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Chapter 6

Scrapping Mining Dependence

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In 1886, in the dry and dusty high veldt of South Africa, a man named George Harrison stumbled across an outcrop of gold. This accidental discovery had significant consequences. The remote farming region was soon transformed into a hive of activity: financiers and mining companies arrived from London and Amsterdam, as did tens of thousands of workers from other parts of southern Africa. The city of Johannesburg grew out of this gold rush. The deposit that lies below the metropolitan area has since produced, by some estimates, a third of all the gold ever mined.[1]

Although Harrison chanced upon nuggets of the metal on the soil's surface, most of Johannesburg's gold lies several kilometers underground, scattered through a giant "reef" of rock and earth. To get to this reef, miners must burrow very deep, extracting several tons of rock and soil in order to produce just a few ounces of the yellow metal. The material is then treated with cyanide in order to separate out the specks of gold from the dirt. More than a century of such digging has completely transformed the landscape around Johannesburg. Pale yellow mountains of waste ore and rock rise above the flat city, towering over its poor, predominantly black neighborhoods. Some of these heaps span several hundred hectares each and are 45 meters high. Winds carry dust containing cyanide and heavy metals from these heaps into nearby homes and schools.[2]

During the first hundred years after Harrison's discovery, South Africa's mining industry flourished using a series of practices that were damaging to both the environment and the mine workers. The mines paid low wages, operated under dangerous working conditions, and employed an almost exclusively black work force—mainly workers brought in from Lesotho, Mozambique, Namibia, and other neighboring nations. Once the apartheid policies that enabled these practices were ended in the late 1980s, the mines began to lose some of their apparent luster. Less than a decade later, world prices for gold and other metals took a nosedive. Companies began to close down mines where operating costs far exceeded returns and to downsize the work force. In the span of just a decade, mining companies laid off half of all mine workers—nearly 400,000 people.[3]

Johannesburg's history is unique, of course, but many of its experiences as a mining-dependent region are not. Mining has left a lasting mark on people and landscapes around the world. Each year mining activities take more materials out of the earth than the world's rivers move. A single mine in Papua New Guinea, the Ok Tedi, generates an astounding 200,000 tons of waste a day on average—more than all the cities in Japan, Australia, and Canada combined. Mines have uprooted tens of thousands of people from their homelands and have exposed many more to toxic chemicals and pollution. And mining is the world's most deadly occupation: on average, 40 mine workers are killed on the job each day, and many more are injured.[4]

Table 6–1. Mining in the Global Economy, Late 1990s

Global Indicator	Mining's Share	Value
	(percent)	
Gross world product	0.9	$361 billion[1]
Employment	0.5	13 million workers[2]
Energy use	7–10	4,900–6,600 terawatt hours
Sulfur dioxide emissions	13	142 million tons[3]
Frontier forests threatened	39	5.3 million square kilometers[4]

[1]Based on gross domestic product data for 1998, in current U.S. dollars. Includes some extraction of oil and natural gas. [2]Employment in nonfuel minerals and metals mining, processing, and basic manufacturing in the formal sector. [3]Data for 1995. [4]Refers to undeveloped tracts of forest. 1997 estimate; includes some oil and gas extraction.
SOURCE: See endnote 5.

If an accountant were to weigh the costs and benefits of extracting minerals from the earth and then processing and refining them, the balance sheet would reveal this: an industry that consumes close to 10 percent of world energy, spews almost half of all toxic emissions from industry in some countries, and threatens nearly 40 percent of the world's undeveloped tracts of forest—while generating only a small share of jobs and economic output. (See Table 6–1.)[5]

Clearly, minerals themselves have brought benefits to those who have had access to them. People use minerals extensively in their daily lives—in utensils used to cook dinner, in bicycles or trains or cars taken to get to work, and in pipes or pitchers that carry water to homes. But is it necessary to extract mountains of ore from the earth in order to improve the quality of our lives? Thankfully, it is not. The billions of tons of material already mined and circulating in cities and factories or lying in landfills can serve the same functions as underground ores, with far fewer ecological costs. Through improved design of cities, transport, homes, and products, societies can find ways to use the existing stock of minerals far more efficiently—and to use smaller amounts of materials overall—dramatically reducing the need to mine underground ores.[6]

Minerals Inventory

The term "minerals" refers to a variety of materials found in the earth. It includes metals such as iron, copper, and gold; industrial minerals, like lime and gypsum; construction materials such as sand and stone; and fuels, such as coal and uranium. The first three categories of minerals are the primary focus of this chapter.[7]

People have extracted minerals from the earth since ancient times. Babylonians, Assyrians, and Byzantines mined for copper and lead thousands of years ago in what is today southern Jordan, for example. Since the Industrial Revolution, however, minerals have been extracted and used in much larger quantities. In recent times, this trend has accelerated greatly: in 1999, some 9.6 billion tons of marketable minerals were dug out of the earth, nearly twice as much as in 1970. (See Figure 6–1.) This figure accounts for minerals that finally reach markets, but does not include the wastes generated in producing these minerals—the unused portion of the ore (the rock or earth that contains minerals), or the earth moved to reach the ore, which is known as overburden. If these categories were included in the total amount of materials mined each year, the figure would be considerably larger.[8]

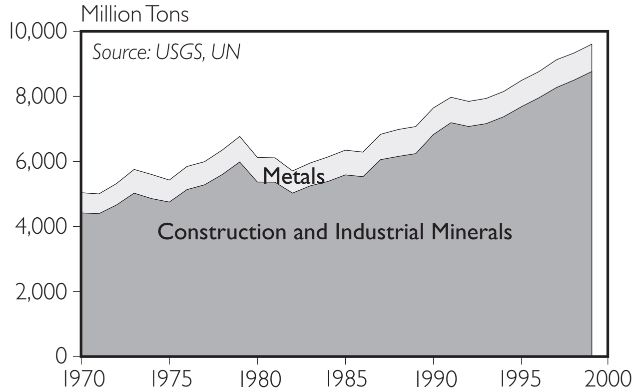

Figure 6–1. Production of Non-fuel Minerals and Metals, 1970–99

By weight, most of the minerals extracted are used for construction, such as stone, sand, and gravel. Although metals are mined in smaller quantities, they are more valuable per unit of weight. Iron is by far the most mined metallic ore. Much of this iron ore is used to make steel—some 845 million tons of raw steel were produced in 2000. About 135 million tons of bauxite ore were mined that same year, which produced some 24 million tons of aluminum—a lightweight metal used in cars, aircraft, and beverage cans. And about 15 million tons of refined copper were produced in 2000, much of which was used in electrical equipment, cables, and construction.[9]

Although gold is produced in much tinier quantities—less than 2,500 tons a year—it brings in a disproportionate share of the revenue from metals mining. Metals mined in 2001 were valued at $125 billion—and about $21 billion of this was gold.[10]

After metal ores are extracted from the earth, the material has to go through several stages in order to produce usable metal. These refining and smelting processes vary, depending on the type of metal. The ore is crushed and ground, and then the metal is separated out through different kinds of processes: gold ore is treated with chemicals, for instance, while aluminum is separated out by exposing the processed ore to an extremely powerful electric current.

Construction materials are typically mined relatively close to where they are to be used. But more valuable minerals have historically traveled quite long distances—gold was shipped from the Americas to Europe in the sixteenth century, for example. With the availability of cheap energy and improved transportation networks in the twentieth century, some metal ores travel thousands of miles just to be refined and processed. For instance, some copper that is mined in Chile gets smelted in Europe—and may end up in radiators of cars made in Japan and driven in California.[11]

Minerals are found all over the world—

Pacific islands, Andean mountains, North American deserts, and African rainforest. Some of the world's largest countries are also the major producers and consumers of minerals. (See Table 6–2.) China, for instance, produces 22 percent of the world's iron ore, 29 percent of the silicon, and 39 percent of the tin. Australian mines produce nearly 40 percent of all bauxite, 27 percent of diamonds, and almost a quarter of all lead. About 14 percent of all gold and a quarter of all phosphate are mined in the United States.[12]

Some ores are mined in just one or only a few regions. Most of the world's bauxite, for instance, comes from Australia, Guinea, Brazil, or Jamaica. South Africa produces 44 percent of the world's chromium, which is used in making stainless steel, and more than half of the world's platinum. Chilean mines produce more than a third of the world's copper.[13]

Mineral consumption is also most concentrated in a few parts of the world. The United States, Canada, Australia, Japan, and Western Europe, with 15 percent of the world's population, together consume most of the metals produced each year: about 61 percent of all aluminum, 60 percent of lead, 59 percent of copper, and 49 percent of steel. On a per capita basis, the different levels of consumption are especially marked: the average American uses 22 kilograms of aluminum a year, the average Indian uses 2 kilograms, and the average African uses just 0.7 kilograms.[14]

How are these billions of tons of minerals used? Most go into expanding the built-up environment: constructing roads, railways, bridges, factories, or residences. In addition to needing sand and gravel to make concrete, construction activities account for 34 percent of the use of steel, 30 percent of copper, 17 percent of lead, and 19 percent of the aluminum consumed in industrial countries. The transportation sector—including vehicle fleets—uses about 70 percent of lead produced each year, 37 percent of steel, 33 percent of aluminum, and 27 percent of copper.[15]

Table 6–2. Major Mineral Producing Countries, Selected Minerals, 2001

Mineral	Countries	Share of World Production
		(percent)
Bauxite	Australia	39
	Guinea	11
	Brazil	10
Copper	Chile	35
	United States	10
	Indonesia	8
Diamond	Australia	27
	Dem. Rep. of Congo	25
	Russia	21
Gold	South Africa	16
	United States	14
	Australia	11
Iron ore	China	22
	Brazil	20
	Australia	16
Lead	Australia	24
	China	19
	United States	14
Mercury	Spain	36
	Kyrgyz Republic	18
	Algeria	16
Nickel	Russia	21
	Australia	15
	Canada	15
Platinum group	South Africa	53
	Russia	35
	United States	5
Silicon	China	29
	Russia	14
	Norway	11
Tin	China	39
	Indonesia	21
	Peru	16

SOURCE: U.S. Geological Survey, *Mineral Commodity Summaries 2001* (Reston, VA: 2001).

In industrial nations, the amount of material being added to the built-up environment each year has continued to grow, even though most of these countries have already put in place much of the urban infrastructure and transportation networks that consume large amounts of materials. Every year, the United States adds another 2 billion tons of material to interstate highway systems, railroads, factories, and buildings that have been in place for decades.[16]

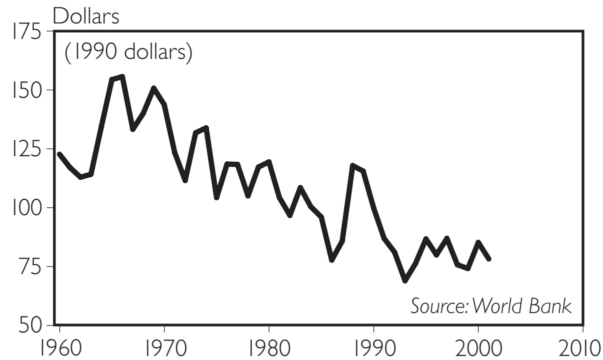

Figure 6–2. Metals and Minerals Price Index, 1960–2001

In addition to the minerals newly extracted from the earth each year, factories and builders get some of their raw materials from recycled or secondary sources. About half of the world's lead comes from recycled supplies, as does a third of aluminum, steel, and gold. But for some metals, the recycling rate is far lower and appears to be falling: for instance, just 13 percent of copper is from recycled sources, down from 20 percent in 1980. Merely 4 percent of the world's zinc is obtained from recycled sources.[17]

It is far less energy-intensive to produce metals from secondary sources than from "virgin" or newly mined ores. Yet recycling's potential is poorly realized. In many parts of the world, governments heavily subsidize the extraction of virgin materials by offering mining firms tax write-offs and inexpensive access to land and by subsidizing diesel and other fuels—making it more expensive to produce minerals from recycled sources than to dig up new supplies from underground. Although minerals are nonrenewable and are mined in greater quantities each year, prices for virgin minerals have been in steady decline since the oil crisis in the early 1970s. (See Figure 6–2.)[18]

The minerals sector is a relatively small player in the global economy. Even though the world consumes enormous volumes of minerals each year, quarrying and extracting minerals generates less than 1 percent of global economic product. The global mining industry includes several large multinational corporations (such as Anglo American, Rio Tinto, and BHP Billiton), state-owned companies such as Chile's Codelco and several in India, and smaller mining companies that are known as "juniors." In addition, some 13 million artisanal or small-scale miners work over productive seams of metal or precious stones alone or in cooperatives. Most of these miners are in the developing world, converging near gold deposits in the Brazilian Amazon and Ghana, in diamond-rich areas in West Africa, and near columbite-tantalite (coltan) ores in the Democratic Republic of the Congo.[19]

The Johannesburg gold reef is an exceptionally rich lode of metal that has been worked for over a century. But firms today develop some mineral deposits with life spans estimated in decades, or even years—and are always in search of new, untapped deposits of minerals. Multinational mining companies have increasingly focused their quest in the developing world, where mines can be worked more cheaply as labor costs are lower and environmental regulations are typically not as strict as in Australia, Western Europe, or North America. In 2001, mining companies spent $566 million exploring for nonferrous metals deposits in Latin America—almost 30 percent of the $2 billion they spent overall—and another $272 million in Africa. Almost two thirds of the exploration expenditure in 1997 was spent in search of gold deposits, but this share fell to about 40 percent in 2001. Since global metals prices took a downturn in the late 1990s, mining companies have invested much less in their quest for new mineral lodes. Total exploration spending fell by half between 1997 and 2001.[20]

Ecosystems, People, and Mines

The Lorentz National Park in the Indonesian province of West Papua, which is the western half of the island of New Guinea, is one of the world's most biologically diverse and least explored places. At 2.5 million hectares—about the size of Vermont in the United States—it is the largest protected area in Southeast Asia. It is a naturalist's dream come true. In the span of about 125 kilometers, the park covers a dramatic range of ecosystems: mangrove swamps at sea level, highland cloud forest, and snow-peaked mountains. Its geographic isolation and the sweeping changes in elevation and climate have made it home to unique plant, amphibian, and insect species; visiting biologists recently discovered a new type of tree kangaroo.[21]

But the area has more than just biological wealth. Lorentz lies next to what is considered the world's richest lode of copper and gold ore, valued at about $50 billion. The U.S. mining company Freeport McMoRan first dug open the deposit in 1973, and has expanded its foothold ever since. The company now dumps 70 million tons of waste each year into the nearby Ajkwa River, and by the time it closes in 30 years, it will have excavated a 230-square-kilometer hole in the forest that is visible from outer space. The region's population has increased from 6,000 to 70,000 in the last 30 years—most of these are immigrant workers—and the area now boasts an 18-hole golf course for mining executives.[22]

Lorentz is one of many world biological treasures that are seriously endangered by mining. Much new mining development is taking place in or near ecologically fragile regions around the world—including World Heritage sites such as the Bystrinski National Reserve in Russia and the Sierra Imataca Reserve in Venezuela. By one estimate, mining projects threaten nearly 40 percent of the world's large, untouched forests. These include a titanium mine being developed in a Madagascar forest that is inhabited by rare lemurs, birds, and indigenous plant species; gold exploration in Peru's Andean cloud forests; and columbite-tantalite mining in the Okapi Reserve in the Democratic Republic of the Congo, home to the endangered lowland gorilla. Also in the works is a nickel and cobalt mine on Gag Island, off the coast of Papua New Guinea. The reefs off the island are inhabited by an astounding variety of coral, fish, and mollusks.[23]

The environmental impact of mines extends beyond the threats to habitat. The mining industry is one of the planet's leading polluters. (See Table 6–3.) Smelting metals contributes some 19 million tons of acid-rain-causing sulfur dioxide to the atmosphere annually—about 13 percent of global emissions. In the United States, processing minerals contributes almost half of all reported toxic emissions from industry, sending 1.5 million tons of pollutants into the air and water each year.[24]

Extracting, processing, and refining minerals is extremely energy-intensive. Between

Table 6–3. Selected Examples of Mining's Environmental Toll

Impact	Example	Details
Biodiversity loss	Okapi Reserve and Kahuzi-Biega National Park, Democratic Republic of the Congo	Mining for coltan—used to make capacitors for cell phones and other electronics—has resulted in an 80–90 percent decline in the population of the eastern lowland gorilla in the Reserve. Only 3,000 gorillas remain.
Water pollution	Ok Tedi, Papua New Guinea	On average, 200,000 tons of contaminated tailings and waste rock dumped each day into Ok Tedi River, which feeds into the Fly River. This has silted up the two rivers to four or five times more than normal, flooding nearby villages and killing off plant life in a 2,000-square-kilometer area near the river basin.
Air pollution	Norilsk nickel smelter, Russia	The smelter is the country's largest source of sulfur dioxide and other air pollutants, which have destroyed an estimated 3,500 square kilometers of forest and harmed the health of local residents.
Water use	Gold mines in north-eastern Nevada	Mines in the Nevadan desert pumped out more than 2.2 trillion liters of groundwater between 1986 and 2000—as much water as New York City uses each year.

SOURCE: See endnote 24.

7 and 10 percent of all oil, gas, coal, and hydropower energy produced globally each year is used to extract and process minerals. (This figure does not include the energy used to ship ores and metals around the world.) Mining and processing just three materials—aluminum, copper, and steel—consumes an astounding 7.2 percent of world energy. This is more than the entire Latin American region uses each year.[25]

A sizable share of the energy used in extracting and refining minerals comes from fossil fuels such as oil and coal, whose burning emits the carbon that is implicated in global climate change. In the United States, half of the electricity used to smelt aluminum comes from coal-burning power plants, for instance. But mining's role in global climate change does not end with its fossil fuel use. Producing cement from limestone releases an additional 5 percent of annual carbon emissions to the atmosphere each year. The aluminum smelting process releases about 2 tons of carbon dioxide for each ton of primary aluminum produced, and another 3 tons of perfluorocarbons, or PFCs—which are very rare gases not emitted through any other industrial activity. PFCs are extremely potent greenhouse gases: a ton of PFCs is equivalent to the greenhouse potential of 6,500–9,200 tons of carbon. In 1997, PFC emissions from aluminum smelters in Australia, Canada, France, Germany, the United Kingdom, and the United States were equivalent to about 19 million tons of carbon—although at least this is 50 percent less than their emissions in 1990, thanks to improvements in smelter efficiencies.[26]

In the last century, lower energy costs and the development of new mining technologies have made it possible to transform landscapes completely. Earth-moving equipment is used to literally move mountains in order to get to a mineral deposit. These technological advancements have led to two trends: the extraction of minerals from lower-grade ores—ores that contain very small amounts of mineral—and the development of surface mines instead of underground ones. Today, about two thirds of metals are extracted from surface mines. These "open-pit" mines use more diesel fuel and generate a lot more waste than the subterranean kind. On average, open-pit mines produce 8–10 times more waste than underground mines do.[27]

The amount of wastes generated by mines is staggering: every year, Canadian mines generate more than a billion tons—60 times larger than the amount of trash Canadian cities discard. To transport these wastes, some mines now use a kind of giant dump truck that can move 360 tons of material—each behemoth tire on this truck weighs 4.5 tons and stands almost 5 meters feet high.[28]

In 2000, mines around the world extracted some 900 million tons of metal—and left behind some 6 billion tons of waste ore. This figure does not include the overburden earth moved to reach the ores. Much of this waste came from the production of just iron ore, copper, and gold. (See Table 6–4.) For every usable ton of copper, 110 tons of waste rock and ore are discarded, and another 200 tons of overburden earth are moved. For gold, the ratio is more staggering: about 300,000 tons of wastes are generated for every ton of marketable gold—which translates into roughly 3 tons of wastes per gold wedding ring. Much of this waste is contaminated with cyanide and other chemicals used to separate the metal from ore.[29]

The amount of waste generated by mines has increased as ore grades have declined for a number of metals. As the more easily accessible and rich veins of metal have been dug out, miners have turned to less abundant sources—using more energy and chemicals to extract the same amount of metal while generating more wastes. In 1906, U.S. copper ores yielded on average 2.5 grams of metal for every 100 grams of ore. In 2000, U.S. miners extracted copper from ore with an average grade of 0.44 grams of metal per 100 grams of ore, meaning that five times more waste is now generated per gram of marketable metal.[30]

Table 6–4. Wastes Produced by Mining Selected Metals, 2000

Metal	Waste Produced	Metal Produced	Share of Ore That is Usable Metal
	(million tons)	(million tons)	(percent)
Iron Ore	2,113	845	40
Copper	1,648	15	0.91
Gold	745	0.0025	0.00033
Lead	260	7	2.5
Aluminum	104	24	19

SOURCE: See endnote 29.

Chemical innovations have also contributed to the dual trends in low grading and surface mines. In the late 1800s, U.S. chemists patented cyanide heap-leaching as a method of separating gold from ore. Today, gold mines everywhere from South Africa to Nevada use this technique. Cyanide is mixed with water and then is poured or sprayed over heaps of crushed ore in order to dissolve bits of gold. Once the usable gold is removed, the stacks of crushed ore—known as tailings—are treated to reduce cyanide concentrations, although the chemical is never entirely diluted. When gold prices shot up in the early 1980s, this method gained new popularity as miners rushed to extract gold from deposits containing even tiny amounts of the metal. Between 1983 and 1999, U.S. consumption of crystalline sodium cyanide more than tripled, reaching 130 million kilograms—about 90 percent of which was used in gold mining. A teaspoon containing a 2 percent cyanide solution can kill an adult.[31]

Where do these chemical-laced wastes end up? They are piled into heaps, walled into constructed holding areas (called dams), and in some parts of the world simply dumped into rivers, streams, or oceans. (Tailings dams are typically built by stacking piles of wastes above ground or in freshwater ponds.) Today only three mines in the world—all of them on the Pacific island of New Guinea—officially use rivers to dump tailings. Even so, mine wastes elsewhere have spilled out of waste sites and poisoned drinking water supplies and aquatic habitat. In the U.S. West, mining has contaminated an estimated 26,000 kilometers of streams and rivers.[32]

There is no reliable way to dispose of billions of tons of materials discreetly. Catastrophic spills of mine wastes in recent years have resulted in enormous fish kills, soil and water pollution, and damage to human health. In 2000, for instance, a tailings dam split open at the Baia Mare mine in Romania. This accident sent some 100,000 tons of wastewater and 20,000 tons of sludge contaminated with cyanide, copper, and heavy metals into the Tisza River, and eventually into the Danube—destroying 1,240 tons of fish and polluting the drinking water supplies of 2.5 million people. That same year major accidents took place at mines in Gallivare (Sweden), Guangxi (China), Cajamarca (Peru), Tolukuma (Papua New Guinea), Sichuan (China), and Borsa (Romania). The accident at a copper mine in Guangxi killed 29 people and destroyed more than 100 homes. Of the hundreds of mining-related environmental incidents since 1975, about 75 percent have involved tailings dam ruptures. According to the U.N. Environment Programme, there are 3,500 tailings storage facilities in active use around the world and several thousand others that are now closed, all of which pose potential risks.[33]

Mining's effects frequently persist long after an operation is closed. Acid drainage is an especially long-lived problem. This happens when a mining operation excavates rock that contains sulfide minerals. When these materials are exposed to oxygen and water, they react to form sulfuric acid. This acid will continue to form, and to drain out of the rock, as long as the rock is exposed to air and water and the sulfides have not been depleted—a process that can take hundreds or thousands of years. The Iron Mountain mine in northern California, for instance, has been closed since 1963 but continues to drain sulfuric acid, along with heavy metals such as cadmium and zinc, into the Sacramento River. The river's bright orange water is completely devoid of life, and has a pH of minus 3—which is 10,000 times more acidic than battery acid. Experts report that the mine may continue to leach acid for another 3,000 years.[34]

Mines have not only transformed landscapes, but have also dramatically altered the lives of local people who live near mineral deposits. (See Table 6–5.) Hundreds of thousands of people have been uprooted in order to make way for mine projects. Many others have had to forsake traditional occupations and endure the effects of living beside a mine that poisons their water supplies or near a smelter that pollutes the air they breathe. At the same time, mines have brought jobs, roads, and electricity to poor regions. Men with little other choice for work and communities living in extreme poverty have had to make the Faustian tradeoff—typically not out of their own choice: incur increased risks of lung disease and other health problems in exchange for jobs and income.[35]

Each year 14,000 mine workers are killed at accidents on the job, and many more are exposed to chemicals or particulates that increase their risks of respiratory disorders and certain kinds of cancers. There have been significant improvements in mine safety in

Table 6–5. Selected Examples of Mining's Impact on Local Communities

Impact	Example	Details
Mining on indigenous lands	Zortman–Landusky mine, Montana, United States	Mining for gold has destroyed Spirit Mountain, a sacred site for the Assiniboine and Gros Ventre tribes. The mine was abandoned by the Pegasus Gold company in 1998, when it went bankrupt, leaving the tribes a toxic legacy of cyanide waste and acid drainage.
Loss of traditional occupations	Tambo Grande, Peru	Farmers have opposed a proposed Canadian gold mine, complaining that it will drain water supplies, take over farmland, and contaminate their soils. In a referendum in June 2002, 94 percent of the area's residents voted against the proposed mine.
Human rights abuses	Monywa Copper Mine, Myanmar (formerly Burma)	The Burmese military government has partnered with the Canadian firm Ivanhoe to develop the copper mine and build railways, dams, and other infrastructure. Nearly a million laborers have been forced to work on the project.
Health hazards	Metals refineries, Torréon, Mexico	Heavy metals emissions from lead, silver, and bismuth refineries have resulted in lead poisoning in children, which can cause permanent brain damage.

SOURCE: See endnote 35.

the last few decades, but mining is still the world's most hazardous occupation. According to the International Labour Organization, the sector employs less than 1 percent of all workers but is responsible for 5 percent of all worker deaths on the job.[36]

Prostitution and drug use are serious problems at mining camps where migrant workers live, which has led to a high incidence of sexually transmitted diseases, including HIV/AIDS. In South Africa, between 20 and 30 percent of workers at gold mines are HIV-positive (although this is not significantly higher than the average infection rate for adults there).[37]

Mine workers in some countries, including Colombia, China, Myanmar, and Russia, are still prevented from forming independent trade unions for collective bargaining. Union organizers there face serious threats: at the La Loma mine in Colombia, for example, three union leaders were murdered in 2001 because of their efforts to organize workers.[38]

Indigenous peoples have been especially hard hit by mining projects. By one estimate, as much as 50 percent of the gold produced between 1995 and 2015 will come from indigenous peoples' lands, in places as diverse as the Kyrgyz Republic and Nevada. The impacts of this intrusion into native lands can be diverse, affecting autonomy, traditional lifestyles, health, occupations, and even physical safety. For instance, the Indonesian Human Rights Commission has confirmed that the Indonesian army is responsible for rapes and the continued use of armed force against Amungme and Ndunga villagers near Freeport McMoRan's Grasberg mine on West Papua. In Australia, the Mirrar—an aboriginal people—have contested a huge uranium mine that is being developed on their traditional lands and sacred sites. This area, the Kakadu Reserve, was declared a World Heritage site in 1998. And in French Guiana, the Wayana people, who live downstream from gold mining operations, suffer from mercury poisoning—their hair sample tests showed mercury levels two to three times higher than World Health Organization limits—which can lead to neurological and behavioral problems, especially in children.[39]

Tailing the Money

More than 200 years ago, Adam Smith observed in *The Wealth of Nations*: "Of all those expensive and uncertain projects which bring bankruptcy upon the greater part of the people that engage in them, there is none perhaps more perfectly ruinous than the search after new silver and gold mines." In contrast, the industry's proponents have held that mining can serve as a powerful and necessary engine of economic development. They argue that poor countries that put up with the ecological and social costs of mining will benefit over the long term because of the income and jobs that mining can help generate. Results on the ground, however, do not bear out these claims.[40]

Mineral dependence has been shown to slow and even reduce economic growth in developing countries—a phenomenon economists have dubbed "the resource curse." Harvard economists Jeffrey Sachs and Andrew Warner studied 95 developing countries that had high ratios of natural resource exports relative to gross domestic product (GDP) for the period between 1970 and 1990. They found that the higher the dependence on natural resource exports, the slower the growth rates per capita. Economist Richard Auty of the University of Lancaster in the United Kingdom looked at economic growth in 85 countries between 1970 and 1993 and found that in this period small countries that were rich in hard minerals (such as copper, bauxite, and tin) actually had negative GDP growth rates, averaging –0.2 percent a year.[41]

This inverse relationship between mineral wealth and economic affluence has held true even in wealthy countries that mine. Between 1980 and 2000, for example, mining-dependent counties in the United States grew at half the rate of other counties on average. Thomas M. Power, who heads the Economics Department at the University of Montana, notes that in the United States "the historic mining regions have become synonymous with persistent poverty, not prosperity." He points to the Appalachian region, with its coal; the Black Hills of South Dakota, which were dug over for gold and silver; and lead mines in the Ozarks, among others. "Persistent poverty" is common to several other historically mined regions around the world: Rio Tinto in Spain, Bihar in India, and Potosí in Bolivia rank among the poorest in their respective countries.[42]

Ten countries—six of them in Africa—derive more than 30 percent of their export income from trading minerals. (See Table 6–6.) Most of these also number among the world's most impoverished nations: almost two thirds of Niger's population lives below the poverty line, for instance, as does nearly half of Peru's.

Several of these mineral-exporting countries are heavily indebted to international lenders. Much of what they earn from minerals and other exports never enters the national economy at all but goes instead to service their huge debts. Mauritania, for instance, spends a quarter of its export earnings repaying interest on its external debt—which is 1.3 times the size of its gross national income.[43]

Conditions in mining-dependent countries have been steadily declining in the last two decades. According to the United Nations Conference on Trade and Development, the proportion of people living on less than $1 a day in developing countries that are mineral exporters rose from 61 percent in 1981–83 to 82 percent in 1997–99.[44]

Table 6–6. Mineral Dependence and Poverty Rates, Selected Countries, 1990s

Country	Share of Non-Fuel Minerals in Value of Total Exports	Population Below Poverty Line[1]
	(percent)	(percent)
Guinea	71	40
Niger	67	63
Zambia	66	86
Jamaica	53	34
Chile	43	21
Peru	40	49
Dem. Rep. of Congo	40	n.a.
Mauritania	40	57
Papua New Guinea	35	n.a.
Togo	30	32

[1]National Poverty Line.
SOURCE: UNCTAD, *Handbook of World Mineral Trade Statistics 1994-1999* (New York: 2001); World Bank, *World Development Indicators 2001* (Washington, DC: 2001); U.N. Development Programme, *Human Development Report 2001* (New York: 2001).

Why are mining-dependent countries more likely to be poor and to grow more slowly? Economists have explained the resource curse in different ways. One is that extracting raw materials for export is far less lucrative than processing the materials or manufacturing finished goods. Second, countries that have made mining the centerpiece of their economies have found that laying all their stakes in this one sector has proved an unsafe bet, given the swings and overall downward trend in world mineral prices.[45]

Other reasons may have to do with the way the resource revenues are distributed. Mineral-rich countries have typically invested little in social services, such as education or health care. Several countries dependent on mining are among the world's most corrupt; others are beleaguered by conflicts over resources and the resulting political instability. A study by Transparency International about the extent of corruption in different parts of the world revealed that 26 out of 32 mineral-dependent countries evaluated—some of which are also oil-dependent—had governments that were categorized as corrupt or highly corrupt. Bolivia, Indonesia, the Philippines, and Zambia all feature on this list.[46]

Although countries such as the United States, Canada, and Australia have historically extracted minerals and continue to do so, the industry has not been the primary driver of their economic development. Thomas Power of the University of Montana notes that these three countries "were high-income, advanced nations with stable political and economic institutions when they started to develop their natural resources." The domestic availability of natural resources provided a competitive advantage for these nations. But as transportation costs have fallen and trade has expanded, a domestic supply of minerals is no longer a prerequisite for economic growth, as it was a century ago. In fact, countries that are resource-poor, such as Japan or South Korea, have grown far more rapidly than many mineral-rich nations.[47]

By extracting minerals, countries are essentially running down their stocks of nonrenewable resources. Under traditional economic accounting, however, this extraction appears on the credit side of the ledger. By conventional measures, mining in Chile contributed between 7 and 9 percent of the country's GDP during the first half of the 1990s. In order to arrive at a more ecologically accurate measure of Chile's income from mining, economists from the University of Chile and Chile's National Commission for the Environment calculated the long-term losses that nation was incurring by depleting its natural resources. They concluded that traditional accounting methods "overestimated the economic income generated by the Chilean mining sector…by 20–40 percent.” The conventional measure is likely to be even more off the mark than this, for the researchers did not factor in environmental or health losses from mining, such as air or water pollution.[48]

Mining, then, has not proved to be an economic winner in either the short term or the long term. Its frequently short-lived appeal contributed the term “ghost town” to the American lexicon a century ago. A rumored gold strike would bring droves of miners into an area, which would be abandoned once the deposit was picked over.[49]

In many ways, mining economies today are subject to the same boom-and-bust cycles. Their fortune is linked to a number of factors such as global mineral prices, labor and fuel costs, and the productiveness of the lode being mined. Take Papua New Guinea, for example. New Guineans have had to endure the development of four of the world’s most polluting mines, which together provide about 15 percent of the country’s GDP. Three of these—Misima, Ok Tedi, and Porgera—are scheduled for closure between 2004 and 2011, less than 20 years after they were first opened. At that point, 5,000 workers will lose their jobs and the country will be left to deal with the legacy of billions of tons of highly contaminated wastes.[50]

Mining provides only a thin trickle of jobs: globally, extracting non-fuel minerals employs just 5 million people, or less than 0.2 percent of all workers. (Processing and refining minerals employs about another 8 million.) And in many parts of the world, these jobs are in decline. An International Labour Organization study reveals that 32 percent of mine workers in 25 key mining countries lost their jobs between 1995 and 2000.[51]

Mine workers are getting laid off as operations close down, cut back on expenses, or invest in labor-saving technological improvements. When minerals prices plummeted in the 1990s, mining companies in Australia, the United States, the Philippines, and elsewhere laid off tens of thousands of workers. (See Table 6–7.) Between 1985 and 2000, Australian mines laid off some 36,000 workers—almost half the work force. Some 40,000 workers lost jobs in Philippine mines between 1985 and 1995, amounting to a 60-percent decline. And in China, 2.4 million mine workers (most of them coal miners) lost their jobs between 1995 and 2000, as minerals prices fell and ores petered out. Job attrition is likely to continue there: another 100 coal and non-fuel mines are scheduled to close in the next few years.[52]

In countries where labor and civil rights laws are strong, mine workers have been paid well in comparison with the prevailing wage—in large part due to the occupational hazards they face and to the efforts of mine workers’ unions. But contrary to industry claims that mining boosts local economies,

Table 6–7. Employment Losses in Mining, Selected Countries, 1985–2000

	Employment in 1985[1]	Employment in 2000[1]	Change, 1985–2000
	(thousands)	(thousands)	(percent)
India	755	600	–21
South Africa	807	417	–48
United States	344	227	–34
Romania	205	77	–62
Mexico	83	68[2]	–18[2]
Canada	78	53	–31
Australia	84	48	–43
Bolivia	70	47	–33
Thailand	58	17	–71

[1]Data for some countries may include coal mining. [2]1999 figure.
SOURCE: International Labour Organization, *The Evolution of Employment, Working Time and Training in the Mining Industry* (Geneva: 2002).

many mining jobs have not gone to local people near the mine site but to a mobile or migrant work force. Companies have frequently imported labor to operate mines and machinery, as happened in South Africa, where miners were brought in from Lesotho, Mozambique, and Namibia.[53]

If the benefits of mining are so mixed and minerals prices so low, why are mining operations still expanding? Mining firms have profited from direct and indirect subsidies handed out to them by governments in many parts of the world. For starters, mining firms benefit immensely from the cheap fuel and from the roads and other infrastructure made available to them.

In traditional mining countries, several pro-mining laws were originally developed in the nineteenth century in an effort to expand the frontiers of colonial control. In the United States, for instance, an 1872 mining law gives miners the right to explore for and extract minerals for as little as $12 a hectare on public lands—with no royalty payments for minerals removed. This law has generated immense profits for mining interests. Between 1993 and 2001, mining firms hauled $11 billion worth of gold, silver, and other minerals off U.S. federal lands, having paid a fraction of 1 percent of that in fees and permits—leading former U.S. Secretary of the Interior Bruce Babbitt to dub the law "a license to steal."[54]

Until 1991, Australia charged no federal income tax to gold miners. Even today, mining firms there pay state governments small amounts of royalties, ranging from 1 to 5 percent. And until 2002, when they were nationalized, most mines in South Africa were privately owned and did not pay royalties or taxes on profits.[55]

In recent years, other countries have tried to emulate some of these outdated laws. Since 1990, more than 100 countries—almost all in the developing world—have rewritten their laws, and in some cases amended their constitutions, in order to attract foreign investment in mining. Countries such as Ecuador, Argentina, and Tanzania now offer fast-track approval processes, allow 100-percent foreign ownership of mines, charge no taxes for imported equipment, let companies repatriate all profits, and in some cases, such as in Papua New Guinea, provide immunity to companies against compensation claims.[56]

The final handout of public money comes when mines close down or are abandoned, and governments and taxpayers are stuck with cleanup bills for the mess left behind. U.S. taxpayers have been left with hefty tabs for cleanup after companies have gone bankrupt or just walked away from uneconomical projects. Altogether, it will cost $32–72 billion to try and mop up toxic messes at the half-million abandoned mines across the United States—and most of these costs will be footed by taxpayers. Galactic Resources, Inc., a Canadian mining company, stuck U.S. taxpayers with a $200 million bill when it declared bankruptcy and walked away from the Summitville gold mine in Colorado in 1992. The 3,300-hectare mine had been leaking cyanide into the Alamosa River since its first week in operation and had destroyed 25 kilometers of the river by the time it was closed. When Galactic left, it had mined $130 million worth of metals at Summitville in exchange for $7,000 in mining permits.[57]

International financial institutions and development agencies have also helped bankroll extractive industries. The Asian Development Bank, the World Bank Group, and assorted export credit agencies have actively promoted mining in developing countries through loans, investment guarantees, and influence over mining and investment laws. Between 1995 and 1999, the World Bank Group spent close to $6 billion to fund mining projects around the world, and the Inter-American Development Bank spent another $1 billion. The World Bank's Multilateral Investment Guarantee Agency (MIGA) has underwritten investment to develop mines in sub-Saharan Africa, Peru, Central Asia, and Russia; in 2000, 12 percent of its guarantees supported the mining sector. MIGA has provided more than $100 million in guarantees and equity coverage to developers of the Antamina mine in Peru, which is being built next to the Huascarán National Park, a World Heritage Site. And it reinsured the Omai Gold Mine in Guyana, where a tailings dam collapse in 1995 released 3 billion liters of contaminated effluent into the Essequibo River. The U.S. Overseas Private Investment Corporation has also backed mine projects that have harmed people and the environment, including the Kumtor Mine in the Kyrgyz Republic, where there have been a series of mine accidents involving cyanide spills.[58]

Digging Out

An ecologically inclined accountant studying the balance sheet for mining might be baffled by our situation. It seems absurd that the world continues to obtain minerals in a way that uses so much energy and generates untenable amounts of pollution, and that poor regions are encouraged to yoke their futures to an unstable and short-lived source of income at risk to the health and safety of their citizens. This accountant would be pleased to learn that there are less-damaging ways to obtain materials and jobs—many of which have been in use for a long time—and that these practices could help balance out the cost-and-benefit account books more evenly.

Most of the energy use and environmental damage associated with minerals production occur during extraction, refining, and smelting of virgin materials. Tapping into minerals that have already been extracted and recirculating them through the economy would eliminate much, although certainly not all, of this damage. For example, producing the most energy-intensive metals—aluminum, steel, and copper—solely from recycled metal could reduce the energy used each year to obtain metals by as much as 70 percent. This savings exceeds the amount of energy used annually by the entire South Asian region—which is home to a quarter of the world's people. This is because it takes far less energy to recycle discarded materials than to extract, process, and refine metals from ore. It takes 95 percent less energy to produce aluminum from recycled materials than from bauxite ore, for instance. Recycling copper takes between five and seven times less energy than processing ore; recycled steel uses two to three-and-a-half times less.[59]

To make up for losses due to recycling, or dissipation, a closed-loop economy might supplement above-ground stocks with some amount of newly mined materials. Truly sustainable use of resources would require using smaller amounts overall and maximizing the amount of service obtained from each kilogram of material. This would require more than just finding ways to recirculate materials through the global economy. For planners, it would involve designing cities and transportation systems in ways that are less spread out and materials-intensive than they are at present. For consumers, using fewer minerals may well involve a shift in what is valued: for many, the "good life" might not be equated to the amount of stuff accumulated.

To comprehend just how absurd it is to continue to mine new metals while existing stocks lie untapped, consider two of the most environmentally damaging metals mined: gold and copper. Currently, three times more gold is sitting in bank vaults, in jewelry boxes, and with private investors than is waiting in the reserves identified in underground mines. (See Figure 6–3.) This is enough gold—150,000 tons—to meet the current demand for 17 years.[60]

But even if we are able to tap into this above-ground gold mine, a more fundamental question is, Does the world really need an additional 2,400 tons of gold each year? Gold industry advertising campaigns try to convince people that this yellow metal is indeed a necessity, but in fact 80 percent of it is used to make jewelry. Much of this is used in wedding dowries in India and the Middle East. Reducing our dependence on newly mined gold—and its sizable environmental impact—will thus undeniably involve cultural change there and elsewhere.[61]

Global data on where copper ends up are more sketchy than for gold. For the United States, however, analysts have estimated the amount of mined copper that is in use or in landfills. (See Figure 6–4.) They surmise that in the United States, about 70 million tons of copper are in products that are currently in use. Some of this copper is built into long-lived products such as buildings and electricity cables, where it has a useful life span of 40 years, on average. Copper is also contained in shorter-lived items such as electronic products and durable goods such as washing machines, whose useful life ranges from one to seven years, on average. Even though copper and its alloys can be easily recycled, about 40 million tons of the metal sits in U.S. landfills—as discarded car stereos, pipes, or other products. (An exception is copper contained in scrap iron and steel, which is nearly impossible to separate out from the ferrous metal.) And U.S. recycling rates for copper are much higher than the global average. Just 13 percent of copper consumed worldwide comes from recycled sources.[62]

This is unfortunate, because metals are eminently recyclable. Used copper or aluminum can be transformed back into the same amount of metal with very little additional supplement of new metal. Aluminum from a beverage container can be melted down, refabricated, and used to make a new can just weeks after it is dropped into a recy-

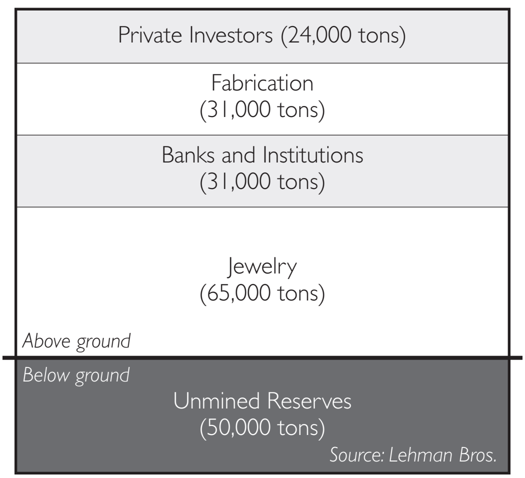

Figure 6–3. Gold Stocks Above and Below Ground, 2000

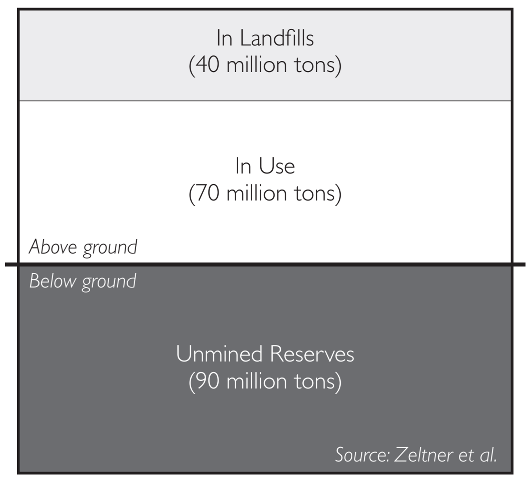

Figure 6–4. U.S. Copper Stocks Above and Below Ground, 1990s

cling bin. Had the 7 millions tons of cans thrown away by Americans between 1990 and 2000 been recycled, they would have yielded enough aluminum to make 316,000 Boeing 737 planes—which is about 25 times the size of the world's entire commercial airfleet.[63]

Why do we expend so much energy trying to find new underground mines if so much useful metal lies in cities and landfills? In several countries, the subsidies offered for virgin materials extraction make it cheaper to dig up new minerals than to recycle existing, aboveground supplies. Mining companies have fought hard to maintain this status. In the United States, for instance, the industry has staunchly opposed any reforms to the 1872 mining law—and has invested large amounts of money to maintain this support. Between mid-1997 and mid-2000, U.S. mining interests contributed almost $21 million to political campaigns.[64]

Current materials systems are aligned along the uneven playing field that favors miners and places recyclers at a disadvantage. For instance, most smelters and refineries are not set up to accept secondary sources of material. In Germany, the government introduced aggressive laws in the 1990s to encourage recycling—without first ensuring that materials markets could absorb an avalanche of secondary materials, much of which ended up languishing in warehouses.[65]

Another constraint to recycling is that many modern products are made of a complex set of alloys and materials, which are not easy to separate out and reprocess. But this is hardly insurmountable: products ranging from computers to cars are being designed to be disassembled for repair, reuse, and, ultimately, recycling. Mitsubishi makes a washing machine that can be taken apart using just a screwdriver; Audi makes a 100-percent recyclable car. To aid recycling, some manufacturers now put bar codes on parts to identify the different materials.[66]

Recognizing the value of scrap metals, auto recyclers in the Netherlands recycle about 86 percent by weight of discarded cars. Most cars there are taken apart and reprocessed to reclaim materials in hubcaps, batteries, and other car parts, and this is funded by a $130 disassembly fee that new car buyers pay. Encouraged by the Dutch model, the European Union (EU) has proposed a Scrap Car Directive, which requires manufacturers to take responsibility for cars at the end of their useful lives. Under the proposal, carmakers will have to recycle all recyclable parts of the vehicle, and 85 percent of all materials by weight. The EU proposal also requires manufacturers to discontinue use of heavy metals such as cadmium, mercury, and lead in auto parts because of the health risks they pose during mining, use, and disposal.[67]

In a similar vein, in June 2000, the European Commission passed a Directive on Waste from Electronics and Electronic Equipment, which is slated to become European law in early 2003. The directive calls for electronics manufacturers to stop using heavy metals by 2006, and for producers to take financial and physical responsibility for recycling, including providing a place for households to return discarded equipment free of charge. Still under negotiation are recycling and reuse targets for producers. Currently, 90 percent of the EU's electronic waste—from computers, televisions, stereos—ends up in landfills. Many countries outside Europe, including Australia, Japan, South Korea, and Taiwan, have introduced or proposed similar laws requiring electronics firms to take back and recycle their products.[68]

Producing materials from secondary sources has significantly smaller impacts than virgin sources would in terms of energy use, toxic emissions, and occupational health hazards—but it does not eliminate them entirely. In a sustainable materials system, repair, reuse, and remanufacture are the methods of first choice. Recognizing this, the Danish government has banned aluminum cans in favor of reusable glass bottles—nearly 100 percent of bottles there are returned and reused.[69]

Secondary materials options are labor-intensive and have the potential to create many more jobs than mining. But this may not be reassuring to skilled mine workers in places with few alternative income sources. If we are to move to an economy based on less virgin materials mining, a key component will be investment in transition plans to provide safety nets and employment opportunities to workers and communities. The Canadian Labour Congress (CLC) has worked hard to promote "just-transition" plans for workers from sectors such as chemicals, pulp and paper, and mining, noting that "just-transition is an essential part of environmental change." It has recommended that displaced workers be retrained for high-paying, "green" jobs. The CLC has highlighted the need for unions and governments to be prepared for change: to anticipate that environmental imperatives will—or should—determine the viability of certain industries and jobs. Trade union federations elsewhere, such as the AFL-CIO in the United States, and the European Trade Union Congress, have also endorsed similar fair transition plans.[70]

With mining jobs in decline around the world, governments, firms, and unions have a tremendous opportunity to create safer, more meaningful, ecologically sustainable employment for these workers and the families they support. Following the enormous layoffs of the 1990s, the South African Employment Bureau and the National Union of Mine workers there developed transition plans to retrain and employ former mine workers—some whom have found new jobs in steel and paper recycling, for instance. In the United States, recycling and remanufacturing employ more than a million people—many more than its mines, which have about 220,000 workers.[71]

Why do we expend so much energy trying to find new underground mines if so much useful metal lies in cities and landfills?

Many towns around the world are looking away from mining and toward more ecologically sustainable industries. Chloride, Arizona, a former silver mining town in the United States, for instance, is looking toward wind energy to reinvigorate its economy. China has 4.3 million mine workers—almost a third of the world's work force in mining—in nearly 400 mining towns. The mines in some 80 percent of these towns have been largely depleted, and about 100 nonferrous metal mines are expected to close down in the next few years. Li Rongrong, the minister in charge of the State Economic and Trade Commission, has urged these moribund mining regions to expand their economies "in line with sustainable development."[72]

Even if we are able to reconfigure our materials economy so that most of our resources come from secondary sources, some mining will likely continue. And there are many immediate opportunities for improving the way mines operate. For instance, it makes sense to do away with some practices that are very damaging and yield so little benefit—such as pouring cyanide over tons of ore to produce a few kilograms of gold that are ultimately used for ornamental purposes. Another practice ripe for change is the dumping of tailings and other mine wastes into rivers and the ocean. And any mining that continues must be out of the boundaries of protected areas, and must be conducted with the free, prior, and informed consent of local communities.[73]

In Costa Rica, intact forests are very valuable to the country—ecotourism is the second-largest source of the country's revenue. In June 2002, President Abel Pacheco declared a moratorium on all open-pit mines, noting that "the true fuel and the true gold of the future will be water and oxygen; they will be our aquifers and our forest." Similarly, the county of Cotacachi in Ecuador has banned all forms of mining in order to protect its cloudforest and people.[74]

Any mining that continues must be out of the boundaries of protected areas and conducted with the free, prior, and informed consent of local communities.

In many parts of the world, a few farsighted leaders are taking strong stands against the continued use of cyanide, mercury, and other toxic chemicals in mines. The Baia Mare spill in Romania in 2000 prompted the Czech Senate and the German Parliament to ban gold mining that used cyanide leaching methods. The Provincial Board of the Mindoro province in the Philippines passed a 25-year moratorium on mining in January 2002, following controversies over cobalt and nickel mining. And in 1998, a citizens' initiative in Montana led to a ban on the use of cyanide leaching for new mines or expansions of existing mines in the state.[75]

Removing subsidies handed out to miners, such as those granted under the U.S. mining law, would have considerable environmental benefits—reducing pollution, for instance, and helping to boost secondary materials production. It would also add income to the public treasury—resources that could be directed toward developing more sustainable materials paths or toward improving social services such as education or health care. Charges for mining permits will also need to be adjusted, to better reflect the long-term costs of depleting nonrenewable resources.

Polluters must also be held responsible for damage caused during mine operations and for the ongoing expenses of mine closure. The cost of trying to clean up hundreds of thousands of abandoned mines in the United States alone is estimated as between $32 billion and $72 billion. Although no overall estimates exist for cleanup costs at mines in China, India, South Africa, or Eastern Europe, it is certain that their governments face very large tabs as well. Legislators and environmental agencies must ensure that polluters, not taxpayers, foot these bills, by requiring companies to provide financial guarantees such as surety bonds before they are allowed to start mining. Unfortunately, the Bush administration in the United States is currently attempting to roll back rules that have required mining companies to post reclamation bonds to cover cleanup expenses at mines.[76]

Many community groups, environmental and human rights organizations, trade unions, and policy think tanks around the world are working together to campaign for some of these changes, which is contributing to the momentum for a new approach to our dependence on minerals and mining. These regional and international networks include the Western Mining Activist Network in North America; the African Initiative on Mining, the Environment, and Society; the Mines, Minerals, and People network in India; and the Global Mining Campaign.[77]

Agencies whose expressed purpose is to reduce poverty are beginning to reconsider their role in financing an industry that has hurt the poor and the environment. Responding to pressure from environmental and human rights groups, MIGA cancelled its risk insurance to Freeport McMoRan's Grasberg mine in West Papua in 1997. In October 2002, the International Finance Corporation, the private arm of the World Bank Group, decided not to back the controversial Rosia Montana gold mine project in Romania, under directions from Bank president James Wolfensohn. The World Bank is currently undertaking an Extractive Industries Review to evaluate its future funding to mining, oil, and gas. The report is due to be completed at the end of 2003.[78]

The mining industry itself has begun to examine its impact on the environment and communities. In 1998, nine of the world's largest mining companies joined together to review the pressing issues they faced; this led to a two-year research effort—the Mining, Minerals and Sustainable Development (MMSD) Project—which issued a report in 2002. Mining companies also jointly formed an International Council on Mining & Metals, which is now charged with implementing the conclusions of that report. The MMSD study acknowledges some aspects of the industry's role in environmental damage and human rights violations, but critics note that it "adds little to the existing debate about how the minerals sector should evolve to meet the challenge of sustainable development."[79]

There is no question that mineral use has done much to improve the lives of billions of people and to foster the development of modern societies. But we are several eons past the Iron and Bronze Ages of our ancestors—and should no longer need to use polluting and destructive methods to continue to obtain these benefits. Our success in accelerating the transition to materials systems that are less polluting, that create healthy and safe jobs, and that tap into existing supplies will help determine our legacy to future generations—and whether ours will be the age that at long last puts harmful mining practices on the scrap heap of history.

Chapter 6. Scrapping Mining Dependence

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5. Toxic emissions refers to data for the United States per U.S. Environmental Protection Agency (EPA), *Toxic Release Inventory 2000*, at <www.epa.gov/tri>, viewed 1 July 2002. Table 6–1 from the following: gross world product from U.N. Statistics Division, *National Accounts Statistics: Main Aggregates and Detailed Tables, 1998* (New York: 2001), data supplied by Gonca Okur, World Bank, e-mail to author, 29 April 2002, and from World Bank, *World Development Indicators 2001* (Washington, DC: 2001); employment from Norman Jennings, ILO, discussion with author, 18 July 2002, and e-mail to author, 10 October 2002, from ILO, LABORSTA database, at <laborsta.ilo.org/>, viewed 26 September 2002, and from World Bank, op. cit. this note; energy is Worldwatch estimate based on various sources cited later in this chapter; sulfur dioxide from Emission Database for Global Atmospheric Research (EDGAR), National Institute of Public Health and the Environment, Bilthoven, the Netherlands, at <arch.rivm.nl/env/int/coredata/edgar/>, updated November 2001; forests from Dirk A. Bryant et al., *The Last Frontier Forests: Ecosystems and Economies on the Edge* (Washington, DC: World Resources Institute, 1997), p. 15.

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9. Production figures from Matos, op. cit. note 8, from USGS, *Minerals Yearbook*, op. cit. note 8,

from idem, *Mineral Commodity Summaries* , op. cit. note 8, and from United Nations, op. cit. note 8.

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