed unevenly in 1989 (table 1-3). Preliminary data for 1990 showed slight declines in domestic iron ore production and consumption.

Steel production and shipments during 1990, on the other hand, registered small gains.

Table 1-3.—Statistics for selected ferrous metals, 1988–90
(Million tons and million dollars, except as noted)

	1988	1989	% change	1990[e]
Iron ore, Mmt				
Production	57.5	59.0	2.6	53.9
Shipments	57.1	58.3	2.1	54.2
Product value	$1,717	$1,902	10.8	NA
Apparent consumption[1]	70.1	75.1	7.1	72.9
Iron and steel, Mst				
Pig iron				
Production	55.7	55.9	0.4	55.5
Reported consumption	56.1	56.0	–0.2	NA
Steel				
Production	99.9	97.9	–2.0	98.0
Apparent consumption[2]	103.6	96.4	–6.9	95.9

[e] Estimated.
NA Not available.
Mmt = Million metric tons. Mst = Million short tons.
[1] Defined as production + (imports - exports) + adjustments for industry stock changes.
[2] Defined as steel shipments + (imports - exports) + adjustments for industry stock changes.

Source: Bureau of Mines, Minerals Yearbook, v. I, 1989, and Mineral Commodity Summaries, 1991.

Iron Ore

The domestic iron ore industry, which serves U.S. and Canadian steel companies, produced 59 million mt of iron ore in 1989, an increase of about 2.6% over 1988, and under 54 million mt in 1990. World production of iron ore in 1989 was 923.6 million mt, the highest level since 1979. A further production increase to almost 929 million mt in 1990 established a new record for annual production. The value of domestic production increased about 11% in 1989 largely because of higher prices.

There were significant changes in the character and quality of domestic iron ore products as domestic steel producers increased their demand for "fluxed" iron ore pellets[3] rather than traditional "acid" iron ore pellets. Although fluxed iron ore pellets are more costly to produce and transport, steelmakers have found that energy savings and productivity improvements from smelting these pellets more than offset their additional cost. The acceptance of this new technology has been so rapid that in 1989 it accounted for more than one-third of the pellet production in the United States. Additional capacity is presently being installed.

Steel

Worldwide, steel production continued to increase slowly with 875 million short tons (st) of steel produced in 1990 as compared to 863 million st in 1989 and 859 million st in 1988. Domestic production of steel declined about 2% and domestic consumption about 7% from 1988 to 1989 and remained relatively unchanged in 1990. Price decreases in a softened domestic market in 1990 were largely responsible for a decline in profits. Little change in shipments of steel mill products (table 1-4), boosted by increased exports to markets in the Middle East, Far East, and the U.S.S.R., prevented a further decline in profitability. Domestic steel imports in 1990 decreased by 28% and exports increased more than 50% over 1988 levels because of the weakness of the dollar relative to other currencies.

Table 1-4. — U.S. steel product shipments, imports, and exports, 1988–90
(Million short tons)

	1988	1989	% change	1990[e]
Shipments	84.0	84.1	0.1	84.2
Imports	22.3	17.3	–22.4	16.0
Exports	2.6	4.6	76.9	4.0

[e] Estimated.

Source: Bureau of Mines; The American Iron and Steel Institute.

One favorable development in 1989 was the significant increase in capital expenditures by the domestic steel industry. The American Iron and Steel Institute reported that capital spending by companies that represent 68% of domestic shipments of finished steel products was an estimated $2.3 billion, 72% higher than the average of the previous 5 years, and the highest since 1981. In particular, the U.S. industry continued to invest heavily in new continuous casting installations to replace obsolete ingot casting and primary rolling mills.

The proportion of U.S. steel produced by using the continuous casting process increased from 61% in 1988 to 65% in 1989. The United States, however, still lagged behind Western Europe and Japan where continuous casting represented 87% and 94%, respectively, of production. At the other end of the spectrum were the Eastern European nations, including the U.S.S.R., where only 18% of the steel was produced using continuous casting, an indication of the relative state of technological advancement in these countries.

A significant development in the adoption of new technology in the domestic steel industry was the mid-1989 startup of the first production-scale continuous casting machine for flat products using a new "thin slab casting" technique. This new facility was installed at a remarkably low capital cost, and marks the beginning of entry by the smaller minimill steelmakers into the flat rolled steel product market, heretofore an almost exclusive domain of the large, integrated steel companies. The operator of the new technology, Nucor, Inc., already has announced plans for a second, more advanced installation. Other companies in the minimill and integrated sectors of the industry are carefully

[3] To produce fluxed pellets, limestone and/or dolomite is blended with iron ore concentrate at a rate of about 3% to 9%.

evaluating the opportunities and competitive problems which this new technology presents.

In 1989, three of the largest U.S. steel companies entered into joint ventures with Japanese steel companies:

- USX, Inc., the parent company of USS, the largest steelmaker in the United States, announced the sale of 50% of its Lorain, Ohio, works to Kobe Steel, Ltd. This major integrated steel plant, now the USS/Kobe Steel Company, produces bar and tubular products, for which USS retains marketing responsibility.

- Armco, Inc., announced that it had sold 40% of its Eastern Steel Division to Kawasaki Steel Corporation. This operation, now known as Armco Steel Company, L.P., consists of Armco's two flat-rolled steel plants located at Middletown, Ohio, and Ashland, Kentucky.

- Inland Steel Co. announced that Nippon Steel Corporation had purchased 13% of Inland's common stock. Inland and Nippon were already co-owners of two joint ventures to build and operate steel processing facilities in Indiana.

Earlier arrangements resulting in Japanese joint ownership of major U.S. steelmaking facilities included, a joint venture by Nucor, Inc., a leading domestic minimill firm, and Yamato Kogyo to build and operate a minimill, as well as a number of other joint ventures involving domestic steel-processing operations.

By the end of 1989, each of the six largest Japanese steel companies was a joint owner in the United States of either a steelmaking firm (producing primary steel from raw materials) or a steel-processing facility (producing products from primary steel) (table 1-5). These joint ventures involved five of the six largest U.S. steel companies. The only known ownership by a U.S. steel firm of a Japanese steel company is the 1% investment interest of Inland Steel Industries, Inc., in Nippon Steel.

Another emerging trend in the ownership of U.S. steel companies is the sale by large, multiplant companies of individual plants to independent owners. The newly independent companies generally consist of steel plants that did not fit into the long-range plans of the former owners, either because they represented excess capacity, or because they demanded more capital for modernization than the owner would or could provide. In several cases, the new companies are employee-owned under Employee Stock Ownership Plans, which enable the employees to retain their jobs by accepting equity in the corporation as a portion of their earnings. LTV Steel has created at least four new, independent steel companies and at least three other companies have sold off one steel plant in this way. In addition, there have been two steel companies sold off by their nonsteel parent companies. These spinoffs, and the new U.S.-Japanese venture companies, have resulted in a significant increase in the number of independent domestic steel companies, without any increase in the number of steel plants or in the steelmaking capacity of the Nation.

The short-term outlook for the domestic steel industry includes a reduced level of sales, with continued competitive pressures on pricing. Profits, therefore, are expected to continue to decline.

Ferroalloys

Ferroalloys are alloys of iron and other elements that are used in the production of specialty metal products, such as steel or cast iron. Three families of alloys comprise the bulk

Table 1-5. — Japanese equity in major U.S. steel companies

Japanese steel co.	Million tons produced 1989	Investment in major U.S. integrated steel companies
Nippon	31.3	13% equity interest in Inland Steel, the #4 steelmaking firm in the United States (1989 steel production: 5.5 million tons).
		40% of a 1.0-million-ton-per-year cold-rolling facility and 50% of a 0.9-million-ton-per-year continuous galvanizing facility—joint ventures with Inland Steel.
NKK	13.6	70% ownership of National Steel, the #6 steelmaking firm in the United States (1989 steel production: 5.4 million tons).
Kawasaki	12.1	40% ownership of Armco Steel Co. (USA), a joint venture with Armco Inc., the #5 steelmaking firm in the United States, Armco (USA) facilities produced an estimated 4 million tons in 1989.
		50% of California Steel, a major west coast rolling and processing facility (formerly Kaiser Steel).
Sumitomo	12.1	40% of one and 50% of another continuous galvanizing facility joint venture with LTV.
Kobe	7.2	50% ownership of USS/Kobe Steel Co., a joint venture with USX Inc., the #1 U.S. steelmaking firm. USS/Kobe facilities produced an estimated 1.3 million tons in 1989.
		Joint venture with USX for a galvanizing line in the Midwest.
Nisshin	3.7	10% investment interest in Wheeling-Pittsburgh, the #10 steelmaking firm in the United States (Wheeling-Pittsburgh has been in Chapter 11 bankruptcy since 1984).
		50% of a galvanizing facility joint venture with Wheeling-Pittsburgh.

Source: Bureau of Mines; The American Iron and Steel Institute.

of the ferroalloy industry's product volume: ferrosilicon, ferromanganese, and ferrochromium. Other common ferroalloys are ferromolybdenum, ferronickel, ferrovanadium, ferrocolumbium, and ferrotungsten. Overall domestic demand for ferroalloys and related materials decreased slightly in 1989, owing to the decline in domestic steel production, the major market for ferroalloys.

Because the United States has no reserves of chromium or manganese ores, the ferroalloy industry relies on imported ores for the manufacture of ferromanganese and ferrochromium. These segments of the industry have been largely displaced by imported ferroalloys produced in nations where low-cost electrical energy and other needed resources are available, and where producers seek to increase their revenues by producing high value-added products. The two remaining domestic manufacturers of ferromanganese and ferrochromium rely on contracts from the Defense Logistics Agency to upgrade ores from the National Defense Stockpile.

Because the United States has abundant raw materials for ferrosilicon production, this segment of the industry continued to be viable in 1989 and 1990. Most ferrosilicon producers also produce silicon metal, used as an alloying element in aluminum and as a starting material for silicon-based chemicals, but included among the bulk ferroalloys. The market for silicon metal was strong due to the strength of the aluminum and chemical industries.

Production of stainless steel grades, which consumes virtually all of the ferronickel and over 80% of the ferrochromium, declined about 12% between 1988 and 1990. Production of ferronickel was resumed at the only nickel smelter in the United States, the Glenbrook Nickel operation at Riddle, Oregon, now owned by the Canadian company, Cominco Resources International, Ltd. The smelter is processing stockpiled ores left on the property since its shutdown in 1986.

INDUSTRIAL MINERALS INDUSTRY

Mineral commodities that are not metals or fuels are generally classified as industrial minerals. Two important end uses for industrial minerals are in construction and in the manufacture of fertilizers. The value of U.S. industrial minerals production in 1989 was about $20.4 billion, approximately two-thirds of the total value of U.S. nonfuel mineral production this year.

Construction Minerals

With the exception of cement and gypsum, production of most construction minerals such as crushed stone, sand and gravel, and asbestos, declined in 1989 owing to weak construction activity (table 1-6). Preliminary data indicated that production of these minerals rose slightly in 1990. Imports continued to be a significant source of cement supply and satisfied about 16% of U.S. demand in 1989 and 13% in 1990.

Consumption of construction aggregate and cement in 1990 increased slightly from 1989 levels (table 1-7). Continued weakness in both the nonresidential and multifamily residential building markets is expected to be compensated by increased demand for road construction and repair work. Further gradual increases in demand for construction aggregates are anticipated. Given a recently published Depart-

Table 1-6. — U.S. production and product value of selected construction materials, 1988–90

(Million short tons and million dollars, except as noted)

	Production			
	1988	1989	% Change	1990[e]
Construction aggregate				
Crushed stone	[e]1,250.0	1,213.0	−3.0	1,216.0
Sand and gravel	923.4	[e]897.3	−2.8	924.0
Gypsum, crude, mined	16.4	17.6	7.3	[e]18.0
Cement, (portland, masonry, and other)[1]	76.9	77.2	0.4	[e]79.7
Asbestos (sales) thousand mt	18.0	17.0	−5.6	[e]20.0
	Product value			
	1988	1989		1990[p]
Construction aggregate				
Crushed stone	$5,558	[e]$5,326		$5,595
Sand and gravel	3,126	3,249		3,409
Gypsum, crude, mined	109	128		135
Cement, (portland, masonry, and other)[1]	[2]4,370	[2]4,355		[2]4,300
Asbestos, (sales), thousand mt	W	W		W

W Withheld to avoid disclosing company proprietary data.
[e]Estimated. [p] Preliminary.
[1]Includes imported cement shipped by domestic producers.
[2]Value received, f.o.b. mill, excluding cost of containers.

Source: Bureau of Mines, Minerals Yearbook, v. I, 1989, and Mineral Commodity Summaries, 1991.

Table 1-7. — U.S. apparent consumption[1] of selected construction materials, 1988–90

(Million short tons, except as noted)

	1988	1989	% Change	1990[P]
Construction aggregate				
Crushed stone	[e,2]1,250	[2]1,213	−3.0	[2]1,216
Sand and gravel	[2]922.8	[2]896.6	−2.8	[2]923.5
Gypsum, crude, mined	[3]26.7	[3]26.8	0.4	[e,3]26.8
Cement, (portland, masonry, and other)[4]	[5]93.3	[5]90.7	−2.8	[e,5]90.5
Asbestos, (sales), thousand mt	71.3	55.3	−22.4	[e]45.0

[e] Estimated. [P]Preliminary.
[1] Defined as production + (imports - exports) + (beginning inventories - ending inventories), except as noted.
[2] Defined as production + (imports - exports) + (changes in inventories were assumed to be zero).
[3] Defined as crude + byproduct + (imports - exports).
[4] Includes imported cement shipped by domestic producers.
[5] Defined as quantity shipped + (imports - exports). Adjusted to eliminate duplication of imported clinker and cement shipped by domestic cement manufacturers.

Source: Bureau of Mines. Mineral Commodity Summaries, 1991.

ment of Transportation national transportation policy report,[4] which projects a significant increase in infrastructure expenditures in the next 5 to 10 years,[5] Bureau of Mines analysts predict that 1995 demands for crushed stone, construction sand and gravel, and portland and masonry cement could reach levels considerably above those of 1990.

New regulations continued to impact the domestic asbestos industry. In July 1989, the Environmental Protection Agency (EPA) issued a final rule banning the manufacture, importation, processing, and distribution of most asbestos-containing products. The ban will be implemented in three stages between August 1990 and August 1996. Only products exempted from the ban can be bought and sold in the United States after August 1996. In August 1989, the Mine Safety and Health Administration proposed revisions to its existing standards for air quality and chemical substances at metal, nonmetal, and coal mines. One of the proposed changes is to lower the permissible level of exposure to asbestos from 2.0 fibers per cubic centimeter to 0.2 fibers per cubic centimeter.

Asbestos consumption would probably decline even if the phaseout were rescinded because of continuing public concern over environmental, health, and liability problems associated with this mineral. Because asbestos mining was not banned under the new EPA regulation, domestic producers should be able to continue to mine asbestos fiber for export. Foreign markets for domestic asbestos exports are expected to remain strong for several years due to the high demand in Southeast Asia and other developing countries for proven lower cost construction materials.

Fertilizer Minerals

Production and consumption of phosphate and sulfur have increased significantly since 1988 (tables 1-8 and 1-9), but were lower than expected because of effects from the 1988 drought and concern about the impact of chemicals on the quality of ground water. Planted acreage, which had been projected to increase by 25 to 30 million acres, increased only 12 million acres from 1988 to 1989, according to the U.S. Department of Agriculture. World demand and trade in sulfur declined in 1989, resulting in significant reductions in worldwide prices. U.S. Frasch[6] exports were at their lowest levels since the early 1930's. No overall decrease in world stock levels was recorded, in contrast to the annual inventory declines that marked most of the decade.

In 1990, apparent consumption of domestic nitrogen fertilizer decreased about 4%, and imports supplied about 18% of U.S. requirements. Potash consumption, which declined 15% between 1988 and 1989, increased about 16% from 1989 to 1990, with consumption recovering near its 1988 level of 5.3 million tons.

[4] U.S. Department of Transportation, Moving America—New Directions, New Opportunities, v. 1, July 1989 and v. 2, Feb. 1990.

[5] The portion of gross national product spent for public construction work has declined from about 3.6% in the 1960's to less than 2% in the 1980's.

[6] When sulfur is mined by the Frasch process, superheated water is forced into a sulfur deposit to melt the sulfur and the molten sulfur is then pumped to the surface.

Table 1-8. — U.S. production and product value of selected fertilizer minerals, 1988–90

(Million short tons and million dollars, except as noted)

	Production			
	1988	1989	% change	1990[e]
Nitrogen-ammonia, (contained nitrogen)	13.8	13.8	0.0	13.8
Phosphate rock, marketable, Mmt	45.4	49.8	9.7	46.0
Potash,[1] marketable, Mmt	1.5	1.6	6.7	1.6
Sulfur, Mmt	10.7	11.6	8.4	11.3
	Product Value			
	1988	1989		1990[e]
Nitrogen-ammonia, (contained nitrogen)	[2]$1,769.9	[2]$1,203.2		$1,863.0
Phosphate rock, marketable	[3]887.8	[3]1,084.0		1,058.0
Potash,[1] marketable	[4]240.3	[4]271.5		260.0
Sulfur	1,017.4	992.6		1,000.0

[e] Estimated.
[1] Includes muriate and sulfate of potash, potassium magnesium sulfate, glaserite, and some parent salts. Excludes other chemical compounds containing potassium.
[2] F.o.b. Gulf Coast.
[3] The total value is based on a weighted value.
[4] Value of sales by producers f.o.b. mine.

Source: Bureau of Mines, Minerals Yearbook, v. I, 1989, and Mineral Commodity Summaries, 1991.

Table 1-9 .— U.S. apparent consumption[1] of selected fertilizer minerals, 1988–90

(Million short tons, except as noted)

	1988	1989	% change	1990[e]
Nitrogen-ammonia, (contained nitrogen)	16.3	16.7	2.5	16.0
Phosphate rock, marketable, Mmt	[2]41.0	[2]42.1	2.7	[2]43.5
Potash,[3] marketable, Mmt	5.3	4.5	–15.1	5.2
Sulfur, Mmt	12.7	12.7	0.0	[4]12.8

[e] Estimated.
[1] Defined as production + (imports - exports) + (beginning inventories - ending inventories), except as noted.
[2] Defined as (sold or used by producers) + (imports - exports).
[3] Includes muriate and sulfate of potash, potassium magnesium sulfate, glaserite, and some parent salts.

Source: Bureau of Mines, Minerals Yearbook, v. I, 1989, and Mineral Commodity Summaries, 1991.

PLASTICS AND ADVANCED MATERIALS INDUSTRY

Consumption of plastics and advanced materials, including advanced polymer composites, advanced metals, and advanced ceramics, has grown rapidly during the last decade and presently accounts for about 10% of the total value of the nonfood, nonfuel material consumed in the United

States. Because of their greater strength-to-density ratio, greater hardness, or superior thermal, electrical, optical or chemical properties, advanced materials have been able to displace conventional materials (metals, paper, and glass) in a growing number of specific applications. Their high-performance characteristics have proven especially desirable in defense applications. Composites and advanced ceramics are now used in fighter aircraft, weapons programs, and logistical systems. Optical fibers and silicon chips have led to advances in telecommunications and computerization (table 1-10).

Plastics

Plastics have made the strongest competitive advances of all materials against metals in many end-use markets. This trend can be expected to continue. It is estimated that at least one-fourth of all plastics produced domestically now competes directly with nonfuel mineral materials. Plastics consumption is growing most rapidly in construction and transportation, markets where it is displacing metals.

Table 1-10. — Actual and estimated U.S. consumption of specialty or high performance polymer matrix composites, by industry
(Thousand metric tons)

	1985	1990	1995
Aerospace	2.9	5.0	9.1
Automotive	(1)	3.3	6.5
Other	2.1	6.7	10.4
Total	5.0	15.0	26.0

1 Included in "Other."

Source: Bureau of Mines, The New Materials Society: Challenges and Opportunities, 1990.

Advanced Polymer Composites

Advanced polymer[7] composites consist of fiber and matrix combinations which yield superior strength, toughness and thermal properties. Typically, they contain a large percentage of high performance continuous fibers. According to the Office of Technology Assessment, less than 2% of the material presently produced by the reinforced plastic-composites industry is considered "advanced."

Advanced polymer composites have only been in use for about 15 years, primarily in the aerospace industry. Between 1985 and 1990, the industry's consumption of advanced polymer composites almost doubled and is expected to almost double again between 1990 and 1995 (table 1-11). In 1989, this industry filled its first orders for the Beech Starship, a twin turboprop commercial aircraft 70% of which consists of fiber-reinforced thermoset polymers, including the airframe and skin.

Advanced polymer composites are also finding uses in the structural design of automobiles because the weight reduction from their use results in fuel savings. In 1989, the Ford Motor Company began testing a prototype of its Taurus model constructed from glass-fiber-reinforced plastic structural components. Bureau of Mines specialists estimate that by 1995 the automotive industry will consume about one-fourth of all advanced polymer composites.

Advanced Metals

Advanced metals which exhibit specific high performance characteristics include superalloys that retain their strength at high temperatures, aluminum-lithium alloys, titanium alloys, intermetallic alloys,[8] and metal-matrix composites (MMC).[9] In 1990, the United States consumed more than $1.5 billion worth of superalloys, titanium alloys, and MMC (table 1-11), the equivalent of about one-half the value of U.S. gold production and more than four times the value of U.S. silver production in 1989. Consumption of aluminum-lithium alloys, intermetallic alloys, and MMC is expected to continue to grow at rates as high as 25% to 35% annually during the 1990's, according to Bureau of Mines specialists.

Aluminum-lithium alloys are among the most promising of the advanced metals. Lithium, less than one-fifth as dense as aluminum, reduces the weight of aluminum alloys, increases stiffness, offers better corrosion resistance, and

Table 1-11. — Actual and estimated values of advanced metals consumed in the United States
(Million dollars)

	1985	1990	1995	2000
Aluminum-lithium alloys1	small	small	550	880
Superalloys	350	600	1,000	1,500
Titanium alloys1	650	720	870	850
Intermetallic alloys	small	small	100	350
Metal-matrix composites	small	220	750	2,000

1 Unreinforced alloys only. Reinforced alloys are included in metal-matrix composites. Typically, three-fourths of the titanium alloys consumed annually in the U.S. go to the aerospace industry. Consumption for aerospace applications is expected to peak in the mid-1990's as composites and intermetallics begin to displace the unreinforced alloys.

Source: Bureau of Mines, The New Materials Society: Challenges and Opportunities, 1990.

7 The term polymer refers to molecules composed of many units and joined by chemical covalent bonds, in many cases in a repeating manner. The large molecular chains commonly link atoms or carbon, hydrogen, and oxygen, but also may contain silicon, nitrogen, and fluorine. Polymers can be plastic, elastomers, liquids, or gums.

8 These alloys have potential for superior performance at very high temperatures. They are familiar as dispersed phase hardeners in certain modern alloys such as maraging steels and the nickel-base superalloys. The major use for intermetallics is expected to be as components and coatings in the turbojet engine. They are also being developed and tested for use in electrical circuit breakers and other temperature-sensitive control and metering devices.

9 MMC's are materials made up on a strengthening phase (the reinforcement) and a matrix (the metal). The reinforcement carries the major stresses and loads, while the matrix holds the reinforcements together, thus permitting stresses and loads to be transferred to the reinforcement.

permits strength retention at higher temperatures than other aluminum alloying elements. Bureau of Mines specialists estimate that by 1995, the aircraft industry could be consuming 25,000 mt of aluminum-lithium alloys annually, and 40,000 mt by the year 2000.

The estimated $200 million value of MMC consumed in 1990 is expected to grow to about $750 million by 1995, and could reach $2 billion by the year 2000. High costs and performance limitations, however, continue to hamper widespread application of these materials. MMC's currently range in cost from $10 per pound for those that are aluminum-reinforced to $200 per pound for selected fiber-reinforced varieties.

Advanced Ceramics[10]

In 1990, electronic applications are expected to account for 90% of the advanced ceramics market, with structural applications, which include automotive, aerospace, and cutting tool uses, accounting for the remaining 10% (table 1-12). Sales are estimated at between $2.5 and $6 billion in 1990, $7 and $11 billion in 1995, and $5.9 and $20 billion in 2000, according to Bureau of Mines analysts.

Research into ceramic high-temperature superconductors is underway in the United States, Japan, and Europe. The first successful applications are expected to be in electronics and sensors, with marketable products expected by 1995. Large-scale applications will require much longer development times. The widespread use of structural ceramics for their high strength and corrosion resistance qualities is somewhat constrained by susceptibility to failure because of their brittle nature.

Table 1-12. — Forecast of U.S. advanced ceramics markets in 1990,1995, and 2000
(Millions of current dollars)

	1990	1995	2000
Electronics	3,740	6,565	11,360
Structural:[1]			
Aerospace and defense-related	80	200	440
Automotive	80	310	820
Bioceramics[2]	15	0	60
Cutting tools	90	245	500
Heat exchangers	15	50	100
Wear parts and other industrial	150	320	720
Total	430	1,155	2,640
Grand total	4,170	7,720	14,000

[1] Includes ceramic composites.
[2] Medical uses.

Source: Abraham, T., Business Communications Co., Norwalk, CT.

CHAPTER 2. — SIGNIFICANT ISSUES FACING THE MINERALS INDUSTRY IN 1990

Although the domestic nonfuel minerals industry generally continues to recover from the downturn it experienced during the earlier part of the past decade, there are a number of significant issues which will influence its future performance. The issues discussed below are broadly related to access to minerals on public lands, costs of regulatory compliance, and regulatory barriers to the recycling of metal products.

ACCESS TO MINERALS ON PUBLIC LANDS

Efforts to protect lands perceived to have special wilderness, recreational, or other natural values, can result in proposed legislation that would restrict or deny access to Federal lands for mineral exploration and development purposes. By the end of 1989, nearly 33 million acres of the U.S. National Forest System lands had been officially designated as wilderness by Congress and are, as a result, closed to future mining activity. Forest Service wilderness bills affecting lands in Idaho, Montana, and Nevada remained on the congressional agenda at the end of the year. Alaska, which has high mineral potential and low exploration activity, continues to be the focus of a significant number of legislative land-use proposals, which would affect access to minerals. Twenty-three areas in the Tongass National Forest, Alaska, alone were considered for wilderness designation in 1989. By the end of the year,,six of these areas, totaling 296,000 acres, had been withdrawn from mineral entry. Congressional bills were also introduced to designate as wilderness certain lands managed by the Bureau of Land Management (BLM) in the California Desert, Arizona, and Utah.

Access to land is critical to mineral exploration and development. Because lands having wilderness designations are closed to future mineral and other development activities, the economic and other benefits, which may result from these activities are foregone. On some lands, the potential benefits from mineral activity may be sufficiently large to offset any adverse impacts that mining might have on other competing uses for the land, such as wilderness or recreation, after full efforts have been made to protect these values.[11]

[10] Advanced ceramics are inorganic nonmetallic solids made from extremely pure starting materials to create a material with high-performance characteristics.

[11] Of particular note, the Red Dog Mine in northwest Alaska is located on land originally designated for withdrawal. This mine is presently generating about $100 million in revenues per year, employs approximately 200 people, and has an expected life of 50 years.

The Department has begun, on a case-by-case basis, to prepare quantitative estimates of the mining-related economic impacts of proposed withdrawals.

The recent congressional debate regarding alternative legislative proposals to designate additional acreage within the California Desert Conservation Area (CDCA) as wilderness provides an example of the contribution that such analyses can make. The CDCA was established in 1976. At that time, approximately one-half of its 25 million acres was closed to mineral exploration and development. Several proposals were placed before the 101st Congress to limit access to minerals on an additional 2 million to 8.4 million acres of the CDCA by redesignating them as national parks or wilderness areas. Some of the areas which were targeted for redesignation by these proposals are known to be highly mineralized, and mining activities thereon currently provide jobs and income for residents of local communities. Moreover, geologic evidence suggests that these same lands are favorable for the existence of as yet undiscovered mineral deposits which if found could provide additional future employment and income opportunities.

For example, San Bernardino County, California, is almost entirely within the CDCA. Some of its rural communities rely heavily on the economic opportunities provided by mining activity. Because of the importance of land access for mining to San Bernardino's rural economy, the Bureau of Mines estimated the economic losses to the county, which could result if certain changes in land access were mandated. The analysis focused on highly mineralized land[12] in the rural northeast quadrant of the county, the East Mojave National Scenic Area (EMNSA).[13] One of the proposals, called the "Park option," would have redesignated the EMNSA as the Mojave National Park. Another proposal, called the "wilderness areas" (W.A.) would have established six wilderness areas within the EMNSA;[14] the remainder of the EMNSA would continue under BLM management for multiple use. Both proposals would preclude new mining activity in the targeted areas.

Table 2.1 shows that the potential economic impacts for San Bernardino County from the Park option would be an order of magnitude greater than those which would result from the W.A. option. Under the Park option, annual average employment losses to San Bernardino County over a 20-year period were estimated at 1,443 jobs, with total cumulative losses of $624 million in personal earnings and cumulative lost income tax payments to the State of $24.5 million. By comparison, under the W.A. option, the average annual employment losses over a 20-year period were estimated to be 214 jobs and $58.0 million in total cumulative losses in earnings.

[12] Identified mineral resources within the study area include gold, lead, molybdenum, silver, and zinc as well as numerous other metals and nonmetals. These resources are estimated to have an in-place value of several billion dollars in 1990 dollars. Mining activity in the area dates back to 1870 and the cumulative value of minerals produced to date is estimated to be approximately $240 million.

[13] Minerals in the East Mojave National Scenic Area, California, v. 1 and 2, MLA 6–90.

[14] The W.A. proposal closely resembles the Administration's CDCA wilderness recommendations.

Table 2-1 .— Summary of the lost economic benefits due to foregone mining activity over a 20-year period in San Bernardino County under recently proposed land restrictions

(Million 1990 dollars, except as noted)

	Park option	W.A. option
Cumulative mine revenues	$1,968.0	$144.0
Cumulative personal earnings, direct and indirect, including mine services	$ 624.0	$ 58.0
Average annual employment (number)	1,443	214
Taxes and fees paid by the mines:		
Cumulative Federal income tax payments	$ 90.3	$ 3.2
Cumulative State income tax payments	24.5	.8
Annual property tax payments	2.3	.2
Cumulative sales tax payments during construction	13.1	.5
Annual sales tax payments during production	2.0	.3
Construction permit fees	18.0	1.3

Source: Bureau of Mines.

These estimates are conservative. The full impact of each option could be greater for several reasons. First, the estimates take into account only the active mines, developed sites, and known but presently undeveloped deposits which economic feasibility studies indicate could be profitably developed at or near current economic conditions. The estimates do not take into account the development potential of known but currently uneconomic deposits. Secondly, this analysis is applicable to only a part of the total acreage that would be newly withdrawn from mining in the CDCA by each of the proposals. San Bernardino County is only one of the potentially affected counties whose rural communities rely on mining. Finally, the estimated impacts would be significantly greater if the potential value of the area's undiscovered resources were taken into account. Geologic evidence suggests that these potential values may be considerable.

Quantitative methods for estimating the potential mineral supply from undiscovered resources which have been developed by the Bureau of Mines and the U.S. Geological Survey are in the process of being applied to the CDCA and other proposed "special management" areas. Because of the importance of continued access to mineralized lands by the mineral industry, the Department will continue to prepare mineral impact analyses on a case-by-case basis for Federal lands which are known or believed to be highly mineralized, and which are, or could become, the focus of congressional proposals to limit their accessibility for mineral activities.

DEVELOPMENT OF A REGULATORY PROGRAM FOR MINE WASTE

A regulatory program to control and manage mineral industry wastes is now being developed by the EPA under the provisions of RCRA. New mine and mineral-processing waste regulations implemented under such a program could add significantly to the environmental compliance costs of major sectors of the domestic minerals industry, including copper, gold, lead, silver, titanium, and zinc.

Regulatory compliance costs affect the competitiveness of the domestic minerals industry in two ways. First, because prices for many minerals are determined in international markets, costs associated with domestic regulations cannot be passed on to consumers. Thus, compliance costs incurred by a domestic industry, but not by its foreign competitors, reduce the competitive position of the U.S. industry by increasing production costs relative to the world price. Secondly, required compliance expenditures reduce capital funds available for investment in new technology and research and development that can reduce future production costs and make the domestic industry more competitive.

Each stage of mining and mineral processing generates solid wastes, some of which results in damage to the environment or can be harmful to human health. The objective of the regulatory program being considered by the EPA is to provide protection against environmental impacts resulting from such waste generation, taking into account their site characteristics (e.g., volumetric, constituent concentrations, toxicologic, carcinogenic) and their regional characteristics (e.g., geologic, climatologic, topographic, hydrologic) where possible. Two important aspects of the regulatory process and major determinants of regulatory compliance costs are: (1) the differentiation of mining waste from other mining materials, such as low-grade rock that will be subject to leaching; and (2) the characterization and designation of those mining and mineral processing wastes that are hazardous and those that are nonhazardous. Wastes that are listed or characterized as hazardous by the EPA must be regulated largely at the Federal level under RCRA Subtitle C—Hazardous Waste Management. Wastes that are found to be nonhazardous, on the other hand, will be regulated under Subtitle D—State or Regional Solid Waste Plans. Mine waste regulations developed under this subtitle can be less stringent and more tailored to local and regional considerations, and may, therefore, have lower compliance costs than regulations developed under Subtitle C.

The EPA has determined that most types of wastes from the extraction, estimation, beneficiation, and processing of ores and minerals are to be treated as nonhazardous wastes.

EPA's Strawman II Proposal

In May 1990, the EPA released its "Recommendations For a Regulatory Program For Mining Waste and Materials Under Subtitle D of the Resource Conservation and Recovery Act," commonly known as Strawman II. This document discusses many of the technical, operational, and organizational issues which EPA believes must be addressed in order to develop and implement an effective State-based program to manage nonhazardous mining and beneficiation wastes. It also proposes language for regulations to implement such a program for wastes and other materials uniquely associated with noncoal mining.

In order to gauge the potential cost impact of Strawman II on a major sector of the domestic minerals industry, Bureau of Mines analysts estimated the potential compliance costs for 10 copper mining operations, representing various production rates, production and beneficiation methods, management practices, and amount and type of waste products. The analysis included wastes from the extraction and beneficiation of copper-bearing ores as well as any mineral-processing wastes which did not exhibit hazardous characteristics and were disposed of by admixture with the mining and beneficiation wastes. Because of uncertainty regarding the stringency of regulations pertaining to permitting, site security, run-on/run-off control, closure, postclosure maintenance, and other activities related to mine waste management which might be implemented by each State, four levels of regulation were considered.

The estimated economic costs for the 10 copper mining operations to comply with each of the 4 regulatory scenarios were calculated using engineering cost functions and range from $157 million under the least stringent scenario to $4.5 billion under the most stringent regulatory scenario, which approaches a Subtitle C program.

Based on extensive comments received by many reviewers on Strawman II, in May 1991, EPA chartered a Policy Dialogue Committee on Mining, under the Federal Advisory Committee Act. The purpose of this Committee is to further facilitate the exchange of information and ideas among the interested parties, refine and further develop issues related to noncoal mining, and identify any areas of agreement and consensus. Some of the specific areas this group is examining include what role the Agency should have in States with approved State plans; whether national technical standards are needed; how to implement a national program without adversely affecting ongoing State programs; and finally, how to develop the program so that it enhances the programs currently administered by the Federal land managers. Members of the mining industry, States, environmental groups, and other Federal agencies serve as representatives on this Committee.

Based on information from the Policy Dialogue Committee, other EPA activities, and the current State agendas and plans, EPA will develop a program for mining wastes under Subtitle D of RCRA. Throughout this process, the technical capabilities of the Department of the Interior will remain available to the EPA to provide assistance in the development of a program that protects human health and the environment as well as our Nation's ability to produce needed minerals.

PROPOSED REGULATION OF CERTAIN NONASBESTIFORM MINERALS AS ASBESTOS

On June 20, 1986, the Occupational Safety and Health Administration (OSHA) published a final rule titled "Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite; Final Rules." The regulation established equal exposure limits for asbestos and the nonasbestiform varieties of the amphibole minerals actinolite, tremolite, and anthophyllite (AT&A), even though, as acknowledged by OSHA, exposure to the nonasbestiform AT&A minerals does not represent as great a health risk as does exposure to asbestos. The 1986 OSHA regulation has been administratively stayed in order to allow OSHA more time to conduct supplemental rulemaking to determine whether and to what extent nonasbestiform AT&A should be regulated.

According to the Bureau of Mines analysis, the economic impact of the OSHA regulation is expected to be greatest on the aggregates industry. An estimated 1,325 crushed stone quarries would need preliminary deposit evaluation and deposit sampling of some kind. This represents 27% of total U.S. crushed stone quarries. Detailed testing would be required at 780 quarries (16% of total crushed stone quarries) because the concentration level of AT&A is expected to approximate the level specified in the regulation. Total sampling and analysis costs were estimated to be $173 million for the crushed stone industry. In addition, the talc industry could lose up to $12 million in sales over a period of several years as consumers substitute AT&A-free products for talc.

The estimated costs do not include the costs associated with product liability and changes in company insurance, changes in production methods and production rates, purchase of safety equipment, employee training, or bankruptcy. These additional costs could exceed those estimated for sampling and analysis.

The Bureau of Mines recommended that AT&A should not be regulated as asbestos unless medical data clearly indicate that these minerals present a significant health risk, which would be reduced through regulation.

HAZARDOUS WASTE REGULATIONS AND RECYCLING

Current hazardous waste regulations promulgated under RCRA have, in some cases, produced unintended environmental and economic consequences and have discouraged the recycling of specific mineral products. This is in conflict with the Environmental Protection Agency objectives which endorse recycling as an important element of its environmental program. Spent aluminum potliner and spent lead-acid batteries are two examples of waste products, which presently are experiencing recycling difficulties because of such regulations. By viewing their recycling processes as environmentally threatening rather than environmentally beneficial, RCRA regulations have discouraged their reuse even in applications which have been shown to be environmentally safe.

Over and above the loss in environmental value from such regulations, there is a loss in economic value of two types. One is the value of the metals which can be reclaimed from the spent product and the second is the value provided by eliminating the storage costs associated with improper or unnecessary disposal.

Spent Aluminum Potliners

The process of reducing alumina to primary aluminum metal occurs in large, flat-bottomed steel pots, which are lined with carbon. The carbon potliners must be replaced after 3 to 7 years on average because of degradation. A spent potliner typically contains 60 tons of a heterogeneous mixture of carbon, aluminum, sodium, fluoride, silicon, calcium, and trace amounts of cyanide and iron.

In early 1988, about 22% of the 2,400,000 short tons of spent potliner generated that year was being reused by the cement, mineral wool, and steel industries to recover the fluoride and to burn as a source of energy; 17% was being stored in anticipation of potential use; and the remaining 61% was disposed of in landfills. In September 1988, the EPA listed spent potliners as a hazardous waste on the grounds that they contained trace amounts of cyanide that could present a significant threat to the environment and human health if managed improperly.

Since then the reuse of spent potliner has effectively been foreclosed, even in those uses when the trace cyanide would be destroyed in the process and the hazard significantly reduced (e.g., the extraction of fluoride in the production of mineral wool). Instead of selling at least some of its spent potliners for reuse, the aluminum industry must now place them in on-site storage or in hazardous waste landfills, incurring thereby the added costs associated with these activities. Moreover, under current RCRA regulations, spent potliners will also become subject to land disposal restrictions, which will require them to be treated before being disposed. Compliance with these regulations will entail additional handling costs for a product known to have some alternative environmentally safe uses. Ironically, treatment could involve processes similar to those used in recycling the material such as treatment by burning it in hazardous waste furnaces.

Spent Lead-Acid Batteries

The recycling of spent lead-acid batteries has been affected by current Federal regulations as well. Each lead-acid battery contains approximately 18 pounds of reclaimable lead and approximately 1 gallon of highly corrosive, lead-contaminated, sulfuric acid. In 1985, lead-acid batteries were classified as hazardous waste because of their acid constituent and became subject to regulation at secondary lead smelters. As a result, secondary smelters are now required to have RCRA permits, to implement strict operational and monitoring systems, to install ground water monitoring systems, and to develop contingency plans.

From 1977 to 1990, the number of domestic secondary lead smelters has been reduced by about one-half to 50 plants because of cost pressures, uncertainties, and disappointing prices. High lead prices over the past few years, however, have resulted in significant capacity expansions for most of the remaining secondary lead plants and helped to boost the recycling of spent batteries from about 57% in 1986 to 95% in 1990. However, such high recycling rates may be difficult to sustain in future periods of low market prices because current regulations pertaining to the storage, handling, transportation, and treatment of scrap batteries have increased the cost of recycling. Additionally, many scrap dealers, concerned that they would be held liable for damages stemming from an association with a facility that ultimately may become a hazardous waste site, have stopped accepting spent batteries. To ensure needed supplies, some smelters and major battery companies have established collection and haulback systems for spent batteries.

Despite recent increases in recycling rates, batteries continue to end up in landfills and municipal incinerators because it is not economic for some consumers to try to recycle the lead contained in batteries and these batteries, therefore, are thrown away. Some consumers are unaware that the spent battery has economic value, or that its disposal may degrade the environment. To deal with problems associated with the disposal of batteries in landfill and municipal incinerators, 26 States have adopted mandatory battery recycling requirements, and several others have such legislation under consideration.

To promote the Nation's environmental objectives, regulations that may pose a barrier to the environmentally safe recycling of mineral products with economic value, such as aluminum potliners and spent lead-acid batteries, should be reviewed and revised when they do not result in any net benefits to society. As an alternative approach to the adoption of mandatory recycling requirements, or mandatory disposal in hazardous waste landfills, economic incentive systems that are specifically devised to promote the safe reuse and recycling of spent mineral products should be considered as a more efficient means of achieving both environmental and economic goals.

IMPLEMENTATION OF THE BASEL CONVENTION

In early 1990, the President announced that the United States would become a signatory to the Basel Convention, a multinational agreement regulating the transboundary movement of hazardous wastes which has become a major environmental issue. The Basel Convention was negotiated under the auspices of the United Nations Environment Programme during an 18-month period and completed at Basel, Switzerland, on March 22, 1989. Fifty-three countries, including the United States, have signed the agreement. To implement the agreement within the United States, it must be ratified by the Senate, and legislation authorizing the Environmental Protection Agency to fulfill U.S. obligations must be enacted. Draft legislation for this purpose has been developed by the EPA.

The primary objective of the Basel Convention is to prevent the dumping of hazardous wastes in developing nations where inadequate provisions may currently exist for their safe disposal. The Convention prohibits the export of hazardous waste except where it is assured that the wastes will be managed in an environmentally sound manner by the receiving country. Safeguards required by the Convention include notification to and written consent from receiving countries prior to the export of any controlled waste. Current U.S. regulations require similar notice and consent from countries into which hazardous wastes are being exported, but do not provide the authority to stop shipments that pose unacceptable environmental risks. Signatories to the Basel Convention agree to prohibit the export of hazardous wastes when they have reason to believe that the wastes will not be managed in an environmentally sound manner.

There are concerns that strict implementation of the Convention can have significant effects on industries, which now recycle wastes such as metal scrap and metal waste products. For example, a directive recently adopted by the European Community (EC) Council of Ministers sets forth a definition of "hazardous waste" under which, it appears, all recyclable metals will be considered hazardous waste by the EC member nations subject to this directive, and will, as a result, be subject to the prenotification and consent requirements of the Basel Convention.

Even in the United States, some materials that now are exempt from regulation as hazardous wastes under RCRA may become subject to restrictions depending on the outcome of multinational negotiations. For example, several categories of recyclable metals have been exempted from RCRA regulations that require notification of intent to export, in order to encourage, or at least not to discourage, recycling. These categories are scrap metal, lead-acid storage batteries, and hazardous wastes containing economically recoverable amounts of precious metals such as gold, silver, and PGM.

Legislation has been drafted by EPA to provide the authority to enforce U.S. Basel Convention obligations. Proposed language does include an exemption for scrap metal. In 1989, the United States had a favorable trade balance in scrap metal of $2.7 billion, with exports valued at $3.7 billion and imports at $1.0 billion. Approximately 96% of those exports and 91% of the imports involved precious metals, iron and steel, copper, and aluminum. In addition to scrap metal, the United States exports precious-metal waste and lead-acid batteries, which are recycled in the importing countries.

The Department supports timely ratification of the Convention and will remain actively involved in negotiations concerning the implementation of the Convention with other countries. The continued participation by the Department in these negotiations is essential in order to assure that the agreements reached discourage the dumping of hazardous wastes as well as promote U.S. goals of encouraging recycling and a competitive market for metals industry recyclable materials.

TAKE PRIDE IN AMERICA

As the Nation's principal conservation agency, the Deparment of the Interior has responsibility for most of our nationally-owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.

U.S. DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

1990 SECRETARY'S ANNUAL REPORT 1990