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Shaba's Cobalt: Western Dependence and Options

An Intelligence Assessment

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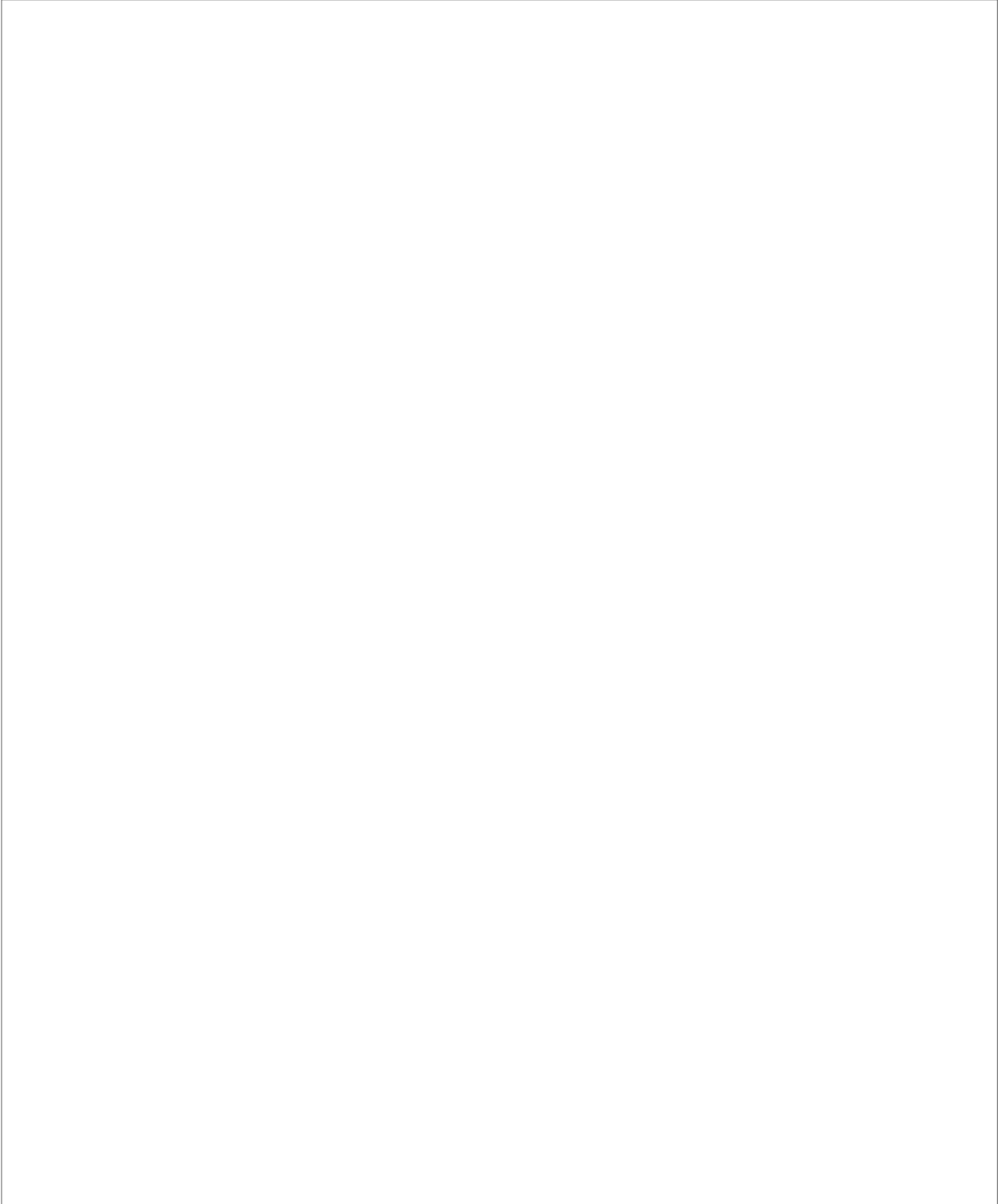
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Shaba's Cobalt: Western Dependence and Options

An Intelligence Assessment

This paper has been prepared by [redacted]
[redacted] Office of Global Issues.
Comments and queries are welcome and may be
addressed to the Chief, Minerals and Resources
Branch, OGI [redacted]

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*GI 82-10144
July 1982*

**Shaba's Cobalt:
Western Dependence
and Options (U)**

Key Judgments

Western concern about raw material supply disruption was heightened in the late 1970s by two rebel invasions of Zaire's mineral-rich Shaba region—the world's largest producer of cobalt and a significant producer of copper. The first incursion in 1977 had no effect on mineral markets, but the second invasion, a year later, prompted substantially higher cobalt prices amidst panic over the continued availability of "risk-free" cobalt from Zaire. [redacted]

In spite of recent rebel activity along Zaire's Angolan and Zambian borders, there is little prospect of a major rebel invasion of Shaba soon. Smaller scale attacks, involving sabotage and hit-and-run operations, are somewhat more likely and could disrupt mining and processing. The risk of another invasion, however, could well increase over time [redacted]

From the standpoint of strategic mineral supplies, the West's main concern with a Shaba disruption would be the loss of access to Zaire's cobalt. Because of large inventories outside Zaire and sagging demand, however, industrial countries could absorb as much as a yearlong supply disruption with little or no trouble. Although this supply cushion will narrow as Western economic recovery boosts demand, inventory overhang and unused capacity outside Zaire will remain adequate to absorb the shock of a one-year Shaba shutdown until well into the last half of the decade. [redacted]

The industrial countries as a whole could get by without cobalt from Shaba indefinitely by developing other sources and by exploiting conservation, substitution, and recycling measures. Because Shaba's cobalt production is relatively inexpensive and the alternatives would require considerably higher investment and operating costs, however, the long-run price of cobalt would have to rise above \$25 a pound to stimulate these changes. While such an increase would be substantial, the impact on cobalt consumers would be minor because cobalt represents only a small fraction of the total cost of its end products. [redacted]

Information available as of 1 July 1982 has been used in the preparation of this report.

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The United States has several large deposits of low-grade ore that could replace most of the cobalt now imported from Zaire. By exploiting these deposits and adopting conservation, substitution, and recycling measures, US demands for cobalt could be satisfied without imports from Shaba. France, Japan, and the United Kingdom do not rely heavily on cobalt from Zaire and could weather any disruption by increasing imports from their major suppliers. West Germany, Sweden, Belgium, and Italy, however, are greatly dependent on Shaba's cobalt and would likely try to develop new foreign sources, including the Soviet Bloc [redacted]

Although currently an importer of cobalt, the Soviet Union is expanding its cobalt-producing facility at Noril'sk, and Cuba plans to expand its domestic industry. As their export capacities grow, these two countries would benefit from price increases resulting from a cutoff in Shaba supplies. Indeed, to the extent that Soviet Bloc cobalt appears on the market, Western producers may be reluctant to expand their own capacities, open new deposits, or pursue substitution, recycling, and conservation plans. Some Western countries could come to rely on the East for yet another important mineral. [redacted]

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Shaba's Cobalt: Western Dependence and Options

Introduction

Western industrial countries have been concerned for several years about the continued availability of cobalt from Zaire's Shaba region. Shaba accounts for over 55 percent of the non-Communist world's output of cobalt. Few producers of the metal exist in the industrialized West. Last year Australia, Canada, and Finland together mined 4,900 tons of cobalt, only a sixth of the non-Communist world's output and less than one-third of the developed West's needs.¹ Although recycling supplies 5 to 10 percent of those needs, most cobalt consumption requirements in the developed West are met by imports. The United States, for example, imports over 90 percent of the cobalt it uses. Nearly 60 percent of US imports come from Zaire; 14 percent come from Zambia.²

While Shaba produces other metals (see map), that activity is far less important to the world economy. The region accounts for 8 percent of the copper mined in the non-Communist world; copper, however, is widely available outside Zaire, and the developed countries produce almost as much as they consume. Moreover, copper is not as highly valued as cobalt in strategic uses, and, while few substitutes have been developed for cobalt, adequate substitutes are available for many of copper's applications. Shaba also produces small amounts of cadmium, zinc, tin, silver, and manganese (table 1) and has the world's largest reserves of germanium. The developed West, however, meets most of its germanium needs from large deposits in the United States and Western Europe.

The Shaba Incursions

Shaba I. Rebels of the Front for the National Liberation of the Congo (FLNC) invaded Shaba in March 1977. Meeting little resistance from security forces, the FLNC quickly captured several towns in the southwestern part of the region and at one point

¹ Weights are given in metric tons unless otherwise noted.

² Belgium-Luxembourg actually account for 15 percent of US cobalt imports. Since all of Belgium-Luxembourg's cobalt is of Zairian origin, however, it is included in the total for Zaire.

Table 1

Shaba Mineral Production as a Share of Non-Communist Output, 1981

	Percent
Cobalt	56.5
Copper	8.3
Cadmium	1.8
Zinc	1.3
Tin	1.0 ^a
Silver	0.8
Manganese	0.1

^a Estimated.

advanced to within 50 kilometers of the key copper and cobalt mining town of Kolwezi. The area affected was limited because a grass-roots uprising expected by the rebels in other parts of the country never materialized. In mid-April at the invitation of Kinshasa, Moroccan troops joined with Zairian Government forces and, in a matter of a few weeks, routed the rebels.

The invasion did not seriously affect Zaire's cobalt output nor the market for the metal. Cobalt production fell by 7 percent, but that was mainly attributable to a decline in the cobalt content of the ore mined that year and was not related to the invasion. Growing demand—not associated with FLNC activities—caused cobalt prices to rise.

Shaba II. FLNC rebels again invaded southwestern Shaba in May 1978. This time they occupied Kolwezi for six days before French Legionnaires, in conjunction with the Zairian Army, retook the mining center. The insurgents destroyed rail stock but did not damage the mines. As many as 130 foreigners and

Zaire at a Glance

Political Status

The Democratic Republic of the Congo, which won its independence from Belgium in June 1960, was re-named Zaire in October 1971. In February 1978, the present one-party constitution was declared.

President and Head of Government

Lt. Gen. Joseph Mobutu became Head of State by military coup in 1965; named President of the Popular Movement of the Revolution in 1967; elected President of the Republic by popular vote in 1970 (albeit as sole candidate); reelected on 23 October 1977, and inaugurated for a second seven-year term on 5 December.

Geography

Zaire, located in west-central Africa, is 2,343,950 square kilometers in area (roughly equal to the United States east of the Mississippi River). However, the coastline, which is entirely on the Atlantic Ocean, is only 37 kilometers long. This equatorial country borders Angola and Zambia to the south; Tanzania, Burundi, Rwanda, and Uganda to the east; Sudan and the Central African Republic to the north; and the Congo to the west (see map).

Resources

Zaire is well endowed with minerals, including cobalt, copper, industrial diamonds, tin, manganese, zinc, silver, cadmium, gold, tungsten, columbium, germanium, and tantalum. Most of Zaire's mineral

wealth and production—including all of its cobalt, copper, zinc, germanium, manganese, and cadmium, is located in the southernmost region of Shaba. In 1975 Zaire began oil production from two offshore fields.

Export Earnings

In 1981 Zaire is estimated to have received more than \$1.5 billion in export earnings. Nearly seven-eighths of this came from the sale of mineral products, including copper (49 percent of export earnings) and cobalt (11 percent).

Population

Estimated 29.4 million in 1981

Capital

Kinshasha (formerly Leopoldville)

GDP

Estimated \$4.5 billion in 1981

Per Capita GDP

Approximately \$150

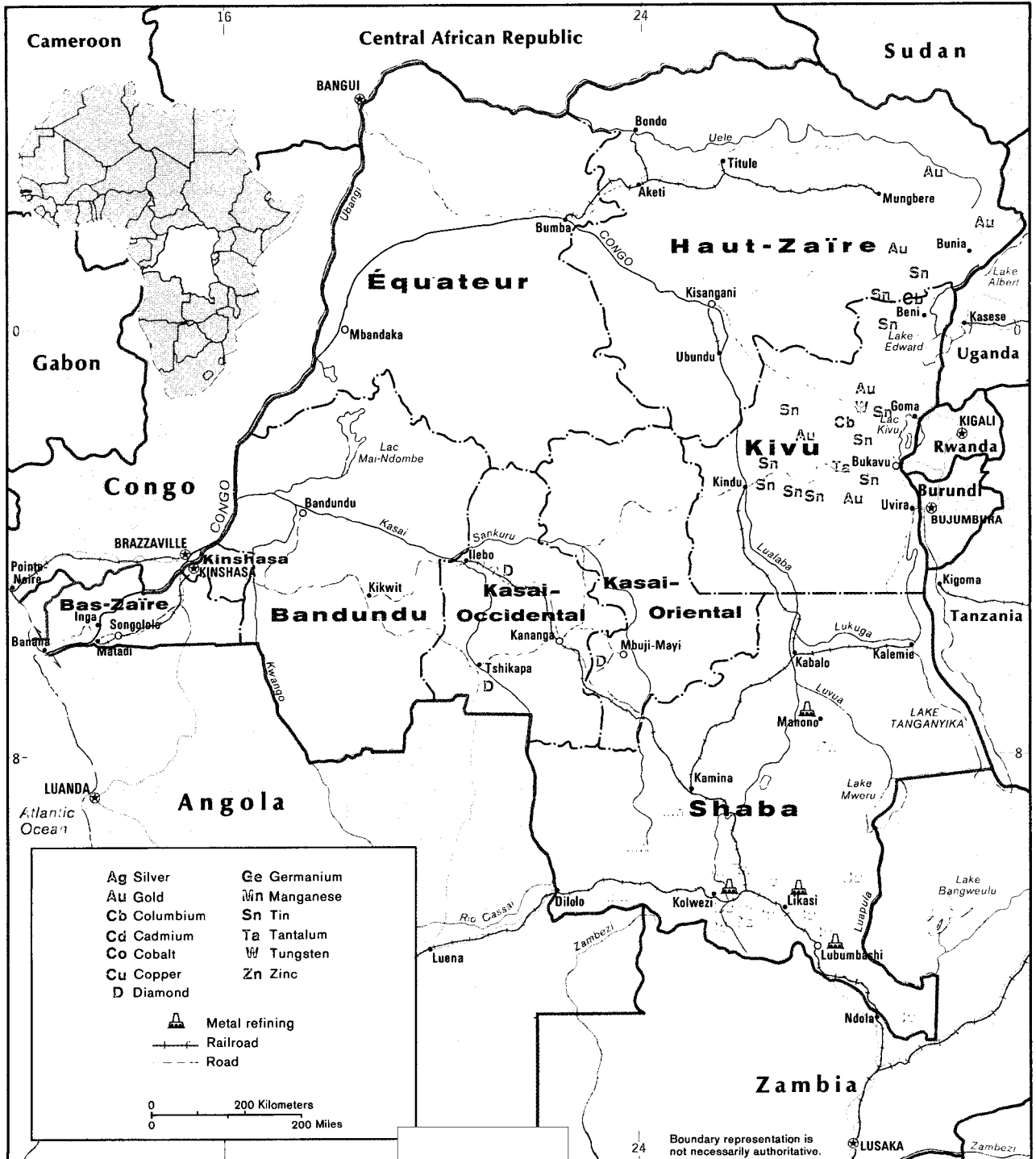
Foreign Debts

Estimated \$4.5 billion in 1981

thousands of Zairians were killed during the fighting. The ensuing flight of foreign managerial and technical personnel made resumption of mineral production difficult and curbed expansion plans. Eventually most of the Europeans returned. By resorting to richer grade ores, Zaire increased cobalt production significantly for the year as a whole [redacted]

The incident aggravated an already tight cobalt market, setting off a round of panic buying and hoarding in the developed West. The producer price reached \$25 per pound by early 1979, up from \$6.85 per pound a year earlier. Prices on the spot market hit \$50 per pound. Even so, the West was not badly hurt by

Zaire: Minerals



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this incident. Since cobalt accounts for a small share of the total cost of most finished products in which it is used, the impact on the prices of cobalt-bearing final products was fairly small. Furthermore, the price increases spurred substitution and conservation measures, which served to reduce Western reliance on cobalt imports, both then and later:

- Steps were taken, almost at the onset of the sharp price increase, to replace alnico (aluminum-nickel-cobalt) magnets with ferrite-ceramic magnets containing no cobalt or with cobalt-samarium magnets, which have a greatly reduced cobalt content. The use of cobalt in magnets fell 50 percent in two years. The magnet market accounted for 21 percent of US uses of cobalt in 1977. By 1980 its share had fallen to 15 percent.
- In some of cobalt's critical uses, substitution and conservation activities also made headway. In high-speed tool steels, for instance, cobalt-free alloys are now commercially available. In jet engines, alloys of nickel, molybdenum, and aluminum have been developed to replace cobalt in some components. Pratt and Whitney, the world's largest user of cobalt, plans to reduce cobalt consumption by 50 percent during the next few years.
- The developed West's dependency was further reduced through intensified recycling. In the United States, for example, secondary cobalt now accounts for about a tenth of domestic needs. By contrast, consumption of recycled cobalt in 1977 amounted to just 3 percent of total US consumption [redacted]

Shaba III: Impact on the West

Should a "Shaba III" occur, a shutoff of mineral supplies of any duration would not affect critical Western needs. The impact on prices and supplies in the developed West would largely depend on market conditions at the time of the incursion and the length of the supply disruption. The latter would be in large part determined by the extent of damage to mining, processing, or shipping facilities. [redacted]

A Yearlong Supply Disruption. A yearlong disruption of cobalt output in Shaba is possible if any future invasion results in significant damage to mines, processing facilities, or the transportation network. A

guerrilla campaign—involving recurring sabotage and hit-and-run operations—aimed at those facilities could bring about the same result. If such a cutoff in cobalt supplies from Zaire were to occur soon—that is, under current market conditions—the developed West would not feel much of a pinch for some time, perhaps a year or so. Cobalt is currently in excess supply and is expected to remain abundant at least until the mid-1980s. Even if world demand for cobalt returns to the 25,000-ton-per-year level of the mid-1970s, the West could manage without serious difficulty because of the production capacity and large inventories available elsewhere [redacted]

- Non-Communist cobalt capacity outside Zaire is now almost 14,000 tons per year.

- Private commercial inventories in the United States amount to about 2,700 tons of cobalt.

- We calculate, [redacted] that other Western countries probably have at least 1,800 tons of cobalt in commercial stocks. [redacted]

In order to sustain its badly needed foreign exchange earnings while dealing with a crisis in Shaba, the Zairian Government could be expected to continue to sell cobalt [redacted] Although actual supply shortages could easily be avoided, prices would almost certainly increase as the disruption wore on. Given the huge inventory overhang, we believe that traders and commercial dealers would be willing to sell off stocks without much resistance. Moreover, under these conditions other cobalt producers would be induced to use their slack mining and processing capacity. [redacted]

Even if the price of cobalt increased sharply, the impact on industrial users would not be particularly serious. In most applications cobalt accounts for only a small portion of final product costs. For example, the 900 pounds of cobalt used in the \$2 million F-100 jet engine now costs around \$9,000. Thus, even if the price of cobalt were to increase to four times the current price, the cost of the engine would rise by less than 2 percent. Similarly, the cost of a gallon of paint using 4 to 5 milligrams of cobalt would rise by no more than one cent. [redacted]

Cobalt: Applications and Market Structure

Cobalt—virtually irreplaceable in some of its applications—is one of the most critical industrial metals. Because of unique hardening qualities and resistance to corrosion, abrasion, and heat buildup, it is required in such strategic end items as jet engines, machine tools, drill bits, wellhead valves, and as a catalyst for petroleum hydrogenation. The quantity needed in each application is relatively small, and with a few significant exceptions, forms only a fraction of final product costs. Consequently, rising cobalt prices do not represent a significant inflationary threat for consuming countries.

Cobalt mine production is dominated by Zaire, which accounted for over 55 percent of the non-Communist world's output and almost 45 percent of total world production in 1981. With the exception of the USSR, which accounts for a sixth of world output, the few other cobalt producers are much smaller. The United States currently has no cobalt mineral production, but it obtains about 10 percent of its current needs by recycling scrap. In 1981 the USSR overtook the United States as the world's largest cobalt user, 6,100 tons versus 5,600 tons. Together these two account for about half of the world's cobalt use. For the second year in a row, consumption in the non-Communist world fell about 20 percent in 1981 because of the Western economic slowdown and continued progress in developing substitutes.

Industrial Uses of Cobalt in the United States

Use	Percent
Superalloys	40
Magnets	15
Catalysts	12
Driers	12
Metal cutting and mining tools	10
Other	11

Growth of cobalt demand during the remainder of the 1980s will depend heavily on the recovery and subsequent growth of the economies of the principal industrial countries and the price of cobalt. Barring a new energy crisis or some other major dislocation, economic growth should rebound from the current deep slump within the next year or so, causing increased investment in products that require cobalt. Without a disruption of cobalt supplies from Zaire we expect that annual Free World demand for cobalt will be about 25,000 tons in 1985 and will grow to between 27,000 and 31,000 tons by the end of the decade.

An Extended Shutdown. The possibility of an interruption in supplies from Zaire lasting several years cannot be ruled out. That might be the case if a civil or military disturbance dragged on beyond a year and were accompanied by destruction of mining and processing facilities. We believe that Zairian security forces would be unable to cope with a reasonably well organized military invasion and even less able to deal

with a campaign of sabotage and terrorism. Moreover, Kinshasa's prospects for receiving the foreign assistance it would need to quash the rebels quickly are significantly less now than they were several years ago. Nevertheless, the FLNC itself is undermanned, ill equipped, disorganized, and demoralized. It probably does not now have the ability to carry out a

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successful military invasion of Shaba but does appear to be able to mount a guerrilla campaign of sabotage and hit-and-run operations. [redacted]

Western mining experience suggests that if Zaire's cobalt mining and processing facilities were destroyed—whether by a well-organized incursion or appropriately directed hit-and-run activity—up to two years would be required to replace them on normal installation schedules: a year to pump out underground mines and restore water-damaged interiors; 12 to 18 months to rebuild concentrating plants; and one to two years to completely rebuild smelters and refineries. Less time would be required, of course, if production facilities were only partially damaged. Refineries and concentrators could be reconstructed in eight months to a year on a "crash" basis with substantial amounts of external aid. [redacted]

Given these factors, a supply disruption lasting three years or more is a distinct possibility. While slack cobalt capacity and inventory drawdowns could satisfy normal consumption patterns during a disruption lasting up to a year and perhaps 18 months, more basic adjustments would be required to absorb the loss of Shaba cobalt for a longer period. The adjustments would have to come on both the supply and demand sides [redacted]

Our analysis of supply alternatives indicates that enough cobalt mine capacity could be developed elsewhere during a three- to four-year period to replace one-third to one-half of Shaba's current mine capacity of 16,000 tons. By the end of the decade, capacity additions elsewhere could completely replace Shaba's capacity. The price increase needed to bring these additional supplies on stream would also provide a strong incentive to develop cobalt substitutes, recycling, and conservation—measures that would reduce demand. Industry statements indicate that a long-run price of between \$25 and \$50 per pound (1981 dollars) would be enough to generate the supply-demand adjustments that would eliminate the need for Shaba's cobalt. [redacted]

Supply Alternatives

The annual cobalt mine capacity of non-Communist countries outside Zaire currently totals almost 14,000 tons. Drawing from a variety of government and

Table 3

Metric Tons

Cobalt: Potential Expansion of Capacity Outside Zaire, 1984-90

Region	Estimated Present Capacity 1982	Potential Capacity Additions 1984-90	Total Potential Capacity 1990
World	23,200	25,900	49,100
Non-Communist countries	13,700	17,400	31,100
North America	2,270	5,500	7,770
Canada	2,270	1,500	3,770
United States		4,000	4,000
South America	0	1,100	1,100
Peru	0	1,100	1,100
Europe	1,400	500	1,900
Finland	1,400	500	1,900
Africa	6,910	7,100	14,010
Botswana	300		300
Morocco	1,800		1,800
South Africa	230	800	1,030
Uganda	0	1,300	1,300
Zambia	4,500	5,000	9,500
Zimbabwe	80		80
Oceania	3,120	3,200	6,320
Australia	1,600		1,600
Indonesia	0	1,400	1,400
New Caledonia	250	1,800	2,050
Philippines	1,270		1,270
Communist countries	9,500	8,500	18,000
Cuba	2,500	2,500	5,000
USSR	7,000	6,000	13,000

industry studies, we estimate that this capacity could be increased by more than 17,000 tons by the end of the 1980s (table 3). The United States could become a major cobalt producer from several low-grade deposits: cobaltiferous laterites in Oregon and California, the Blackbird mine in Idaho, the Duluth complex in Minnesota, and lead-zinc deposits in Missouri. [redacted]

[redacted] these deposits could produce 4,000 tons annually. Zambia could expand its cobalt output considerably by exploiting

Table 4

Thousand Metric Tons

Cobalt: Estimates of Reserves and Resources

Region	Bureau of Mines ^a			German Institute for Economic Research ^b		
	Estimated Reserves	Total Resources	Percent Reserves Produced Annually	Proven and Probable Reserves	Total Resources	Percent Reserves Produced Annually
World	1,483+	4,278+	2.4	3,665+	8,120+	0.9
Non-Communist countries	1,165+	2,998+	2.4	2,665+	6,645+	0.9
North America	30	1,010		220	650	
Canada	30	250	7.6	220	250	1.0
United States		760			400	
Western Europe	18	25		20	320	
Finland	18	25	5.7	20	25	5.2
Greece					200	
Spain					20	
Yugoslavia					75	
Latin America				45+	255+	
Brazil				30	100	0
Colombia					30	
Dominican Republic					50	
Peru	NA	NA		NA	NA	
Puerto Rico					45	
Other				15	30	0
Oceania-Asia	511	890		1,555	4,295	
Australia	49	300	3.3	135	300	1.2
India				45	45	0
Indonesia				565	865	0
New Caledonia	272	390	0.1	385	835	0
Papua New Guinea					40	
Philippines	190	200	0.6	425	2,175	0.3
Solomon Islands					20	
Other					15	
Africa	606+	1,073+		825+	1,125+	
Botswana	26	30	1.0	25	30	1.0
Morocco	13	13	5.8	10	15	7.5
South Africa	NA	NA		NA	NA	
Uganda				10	20	0
Zaire	454	680	3.4	450	680	3.4
Zambia	113	350	4.0	300	350	1.5
Zimbabwe				30	30	0.3

Table 4 (continued)

Thousand Metric Tons

Region	Bureau of Mines ^a			German Institute for Economic Research ^b		
	Estimated Reserves	Total Resources	Percent Reserves Produced Annually	Proven and Probable Reserves	Total Resources	Percent Reserves Produced Annually
Communist countries	318	1,280	2.6	1,000	1,475	0.8
China					20	
Cuba	109	1,050	1.8	800	1,100	0.3
USSR	209	230	3.0	200	350	3.2
Other					5	

^a US Bureau of Mines, *Cobalt, Mineral Commodity Profiles*, October 1979, p. 8.

^b Kruszona, Manfred et al., *Cobalt*, San Francisco: Miller Freeman Publications, 1979, p. 67.

new high-grade deposits and improving existing processing facilities. Uganda is anxious to process cobalt-rich tailings from past copper production. Additional major non-Communist expansion of cobalt output could occur in Canada, Indonesia, New Caledonia, and other countries with large cobalt resources (table 4). Investments could be delayed if equipment were difficult to obtain and install, which might well be the case with numerous expansion and development projects under way simultaneously, or if economic growth remained or again became sluggish.

Compared to the relative low cost of cobalt available from Zaire, however, development of new cobalt deposits and expansion of existing production elsewhere would be expensive. Investment decisions, therefore, would be heavily influenced by expectations of long-run price trends. The prospect of renewed large-scale cobalt production in Shaba, causing the world price to fall again, would greatly discourage investment elsewhere. Thus, such investment would probably not be made unless a disruption of Shaba output were expected to last at least five years or unless governments or consuming industries were willing to underwrite alternative cobalt production by price guarantees or subsidies.

Technological Change

In addition to development of alternative sources, there is considerable room for reducing demand and limiting its growth through technological adjustments. Indeed, technological alternatives to Shaba's cobalt have already made inroads into demand for the metal. The expectation of even a short disruption has caused some buyers to reduce their dependence on cobalt, regardless of cost, rather than face periodic supply problems. Government encouragement of recycling, conservation, and substitution would greatly speed the development of these measures:

- **Recycling.** The possibilities for increased recycling of cobalt are limited because in most applications the metal is dispersed in a host material. However, recently announced US projects alone would produce over 700 tons of cobalt per year from recycled catalysts and cobalt-bearing machinery scrap by 1985. More recycling possibilities would be explored as the price of cobalt increased.
- **Conservation.** The use of powder metallurgy is already reducing cobalt waste in the manufacture of superalloy components of jet engines. This and other

techniques for conserving cobalt would be aggressively pursued if the price of cobalt were to rise beyond the peak reached in 1979.

- **Substitution.** Nickel-based alloys and ceramics can be substituted for cobalt in some superalloy and magnet uses. Should cobalt prices increase, the development of rapid solidification and superplastic metals technology, metal glasses, metal-matrix and carbon-carbon composites, and reinforced plastics would provide still other materials that could be substituted for cobalt in a number of applications.

As new sources of cobalt, substitutes, and recycling and conservation techniques are being developed, governments could institute priority allocation schemes to assure that timely and adequate supplies of the metal reach defense and critical civilian users. This option might be needed during a transition period if commercial inventories decline too rapidly or if commercial traders withhold stocks from the market. In addition, a few countries maintain strategic stockpiles of cobalt. The US strategic stockpile of somewhat more than 21,000 tons is available for use in a national emergency.

Individual Country Responses

While the non-Communist countries as a whole could well weather any disruption in cobalt supplies from Shaba, the situation in various countries could differ greatly. The United States, with its large domestic resources and technological lead in recycling, substitution, and conservation, could get by without cobalt from Shaba. France, Japan, and the United Kingdom, which now rely less than others on Zaire, would press current suppliers to replace at least part of the lost Shaba cobalt and would expand their use of alternative sources:

- France imports heavily from Morocco and French-controlled New Caledonia.
- Japan produces most of its own cobalt from copper-nickel ores imported from the Philippines, Australia, and New Caledonia.
- The United Kingdom produces a large amount of cobalt in refining Canadian nickel and imports a good deal more from Zambia and South Africa.

West Germany, Italy, Belgium, and Sweden have fewer options. Only Sweden has a small strategic stockpile. These countries, then, would need to develop new foreign sources much sooner than the others.

East-West Issue

The Soviet Bloc would be in a position to take advantage of any high prices resulting from a disruption of the cobalt market. Cuba already exports cobalt to Japan and nickel to West Germany, France, Belgium, the Netherlands, Italy, and Japan. Moreover, it has major expansion plans; enlargement of two processing plants will soon be completed.

Although the Soviet Union is now a small importer of cobalt, it is a major producer of the metal and is expanding mining and processing capacity at its Noril'sk facility.

As export capacities in the Soviet Union and Cuba grow, these two countries would welcome a disruption of Shaba cobalt production:

- Cobalt exports could substantially increase Cuba's hard currency earnings.
- Soviet cobalt exports would neither flood Western markets nor earn significant amounts of hard currency compared to total Soviet trade and hard currency needs, but such exports extend the USSR's presence in Western Europe.

Moreover, to the extent that Soviet Bloc cobalt appears on the market, some Western producers might be reluctant to expand their own capacities; open new deposits; or pursue substitution, recycling, and conservation plans. Some West European countries—West Germany, Italy, Belgium, and Sweden—could become dependent on the East for yet another important mineral.

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