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Trends in Consumption and Production: Selected Minerals

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Abstract

Global production of aluminium and copper has steadily increased over recent decades, while lead production has been fairly stable. Recycling has also been increasing, reducing the growth rate of primary production of aluminium and copper, and reducing primary production of lead. Despite depletion of the richest ores and a shift to less concentrated ores, advances in mining technologies have lead to generally declining, though fluctuating, metal prices. Supplies of these metals are sustainable for the foreseeable future. Sustainable development issues relate rather to energy consumption, revenue reductions for exporting countries, and health and environmental impacts.

Introduction

The work programme of the Commission on Sustainable Development on changing consumption and production patterns, as adopted by the Commission in 1995 (E/1995/32 - E/CN.17/1995/36), includes the element, "identifying the policy implications of projected trends in consumption and consumption patterns." As part of that element, the Secretariat has been analyzing trends relating to sustainable development as a basis for identifying the policy implications of those trends.

In 1997, as part of the five-year review of progress since the United Nations Conference on Environment and Development (Earth Summit), a report on "Critical Trends: Global Change and Sustainable Development" was prepared examining long-term historical trends and future projections in such areas as population, energy and material consumption, agriculture and food supply, water and human development (ST/ESA/255). That review provided a basis for the policy recommendations presented to the Commission on Sustainable Development and the nineteenth Special Session of the General Assembly. A second broad analysis of critical trends is to be prepared for the 2002 ten-year review of progress since the Earth Summit.

For the period 1998-2002, the General Assembly, at its nineteenth Special Session, adopted a work programme with specific themes identified for each year. For the years 1999-2001, a series of reports and papers are planned analyzing trends in selected areas relating to the work programme elements for that year. For 1999, one of the Commission's themes is consumption and production patterns, and the trends analyzed in the present paper and papers on trends in household energy consumption and private transportation are related to that theme. Future reports on trends will examine land resources and agriculture (2000) and energy and transport (2001). These analyses will contribute to the broad review of trends for 2002.

Production and consumption of raw materials is a critical area of sustainable development. The present paper examines trends in production, consumption and recycling of a number of selected mineral resources. Selected renewable resources will be considered in 2000 under the theme of land resources and agriculture. The selection of aluminium, copper and lead for analysis in the present report should not be taken as an indication that those metals are considered particularly critical for sustainable development, but rather as mineral resources of major economic importance that illustrate the sustainable element issues that apply to non-renewable resources in general. Production and consumption of these and other minerals are important not only with respect to the sustainability of nature resource use, but also with respect to energy consumption, waste generation, land degradation and public health.

As the present paper is a first step toward a more comprehensive review of trends to be prepared for 2002, the Division for Sustainable Development welcomes comments on the data and analyses presented here and contributions toward the reviews planned for future years.

Aluminium

Production and recycling

Production of both primary and recycled aluminium has increased substantially over the last two decades (Fig. 1). Primary aluminium production from bauxite grew from less than 13 million metric tons in 1976 to almost 22 million metric tons in 1997. Secondary aluminium production in the world reached more than 7.3 million metric tons in 1997 compared to under 2.8 million metric tons in 1976.[1, 2,3] For most countries, there are no data to distinguish between production of secondary aluminium from post-consumer scrap (discarded aluminium products) and new (manufacturing) scrap. Such data exist for the United States, which accounts for almost 50 per cent of total world secondary production. In 1997 in the

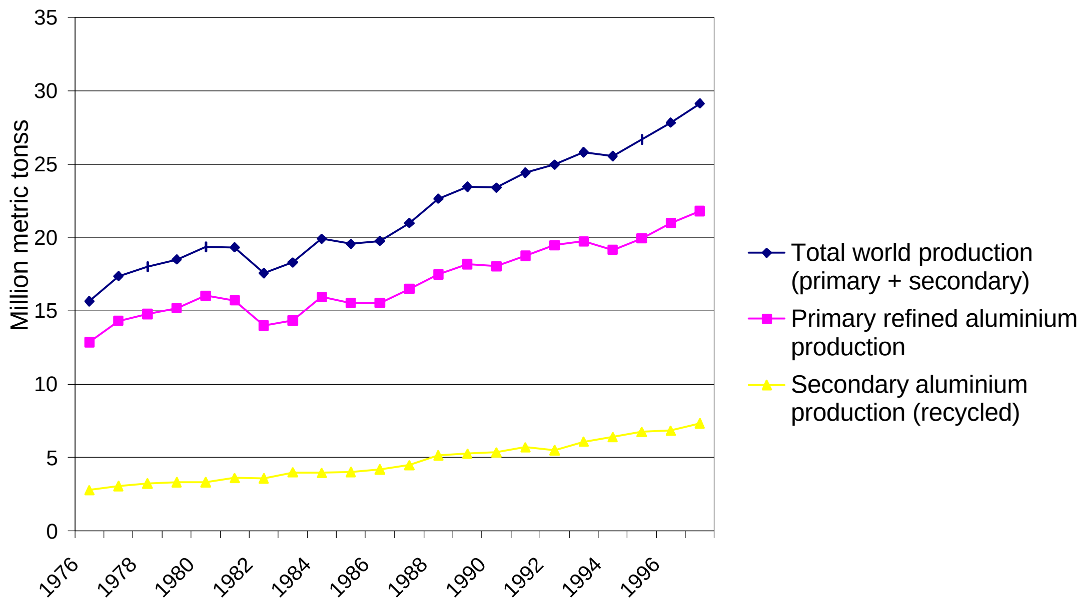

Fig. 1. Aluminium Production and Recycling
Source: *World Metal Statistics*

United States, 59 per cent of the secondary aluminium was recovered from new scrap and 41 per cent from post-consumer scrap.

The proportion of secondary aluminium production in global aluminium production grew from less than 18 per cent in 1976 to more than 25 per cent in 1997 (Fig. 2).[1] In absolute terms, recycling of aluminium was more than 2.5 times higher in 1997 than two decades ago. Six countries (United States, Japan, Italy, Germany, United Kingdom, and France) account for approximately 85 per cent of the world secondary aluminium production.

Approximately one-half of the post-consumer aluminium scrap recycled in the United States comes from used beverage cans (UBC). The majority of it is reprocessed into aluminium sheet from which new aluminium cans are produced. The recycling rate of aluminium beverage cans is above 60 per cent, and their post-consumer recycled content averages more than 50 per cent, a higher percentage than any other packaging material. The latest data show that the trend toward increasing recycling of UBC's continues. The recycling rate of aluminium cans has reached more than 70 per cent in Japan and over 66 per cent in the United States in 1997, and 31 per cent in the United Kingdom in 1996.[3] Other types of old scrap are recovered in the form of alloys used for diecasts, particularly in the automotive industry.[4]

The economic incentives for recycling aluminium are currently more important than environmental considerations. The energy savings in the production of aluminium from scrap can reach as much as 90 per cent in comparison with primary production. Furthermore, the capital cost of a recycling plant is about one tenth of the cost of a smelter complex. [5,6]

Reserves and resources

Primary aluminium is produced from alumina (aluminium oxide). On a commercial basis almost all alumina is currently produced from bauxite. Reserves of bauxite are estimated at 23 billion metric tons, and reserve base at 28 billion metric tons. Estimates of

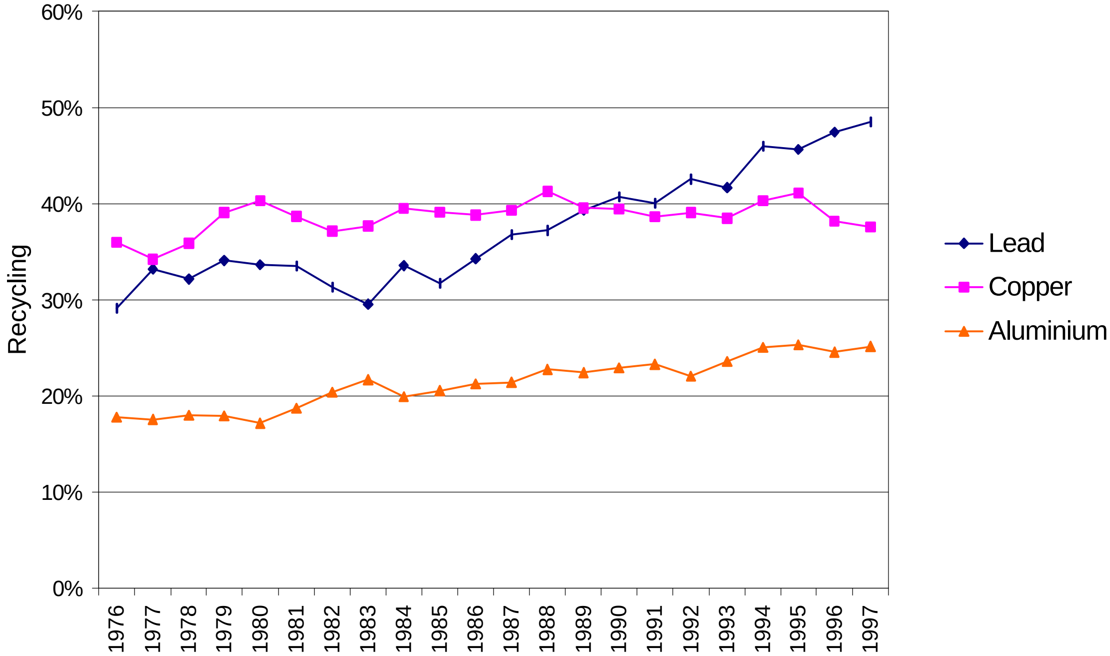

Fig. 2. Secondary Production (Recycling) of Selected Non-Ferrous Metals as Percentage of Total Production
Source: *World Metal Statistics*
Note: For copper, recycling is shown as percentage of world refined production

bauxite resources are between 55 and 75 billion metric tons.∗ Current annual world mine production of bauxite is approximately 115 million metric tons. The issue of depletion of resources for primary aluminium is even less acute than for other metals. Even with bauxite consumption rising at a current rate of about 2.5 million metric tons per year, its reserves will last for about 100 years and estimated resources between 170 and 200 years. It is also plausible to make an assumption, based on historical trends, that new discoveries will lead to increases in the estimates for the reserves and resources of bauxite, as well as other metal ores. Aluminium is one of the most abundant elements in the earth's crust (about 8 per cent by weight compared to 5 per cent for iron and only 70 parts per million (ppm) for copper and 16 ppm for lead, and its resources in minerals other than bauxite are practically inexhaustible. Commercial use of these resources is likely to become feasible as reserves of bauxite are eventually depleted.[7, 8, 9]

Major uses and possible substitutes

Major uses of aluminium are in the transportation industry, container and packaging industries, building

∗ The terms resources, reserve base and reserves are used as defined in Mineral Commodity Summaries[7]. Resource - a concentration of naturally occurring material in the earth's crust in such form and amount that economic extraction of a commodity from the concentration is currently or potentially feasible. Reserve base - part of an identified resource that meets specified minimum criteria related to current mining and production practices. It may encompass those parts of the resources that have a reasonable potential for becoming economically available within planning horizons beyond those that assume proven technology and current economics. Reserves - part of the reserve base which could be economically extracted or produced at the time of determination.

and construction, and electrical and consumer durables. For example, in the United States in 1997, about 29 per cent of aluminium was used in transportation, 22 per cent in containers and packaging, 13 per cent in building and construction, 7 per cent each in electrical industry and consumer durables, 6 per cent in machinery and equipment, and the rest in other markets and exported.[3] It should be noted that proportions of particular uses of aluminium vary significantly among countries. A number of materials can serve as substitutes for aluminium in various applications. In electrical applications aluminium can be replaced by copper. Magnesium and titanium alloys and steel can substitute for aluminium in structural and transportation uses. In construction composites, wood and steel can replace it. Glass, plastics, paper and steel can be its substitutes in packaging.[6, 7]

Price trends

Since 1970, the real price of aluminium, as of almost all other metals, exhibited a downward trend indicating that there is presently very little concern over possible depletion of aluminium resources (Fig. 3).[3, 9] Price fluctuations over the years and often from month to month have been significant. Such cycles often threaten sustainability of development in the areas where alumina and aluminium are produced and where bauxite is mined. This is particularly true for developing countries, where bauxite and/or alumina are major export items and sources of hard currency, e.g. Guinea and Jamaica. In 1995, exports of bauxite and alumina generated more than 56 per cent of the total export revenues for Guinea. For Jamaica, export of bauxite, alumina and concentrate of aluminium represented more than 44 per cent of its total exports.[10, 11]

Major ore producers

Top ten bauxite producing countries are listed in Table 1 (1996 data).[1] The combined output of these countries represents more than 90 per cent of world bauxite production.

Table 1. Share of major bauxite producing countries in world bauxite production.

Australia	35.1%
Guinea	15.0%
Jamaica	9.6%
Brazil	9.0%
China	7.3%
India	4.7%
Venezuela	4.6%
Russia	3.1%
Surinam	3.0%
Guyana	2.0%

Source: *World Metal Statistics*

Environmental and health effects

Aluminium is released to the environment both by natural processes and from anthropogenic sources. Aluminium is the third most abundant element in the earth's crust, therefore contributions from natural processes are much larger. More than 90 per cent of the daily intake of aluminium by humans come from food and beverages. Aluminium has not been shown to pose a risk to healthy, non-occupationally exposed humans. Also, there is no evidence that it is carcinogenic or has adverse effects on reproduction. At high doses aluminum is neurotoxic, with adverse effects on neurological development and brain function. At present, the hypothesis that aluminum in drinking water is a risk factor for the development or acceleration of Alzheimer's disease and a possible cause of impaired cognitive function in the elderly and in occupationally exposed workers has not been reliably confirmed or dismissed. Aluminium and its compounds does not accumulate significantly in humans. Concerning risks to the environment, under certain circumstances, concentrations of aluminum can increase to levels that may result in adverse effects on aquatic organisms and terrestrial plants.[13]

There are several environmental concerns related to mining, refining, and smelting of

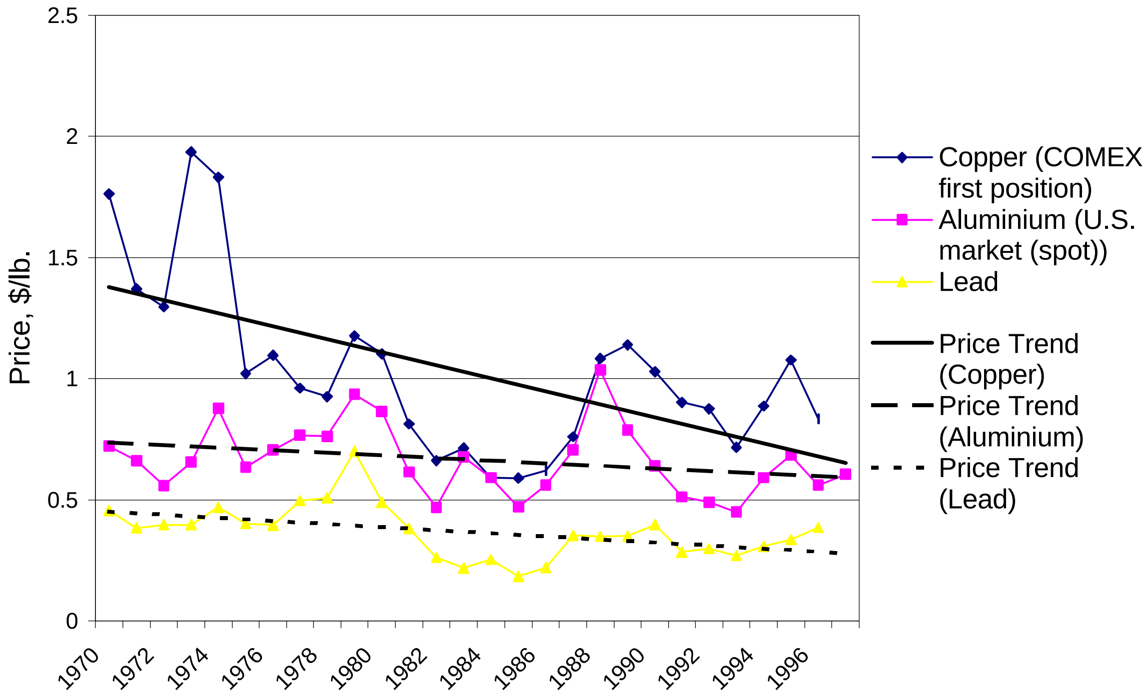

Fig. 3. Average annual prices of selected metals (in 1982 US dollars)
Sources: *USGS Minerals Information: Statistical Compendium; Minerals Yearbook*
Note: Nominal prices are deflated by the United States producer price index for commodities, with 1982 as the base year. [12]

aluminium. Mining of bauxite is a surface process, which disturbs significant land areas. Generally, mine rehabilitation is carried out, and topsoil removed before mining is restored after a mine closes. Nonetheless, the restored soil is usually less capable of retaining water. Alumina production is associated with emission of dust and corrosive materials and creation of large amounts of alkaline mud ("red mud"). The problem of tailings is most often solved through disposal of red mud into sealed ponds that become permanent facilities. Dust and caustic soda contamination are also significant environmental concerns associated with the refining process. The biggest problem of smelting operations (processing alumina into aluminium) is fluoride emissions. The best available technologies allow minimization of negative environmental effects.[14,15]

Copper

Production and recycling

Production of copper has increased steadily for the past twenty years. Total world production of refined copper increased from less than 8.8 million metric tons in 1976 to more than 13.3 million metric tons in 1997 (Fig. 4). Recycling of copper, including production of secondary refined copper and direct scrap used by manufacturers, increased from about 3.1 million metric tons in 1976 to over 5 million metric tons in 1997, while its proportion in total production has remained almost unchanged, fluctuating between 35 and 41 per cent (Fig. 2).[1, 2, 3] Data on the recovery of old (post-consumer) vs. new (manufacturing) scrap are only available for certain (mostly developed) countries. In the United States, the proportion of old scrap in total recycled scrap has

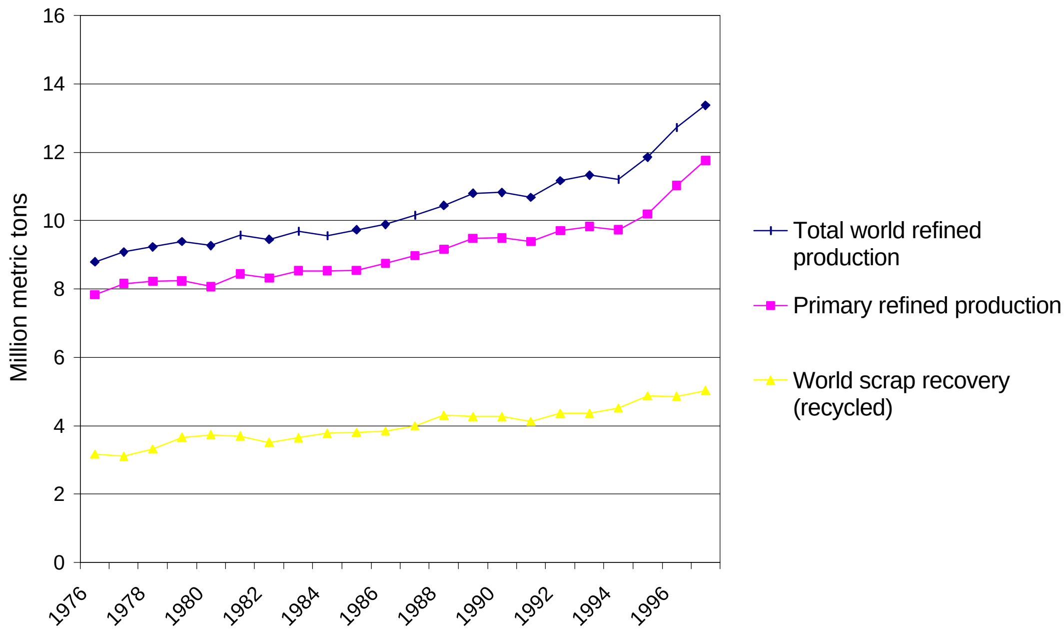

Fig. 4. Copper Production and Recycling
Source: *World Metal Statistics*

fluctuated between 39 per cent and 47 per cent and is sensitive to copper prices. [16]

An increase in the proportion of new scrap relative to post-consumer recycling in the 1940s and 1950s is partially explained by the expansion of copper manufacturing activities that generate new scrap. Energy savings from recycling of copper scrap compared to production of primary copper can range from 65 per cent to 95 per cent depending on quality and copper content of the scrap.[8]

Sources of old scrap for copper are more diverse than for aluminium and lead. Both aluminium and lead have one prevalent source of old scrap. For aluminium it is beverage cans whose life span is very short, usually several weeks. For lead it is lead-acid batteries, also with a relatively short lifetime of several years. That makes availability of old scrap for both aluminium and lead fairly predictable. For copper there is no such single source, and the lifetime of copper-containing goods is generally much longer, ranging from 10 to 35 years and more depending on end-use. [8]

Reserves and resources

No shortage of copper due to the depletion of copper ore is anticipated in the foreseeable future. Even though its average concentration in the earth's crust is only about 70 ppm, its reserves are sufficient for an uninterrupted supply well into the future. World reserves of copper are estimated at 320 million metric tons, reserve base at 630 million metric tons. World resources of copper are estimated at 2.3 billion metric tons of which 1.6 billion metric tons are land-based and 0.7 billion metric tons are in deep-sea nodules. Annual world mine production of copper is currently above 11 million metric tons.[7] Assuming that it will grow at approximately 0.2 million metric tons per year, the reserve base of copper will last for more than 40 years and copper resources for more than 105 years. Historically, the copper industry has been successfully dealing with the problem of extracting copper from lower concentration ores by employing new and improving existing technologies, even with declining prices.

Major uses and possible substitutes

Major uses of copper include building construction (building wire, plumbing and heating, air conditioning and commercial refrigeration, builders' hardware, and architectural applications); electrical and electronic products; industrial machinery and transportation equipment; and consumer and general products. According to this classification, in the United States in 1996, building construction accounted for about 43 per cent, electronic and electrical products for 24 per cent, industrial machinery and transportation equipment for 12 per cent each, and consumer and general products for 9 per cent. If various electrical applications are combined, they constitute approximately 70 per cent of total copper use in the three largest copper-using countries, United States, Japan, and Germany.[3,8]

In electrical equipment, automobile radiators, cooling and refrigeration tubing, and some other applications, aluminium may be used as a substitute for copper. Titanium and steel are used in heat exchangers. In some telecommunications applications, optical fiber is replacing copper wire. Plastics substitute for copper in water pipes, plumbing fixtures, and many structural applications. Although substitutes for copper are widely used, there is little threat that materials substitution and "dematerialization" will lead to a decrease in copper use. Expansion of electronic networks, proliferation of fax machines and telephones offset losses to fiber-optics. The microchip industry intends to partially switch from aluminium to copper. Copper is also regaining its traditional markets, such as wiring, plumbing, and radiators from aluminium. On the other hand, competitive pressure on copper due to the emergence of new materials and its high price sensitivity of demand is expected to continue.[6,7]

Price trends

The world market price for copper fluctuated significantly in recent decades, but the general trend has been downward (Fig. 3).[3,17] Most of the price fluctuation is attributed to alternating periods of excessive and inadequate investments in mining operations.[18] As in the case of aluminium, countries that are most adversely affected by declines in copper prices are those developing countries which rely heavily on its exports. In particular, the share of copper exports∗ in total exports in 1995 exceeded 70 per cent for Zambia, 54 per cent for Mongolia (1.1 per cent share in world mine production), 40 per cent for Chile, 35 per cent for Peru, and 23 per cent for Papua New Guinea (1.7 per cent share in world mine production).[10,11]

In Chile, a sharp decline in copper prices since June 1997 led to a loss of $1.5 billion in export earnings in the first 10 months of 1998. The growth rate in the first half of 1999 is expected to be zero-to-negative. Unemployment in 1998 increased to 6.9 per cent from 6.5 per cent in 1997, and a further increase to 8.5 per cent is predicted by government economists by June 1999.[19]

In periods of falling copper prices, recycling has tended to decline, particularly when considered as a portion of total production (Fig. 2). These declines are moderate and reflect the fact that the costs of collecting and processing old scrap (which do not depend on the price of copper) make its recycling less profitable when prices are low.[4] In general, the price for copper scrap may exceed 90 per cent of the price of new refined copper in case of clean, unalloyed, uncoated copper solids, clippings, bus bars, punchings, commutator segments, clean pipe, and tubing (No. 1 scrap).

Major ore producers

Major copper ore producing countries are listed in Table 2 (1996 data).[1] Their combined share is above 80 per cent of the world copper mine production.

Environmental and health effects

Another issue that may have an impact on the future use of copper is its toxicity. Although it is an essential element at low concentrations for all living organisms including humans, large doses can be harmful. The impact on human health increases with both level and length of exposure. Water containing high levels of copper may cause

∗ For certain countries, exports may include refined and unrefined copper and copper ores and concentrates.

Table 2. Share of major copper ore producing countries in world mine production of copper.

Chile	28.2%
United States	17.4%
Canada	6.2%
Australia	5.0%
Indonesia	4.8%
Russia	4.4%
Peru	4.3%
China	4.0%
Poland	3.8%
Zambia	3.1%

Source: *World Metal Statistics*

vomiting, diarrhea, stomach cramps, and nausea, and very high intakes of copper or long-term exposure to high levels of copper in food and water can cause liver and kidney damage that may be fatal.

At high concentrations, copper and its compounds are also toxic to aquatic life. Its acute toxic effects may include death of animals and plants. Chronic toxic effects may include shortened lifespan, lower fertility, and changes in appearance or behavior of animals and lower growth rates in plants.[20]

These considerations lead to restrictions in certain applications of copper. In Sweden manufacturers must prove that there is no feasible substitute if they want to use copper in any application. Also under examination are potential health implications of copper in drinking water. This may influence use of copper alloys in water distribution networks and in the treatment of drinking water (as copper sulphate).[6,21]

With regards to the Basel Convention, copper scrap, copper slags, and copper oxide mill scale are included in the B list of materials that are not classified as hazardous wastes and therefore are not subject to the export ban from developed to developing countries.[3]

One of the major environmental impacts associated with copper production is SO_2 emissions that occur in the process of copper smelting; the weight of SO_2 released more than twice that of the metallic copper produced due to the high sulphur content in the ores. Almost half of the world's smelters capture less than 84 per cent of SO_2, and 10 per cent, mostly in Asia, South America, and Africa, capture none at all.

One of the best available technologies to prevent SO_2 emissions is flash smelting, capturing up to 99 per cent of SO_2, which is then used for production of sulphuric acid. This technology, often in conjunction with another recently developed closed process, flash converting, allows compliance with the strictest environmental standards on emissions. Kennecott's copper smelter in Utah, United States, for example, employs this technology following modernization in the mid-1990s to achieve a sulphur fixation rate of 99.9 per cent.[22]

Mining copper ore also disturbs the natural environment. Large open-pit operations, which are becoming more common and necessary for companies to stay competitive, alter the local environment permanently. A major task is therefore to minimize the undesirable impact. Extremely important are reclamation schemes to be implemented after mine closure and appropriate measures to prevent or minimize pollution during mine operation, including prevention of groundwater pollution and proper tailings containment facilities (which is true not just for copper but for other metals as well).

Retention of the mining wastes by tailings dams helps prevent discharge of the polluted waste into the environment, including surface water and ground water. The total number of tailings dams in the world is measured in thousands. Large-scale accidents at the dams present a major threat to the environment. Even though they are relatively infrequent - fewer than ten major failures since 1980 - when they occur, they cause widespread environmental damage. One of the latest such failures was the breach of Boliden Apirsa's tailings dam at Aznalcollar in southern Spain in April 1998. Approximately 4-5 million m^3 of acidic water were released into the nearby river, as well as tailings materials containing sulphur, zinc, copper, iron, and lead. Such occurrences can be prevented and smaller incidents minimized through available engineering technology, taking into account the risk of major natural forces, such as earthquakes and flooding. Development of a worldwide database of tailings impoundments would be helpful in achieving greater environmental safety of mining operations.[23]

Lead

Production and recycling

World production of refined lead from both primary and secondary sources grew from about 5.0 million metric tons a year in 1976 to slightly less than 5.7 million metric tons in 1997, with the peak production of almost 6.0 million metric tons in 1989 (Fig. 5). Current trends in consumption and production of lead suggest that its production will remain at approximately current levels in the coming decade or may experience only moderate growth. World primary production of refined lead amounted to approximately 3.5 million metric tons in 1976, peaked at almost 3.9 million metric tons in 1985, and declined to less than 3.0 million metric tons by 1997. A major portion of any future increases in demand are likely to be met by recycling. Although some industry representatives anticipate increases in primary production, there are few grounds for this view. The supply of primary lead is inelastic because it comes primarily from polymetallic operations where most revenue is generated from other metals, particularly zinc and silver. However, the lead-to-zinc ratio in deposits that are being mined is decreasing, from 0.7:1 in 1960 to close to 0.2:1 now.[1,24,25]

There has been a pronounced increase in recycled material as a proportion of total production.[1,2,3] World secondary refined lead production reached almost 2.8 million metric tons in 1997, compared to less than 1.5 million metric tons in 1976 (Fig. 5).

Separate data for lead recovered from old (post-consumer) and new (manufacturing) scrap are not available, but most secondary lead is recovered from old scrap, and the proportion of old scrap is rising.[7] In the United States in 1996, approximately 96 per cent of all secondary lead was recovered from old scrap compared with 93 per cent in 1993 and 82 per cent in 1970. Secondary refined production in the United States accounted for more than 41 per cent of world secondary refined lead production.[3,8] Secondary refined production as a percentage of total global refined production grew from under 30 per cent in 1976 to close to 50 per cent in 1997 with growth increasing after 1987 (Fig. 2).

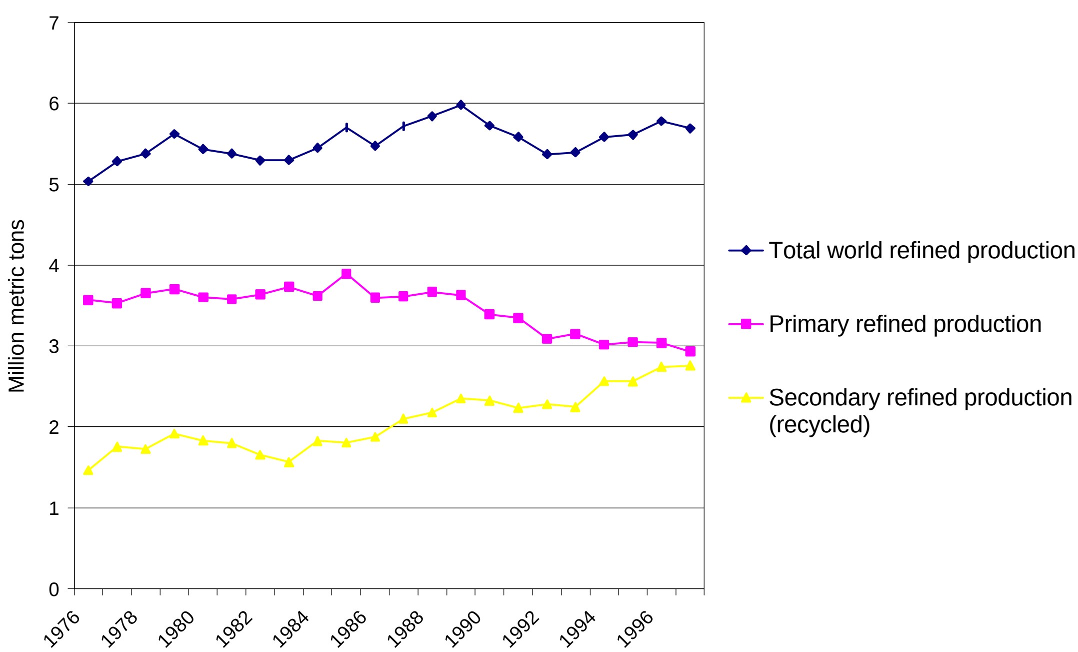

Fig. 5. Lead Production and Recycling
Source: *World Metal Statistics*

Recycling therefore accounts for about half of the world's supply of lead and is expected to continue to grow. In the United States in 1996, about 75 per cent of the production of refined and alloyed lead came from recycled scrap.[4] The major source of the recycled lead is spent lead-acid storage batteries. In Canada, the estimated recycling rate for lead-acid batteries from motor vehicles exceeds 94 per cent.[5] Energy required for secondary lead production is approximately a quarter of that required for production of primary lead.[8]

Reserves and resources and price trends

The price of lead in constant dollars for the period from 1970 to 1997 has gradually declined (Fig. 3). The fact that a number of the applications for lead have been eliminated or reduced has been a significant factor in the decline of the real price of lead in recent years. Scarcity of lead is not envisioned in the foreseeable future. Estimated world reserves of lead are 65 million metric tons, the world reserve base is estimated at 120 million metric tons, and identified resources exceed 1.5 billion metric tons. With world mine production of lead at approximately 2.9 million metric tons in 1997 and under the assumption that it will not be changing significantly, the lead reserve base is sufficient for more than 40 years of production, and identified resources for more than 500 years. [3,4,26]

Major uses and possible substitutes

Lead-acid batteries are the major use of lead. In the United States, almost 88 per cent of lead consumption in 1996 went into storage batteries.[4] Worldwide they account for more than 60 per cent of lead consumption.[24,25] Trends in the automotive industry are therefore one of the most significant factors in demand for lead.[27] Other applications include soundproofing in buildings, blocking X-ray and gamma radiation in hospitals, and shielding against nuclear radiation in nuclear facilities and while transporting nuclear materials.[26]

Certain uses of lead had been eliminated or substantially reduced. In addition to reductions in the use of lead in gasoline (discussed below), lead has also been reduced in building construction, electrical cable covering, and cans and containers, primarily due to substitution by plastics. Aluminium, tin, iron and plastics serve as substitution for lead and compete with it in packaging and protective coatings. In the United States, tin has replaced lead in solder for new or replacement drinking water systems.[9]

Major ore producers

The top ten lead ore producing countries (Table 3) represent approximately 85 per cent of total lead mine production (1996 data).

Table 3. Share of major lead ore producing countries in world mine production of lead.

China	21.1%
Australia	17.2%
United States	14.6%
Canada	8.4%
Peru	8.2%
Mexico	5.5%
Sweden	3.2%
South Africa	2.9%
Morocco	2.4%
Poland	1.8%

Source: *World Metal Statistics*

Environmental and health effects

The hazardous effects of lead on human health are well known. Lead and certain lead compounds cause reproductive damage, such as reduced fertility and interference with menstrual cycles. Long-term or repeated high exposure can cause brain and kidney damage and adversely affect the cardiovascular system. Other long-term effects of lead poisoning include poor appetite, upset stomach, headaches, irritability, and aching joints and muscles. Fatigue and anemia also occur. Most disturbing are the adverse effects on young children. It damages their nervous system, resulting in reduced intelligence, hyperactivity and attention deficit, learning problems and behavioral abnormalities.[28]

Other environmental hazards of lead include the death of animals and death or low growth rate in plants. Lead and its compounds have high acute toxicity to aquatic life. Chronic toxic effects in animals may include shortened life-span, reproductive problems, lower fertility, and changes in appearance or behavior. Lead, like some other metals, bioaccumulates in living organisms through contaminated air, water or food, becoming concentrated in the tissues and internal organs of animals and humans. The concentration of lead and its compounds in fish tissues is much higher than the average concentration of lead in the water from which the fish are taken.

Risk assessment allows analysis of the risks at each stage of a product's life and a focus on stages where toxic substances may be released. Such risk-based approaches allow enjoyment of the benefits of potentially harmful substances like lead, while ensuring that their release into the environment and human exposure is kept within safe limits.[5]

Recent trends in lead exposure show that risk assessment may significantly reduce toxic effects. World refined lead consumption reached 5.5 million tons in 1995 compared to 5.2 million tons in 1985, and demand in OECD countries has increased to record levels. At the same time, average levels of lead in blood in most industrialized countries are now close to those occurring naturally and below the level of concern. This is largely due to the fact that applications of lead that posed substantial health risks because of their dispersive nature have been eliminated or substantially reduced in developed countries and are declining globally. Those include use of lead as an additive to petrol, lead paint, lead pipes, and soldered food cans. Reducing dispersive applications of lead such as in petrol and paint are also among the reasons for higher rates of lead scrap recovery.[5,24,27]

As recommended by the Commission for Sustainable Development at its 2nd Session and by the UN General Assembly at its 1997 Special Session, several countries have completely eliminated the use of lead additives in gasoline. In addition to a number of developed countries, these include Argentina, Brazil, Colombia, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, the Slovak Republic, and Thailand. The complete removal of lead from gasoline is technically feasible and in most cases can be carried out at relatively low cost. Costs of a transition to unleaded gasoline are clearly outweighed by the benefits of improved health conditions, savings in educational and medical costs, reduced mortality, and improved productivity.[28]

In dealing with lead pollution, commitment of national governments is important. In many countries in Central and Eastern Europe, rapid traffic growth combined with increasing control of industrial lead emissions resulted in an increased proportion of vehicular emissions in total airborne lead emissions: 84 per cent in Hungary and 61 per cent in Bulgaria in the early 1990s, with even higher figures in large urban areas. By 1995 the Slovak Republic completely phased out lead in gasoline, Bulgaria, the Czech Republic, Hungary, and Poland reduced the permissible lead content to 0.15 g/l in line with European Union standards, while in Romania and most countries of the former Soviet Union, gasoline may still contain from 0.37 to 0.6 g/l. To reduce lead in gasoline governments can set and enforce regulations for the lead content of gasoline, introduce incentives to reduce lead additives as rapidly as possible, facilitate a broad consensus among government agencies, industrial and business enterprises, non-governmental organizations, and consumers, and raise public awareness.[28] Complete elimination of lead additives in gasoline should be the ultimate goal.

Environmental concerns related to mining of lead include the problem of "disposal" of tailings. The current practice is to create dams across valleys and pump the tailings as a slurry into the lakes created. The problems of leachate into creeks and blowing tailings dust remain, as the tailings contain significant levels of heavy metals, primarily lead, cadmium and zinc in the form of small particles. SO_2 emissions and dust contaminated with heavy metals are associated with smelting operations.

Issues related to lead toxicity may influence future trends in its production and consumption, further narrowing the range of uses. Policies that are currently under consideration by the European Commission, Denmark, and Sweden would eliminate the use of lead in vehicles (except for in batteries) and in electrical and electronic products.[27] Recycling of lead may be somewhat hampered by the Basel Convention, which imposes restrictions on the international movement of scrap lead, creating a shortage for secondary lead smelting in developing countries.

Conclusion

The overview of trends in production and consumption of aluminium, copper, and lead confirms that there is no immediate threat related to the depletion of these metals. In general, economic indicators do not provide evidence that these or other non-renewable resources are becoming significantly more scarce. Other factors, such as the discovery of new deposits, advances in extraction technology, and the development of resource substitutes, have mitigated the effect of depleting existing deposits.[29] However, there are other issues that may be of concern with regards to further development of related industries.

- Price fluctuations and general trends of declining commodity prices negatively affect certain developing countries that depend heavily on the export of metal ores and/or metals for their foreign exchange revenues.
- Declines in metal prices are, to some extent, a consequence of declining energy prices. It is therefore possible that energy cost increases may reduce the profitability of primary metal production and further boost recycling and substitution.
- The role of recycling in the production of metals continues to grow. Due to the high value of metals, economic considerations are usually sufficient to ensure reasonably high recycling rates and efforts to increase it. Environmental concerns currently play a secondary role.
- The issue of toxicity of particular metals (e.g., lead) remains a major topic of policy debates. One approach is to limit the use of a potentially harmful substance to applications where the risk of its release into the environment and thus to become an actual hazard is minimal. Another is to fully comply with the precautionary principle and completely eliminate the use of the substance. In the latter case, a substitute material must be available and economically feasible, have comparable performance characteristics, and not be harmful itself.

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