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STRATEGIC MINERALS

Extent of U.S. Reliance on South Africa

GAO/NSIAD-88-201

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National Security and
International Affairs Division

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The Honorable Edward M. Kennedy
The Honorable Lowell P. Weicker, Jr.
United States Senate

On October 28, 1987, you requested that we examine trade with South Africa and changes in that trade over the past 5 years; public and private credit available and changes in availability; the status of U.S. disinvestment and how it has been implemented; and U.S. dependence on South African strategic minerals. As requested by your offices, we issued an interim report on April 29, 1988 (GAO/NSIAD-88-165), which summarized our work to date on trade, credit, and investment. As subsequently agreed with your offices, we are now issuing this interim report summarizing our work to date on U.S. import dependence on strategic minerals from South Africa. A more complete final report responding to all your questions will be provided at a later date.

The Comprehensive Anti-Apartheid Act of 1986, as amended (Public Law 99-440, 22 U.S.C. 5001 et seq.), contains a number of prohibitions on trade with the Republic of South Africa. These include a ban on (1) imports of agricultural products, coal, iron and steel, and textiles and (2) exports of oil, arms, nuclear materials, and computers to apartheid-enforcing agencies.

Section (303) of the Act prohibits imports from parastatal organizations (corporations or partnerships owned, controlled, or subsidized by the South African government) but exempts strategic minerals when quantities essential for the economy or defense of the United States are unavailable from reliable and secure suppliers. Section 303(a)(2) requires that the President certify those strategic minerals to the Congress. On February 11, 1987, the Department of State certified 10 such strategic minerals and published them in the Federal Register. These minerals, hereinafter referred to as the "certified minerals," are

1. andalusite,
2. antimony,
3. asbestos, chrysotile,
4. chromium (including ferrochromium),
5. cobalt,

6. industrial diamonds (natural),
7. manganese (including ferromanganese and ferrosilicomanganese),
8. platinum-group metals,
9. rutile (including titanium-bearing slag), and
10. vanadium (including ferrovanadium).

In preparing this list of ten strategic minerals State considered several factors. These included: (a) whether the absence of the specified minerals would adversely effect the peacetime economy of the United States, United States competitiveness, or the defense of the United States; and (b) whether the minerals are available in sufficient quantities from alternative reliable and secure suppliers. The Soviet Union and the Eastern European bloc were not considered to be reliable and secure suppliers within the meaning of the Act.

Each of these minerals has some direct or indirect military application. (See app. I.) For example, cobalt is used to manufacture high performance gas turbine jet engines, chrysotile asbestos is used in missile systems, manganese is used in making high-alloy steel used for various military purposes, and platinum-group metals are used in catalysts for the production of chemicals and petroleum products and electronic applications.

EXTENT OF U.S. DEPENDENCE ON SOUTH AFRICAN STRATEGIC MINERALS

The extent of South Africa's role as a supplier of the certified minerals to the United States has varied over the past 5 years among the 10 minerals. It has become a more important supplier for some, a less important supplier for others, and its supplier role has remained unchanged for the remainder. The Soviet Union is not now nor has it been a major supplier of any of the 10 certified minerals since at least 1983.

Table 1 shows the Department of Interior's Bureau of Mines' estimate of the U.S. net import reliance[1] on several of the certified minerals in 1987.

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[1]Defined as imports minus exports plus adjustments for government and industry stocks, as a percent of apparent consumption.

Table 1: U.S. Net Import Reliance on Selected Minerals in 1987 from All Countries[a]

Mineral[b]	Reliance (percent)
Manganese	100
Natural industrial diamond stones	89
Platinum-group metals	88
Cobalt	86
Chromium	75
Vanadium[c]	54
Asbestos	51

[a]Does not include minerals recycled in the United States that were imported in previous years.

[b]Exact figures are not available for andalusite, antimony, and rutile, but sufficient data are available to indicate a significant degree of dependence on imports.

[c]1984 data; more current data are not available.

South Africa is a major world producer of strategic minerals. In 1986, it led the world in the quantities mined for 3 of the 10 certified minerals, (chromium, rutile, and vanadium) and ranked second in 2 others (manganese and platinum-group metals). South Africa also contains the largest reserve base (minerals in the ground that are currently or potentially economical to mine) for 4 of the 10 minerals (chromium, manganese, platinum-group metals, and vanadium), including 84 percent of the world reserve base for chromium and 89 percent for the platinum-group metals. According to a Bureau of Mines mineral specialist, South Africa is also believed to rank first in world production and reserve base for andalusite, but comprehensive worldwide data on andalusite are not available.

Appendix II provides data on U.S. imports for consumption (1983-87) and the worldwide mine production and reserve base for each of the 10 certified minerals. Between 1983 and 1987 the percent of U.S. imports of platinum-group metals and rutile from South Africa increased significantly (see tables II.1 and II.5) and the percent of imports of chromium and manganese first increased and then declined, with 1987 imports somewhat higher than 1983 imports (see tables II.2 and II.3). South Africa has been the sole U.S. supplier of andalusite throughout the period (see table II.8). Import statistics for vanadium, which show a large increase in the percentage from South Africa between 1983 and 1984, do not represent a sudden increase in the demand for the mineral. It reflects irregular shipments to the United States prior to 1984 rather than a sudden surge in U.S. imports from South Africa.

Antimony, chrysotile asbestos, and industrial diamond imports from South Africa decreased as a percent of total U.S. imports between 1983 and 1987. Direct imports of industrial diamonds have virtually ceased, with the United States now importing most industrial diamonds from countries that serve as transshipment points (see table II.10). Most of the world's mine production is centered in Zaire, Australia, the Soviet Union, and South Africa, in descending order of importance. Imports of antimony fell by 50 percent. South Africa provided almost no cobalt to the United States throughout the period, but generally more than half of U.S. imports, which came from two other Southern African countries, were shipped through South Africa (see table II.9).

The United States has imported no andalusite, chrysotile asbestos, cobalt, manganese, rutile, or vanadium from the Soviet Union since 1983 and has imported only a small percentage of antimony, chromium, and industrial diamonds in any one year. (See tables II.2, II.6, and II.10.) In 1987, the Soviet Union provided 10 percent of U.S. imports of platinum-group metals, down from a 5-year high of 13 percent in 1983.

ALTERNATIVES TO SOUTH AFRICAN STRATEGIC MINERALS

Except for two of the platinum-group metals--platinum and rhodium--andalusite, and a specific type of industrial diamond and grade of chrysotile asbestos, alternative supply sources exist for the certified strategic minerals imported from South Africa according to Bureau of Mines data and discussions with Bureau of Mines, Commerce, and Defense Department officials. Aside from these exceptions, minerals could remain available to the United States in the case of a unilateral embargo imposed by the United States, although according to a recently issued Bureau of Mines report[2] there would probably be supply disruptions and increased economic cost to the United States.

The Bureau of Mines report estimates the economic impact of a U.S. import embargo on South African strategic minerals.[3] The report assesses the availability of 6 of the 10 certified minerals and concludes that there are sufficient alternative sources for manganese, chromium, palladium (one of the principal platinum-group metals), titanium (rutile), and vanadium to meet U.S. industrial demand in the event of an embargo, but not for platinum and rhodium (two other platinum-group metals). The report also states that cobalt supplies would remain available with the use of alternative routes for transporting cobalt from Zaire, the U.S. principal supplier. Cobalt from Zaire and Zambia is presently shipped via South African rail to South African ports for export.

The report estimates the 5-year cumulative direct economic cost of a U.S. embargo on South Africa for the six minerals at $9.25 billion, or $1.85 billion annually. These direct economic costs include higher prices paid by U.S. consumers for the minerals, reduced consumption of the minerals or the use of substitutes, and resources spent developing low-grade domestic ores or using more expensive recovery

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[2]Estimated Direct Economic Impacts of a U.S. Import Embargo on Strategic and Critical Minerals Produced in South Africa, Bureau of Mines, OFR 19-88, Jan. 1988. The report estimates only the direct economic impact of an embargo and not the indirect effect on the U.S. gross national product.

[3]The impact analysis is made for the years 1988-92, and among its major assumptions are that (1) the United States does not import strategic minerals that were mined in, refined in, or transported through South Africa, including South African minerals processed in other countries, (2) the embargo is unilateral, i.e., South African minerals will remain available to other countries, (3) non-South African supplies of the embargoed materials that were formerly exported to countries other than the United States can be made available to the United States, and (4) releases of strategic minerals from the National Defense Stockpile will not be considered.

techniques. The platinum-group metals alone account for 94 percent of this cost.

We discussed the Bureau of Mines report with U.S. industrial users of strategic minerals. Although they had not had an opportunity to review the report, their initial reaction was that it understated the economic costs of an embargo and overstated the ability of other mineral producing nations to replace South African exports to the United States. Industry officials also said the report did not address the potential illegal entry of South African minerals into the United States through false documentation showing another country of origin.

The report does not address the other four certified minerals as the Bureau of Mines believes the economic impact of a U.S. embargo on these minerals would be very small. South Africa is not a dominant producer of three of these--antimony, chrysotile asbestos, and industrial diamonds--but one form of chrysotile asbestos, which is used in missile construction, is currently mined only in Zimbabwe and is exported through South Africa. Similarly, a form of industrial diamond, type II-B, which is necessary for a unique defense communication application, is found in a single mine in the world, which is in South Africa. The two largest producers of andalusite, the other mineral not discussed in the report, are South Africa and France, and French andalusite is not considered to be suitable for most U.S. uses. We plan to seek additional information on andalusite's importance for inclusion in our final report.

Appendix III contains further detail on supply alternatives for specific minerals.

STATE DEPARTMENT PLAN TO REDUCE DEPENDENCE ON SOUTH AFRICAN MINERALS

Section 504(b) of the Comprehensive Anti-Apartheid Act requires that the President develop a program to reduce any U.S. dependence on South African strategic minerals. The Act did not establish a time period for developing the program. The President delegated the authority for implementing section 504 to the State Department in Executive Order 12571.

The status of the plan is unchanged from that reported in our October 1987 report, SOUTH AFRICA: Status Report on

Implementation of the Comprehensive Anti-Apartheid Act (GAO/NSIAD-88-44). In that report, we noted that the State Department expected to prepare an options paper for submission to the National Security Council, which would make the final decision on the program. State considers its obligations under section 504(b) will be fulfilled at that point.

A preliminary working document, detailing the guidelines and principles for the section 504(b) options paper, identifies nine general principles for developing mineral-specific options. These include focusing the analysis on normal peacetime conditions (i.e., not considering the national defense stockpiles) and closely examining the economic consequences of stockpiling, including U.S. competitiveness and the effects on the federal budget.

According to State's working document, the final options paper will provide a case-by-case examination of the 11 strategic minerals imported from South Africa as defined by the Strategic and Critical Materials Stock Piling Act, as amended (Public Law 96-41, 50 U.S.C. 98 et seq.) (the 10 certified minerals minus andalusite plus vegetable tannin extract and fluorspar, acid grade), including an analysis of the available options to reduce U.S. peacetime dependence on South Africa. These options include substitution, conservation, alternative suppliers, and economic stockpiles/private inventories. State's goal is to complete the options paper by September 1988, but State officials told us it is unlikely to be completed before the end of the year.

OBJECTIVES, SCOPE, AND METHODOLOGY

We obtained data on U.S. imports of the 10 certified minerals from the commodity specialists at the Bureau of Mines. Data on country mine production and reserve base were principally obtained from the Bureau's publication Mineral Commodity Summaries 1988. To identify alternative sources of supply, we relied on the import data collected and on various Bureau publications. We spoke with officials at the Departments of Commerce and Defense in an effort to further clarify any defense applications of the minerals. To assess efforts of U.S. users to locate alternative supply sources, we interviewed representatives of the industries most reliant on the minerals and their industry associations--the iron and steel industry, including the specialty steel industry, and the automotive industry. We also spoke with international commodity traders of several of the minerals. Finally, to update the status of the State Department's plan to reduce U.S. dependence on South African strategic minerals, we spoke to State Department officials responsible for that plan.

Our review was performed in accordance with generally accepted government auditing standards between January and June 1988.

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We discussed a draft of this report with officials from the Departments of Interior and State and considered their comments in preparing the final report. As requested, we did not obtain official agency comments.

Unless you announce its contents earlier, we plan no further distribution of the report until 10 days after its issue date. At that time, we will send copies to the Secretaries of Commerce, Defense, Interior and State, the Director of the Office of Management and Budget, and to other interested parties upon request.

Frank C. Conahan
Assistant Comptroller General

CONTENTS

ABBREVIATIONS

PGM Platinum-Group Metals

STRATEGIC MINERALS AND THEIR USES

Andalusite	Because of its high heat resistance, it is used in bricks for high temperature blast furnaces for steelmaking.
Antimony	Used in lead-acid storage batteries, flame retardant materials, and aircraft night-vision systems.
Chrysotile Asbestos	Because of its tensile strength and heat and chemical resistance, it is used for construction materials, such as cement pipe and sheet and roofing products. It is also used in missile and submarine construction.
Chromium	Chromium metal and an intermediate product called ferrochromium are derived from chromite ore. Chromium metal and ferrochromium are used in making stainless steels and superalloys (used in the aerospace industries) that resist corrosion and oxidation. These end products are some of the most strategic and critical materials to the U.S. economy. Chromium is also used as a catalyst in the chemical industry and to make heat resistant bricks for open hearth furnaces.
Cobalt	Cobalt is important to defense-related industries because it is used in jet turbines and alloys that are highly temperature resistant. It is also used to give alloys resistance to wear, high strength, and magnetic qualities.
Industrial Diamonds	Because of their great hardness, they are used for cutting, grinding, and drilling. Most of the diamonds are employed in the oil, gas, and mineral services industries. They also have a classified use in defense communications.
Manganese	Because of its strength, toughness, and hardness, it is used as an alloy with iron and steel. It is also used as an alloy with aluminum, magnesium, and copper and to produce batteries and chemicals.

Platinum-Group Metals

Mainly used in catalytic converters for toxic emission control in vehicles but also used in petroleum refining, electronics, chemical production, and the dental and medical fields. Platinum, palladium and rhodium have the greatest economic significance of the platinum-group metals.

Rutile/Titanium

Titanium metal is made from the mineral rutile. Titanium is mainly used as a pigment in paints, paper, and plastics. It is also important in the aerospace industries because of its high strength-to-weight ratio and resistance to corrosion.

Vanadium

Used mainly as an alloy in high-strength, low-alloy steels used in high-rise buildings, bridges, pipelines, and autos. It is also a catalyst in the production of sulfuric acid and organic chemicals.

SELECTED STATISTICAL INFORMATION ON SOUTH AFRICAN STRATEGIC MINERALS

Table II.1: Platinum-Group Metals[a]

	U.S. Imports for Consumption 1983	1984	1985	1986	1987	World Mine Production (1986)	Current World Reserve Base
Thousand troy ounces	3,218	4,474	3,990	4,477	3,807	7,800[b]	2,140,000
	(percent)						
Country							
South Africa	38	42	46	43	46	46	89
Canada	7	9	7	11	5	4	(c)
Soviet Union	13	12	8	7	10	49	9
United Kingdom[d]	20	17	16	18	14	0	0
Other	22	20	24	21	25	1	1[e]

[a]Includes platinum, palladium, iridium, osmium, rhodium, and ruthenium.

[b]Excludes U.S. production.

[c]Less than one-half of 1 percent.

[d]Most of the imports from the United Kingdom are believed to have been processed there from ore from South Africa, Canada, and the Soviet Union.

[e]Most of this other reserve base is in the United States.

Source: U.S. Bureau of Mines.

Table II.2: Chromium

	U.S. Imports for Consumption[a] 1983	1984	1985	1986	1987	World Mine Production (1986)	Current World Reserve Base
Thousand short tons, chromium content	226	342	315	379	355	3,418	2,250,000
	(percent)						
Country							
South Africa	56	62	64	62	58	34	84
Finland	0	1	4	2	(b)	4	(b)
India	0	1	0	0	0	6	1
Philippines	1	4	4	1	1	2	(b)
Turkey	4	9	9	15	19	6	1
Soviet Union	(b)	0	0	2	2	29	2
Zimbabwe	16	10	8	8	10	5	11
Other	23	13	11	10	10	15	1

[a]Includes chromite ore and concentrate from ore, low-carbon and high-carbon ferrochromium, ferrochromium-silicon, and chromium metal.

[b]Less than one-half of 1 percent.

Source: U.S. Bureau of Mines.

Table II.3: Manganese

	U.S. Imports for Consumption[a] 1983	1984	1985	1986	1987	World Mine Production (1986)	Current World Reserve Base
Thousand short tons, manganese content	555	606	609	689	603	9,615[b]	3,900,000
	(percent)						
Country							
South Africa	22	25	26	29	27	17	74
Australia	5	6	10	8	11	9	4
Brazil	15	14	14	10	7	12[b]	2
France[c]	17	16	15	10	16	0	0
Gabon	15	11	11	17	15	13	5
Mexico	10	9	10	7	7	2[b]	(d)
Soviet Union	0	0	0	0	0	32[b]	13
Other	16	19	14	19	17	15	2

[a]Includes manganese ore, manganese dioxide, manganese metal, silicomanganese, and ferromanganese.

[b]Estimated.

[c]Approximately 90 percent of French imports of manganese ore in 1984 were from Gabon and South Africa.

[d]Less than one-half of 1 percent.

Source: U.S. Bureau of Mines.

Table II.4: Chrysotile Asbestos

	U.S. Imports for Consumption 1983	1984	1985	1986	1987	World Mine Production (1986)	Current World Reserve Base
Million metric tons	196	210	142	108	94	4,013	137,000
	(percent)						
Country							
South Africa	6	7	8	4	4	2	1
Canada	94	93	92	96	96	16	34
Soviet Union	0	0	0	0	0	60	47[a]
Other	(b)	(b)	(b)	(b)	(b)	21	17

[a]Most of this is in the Soviet Union, but a small amount is in other Soviet bloc countries.

[b]Less than one-half of 1 percent.

Source: U.S. Bureau of Mines.

Table II.5: Rutile and Rutile Substitutes

	U.S. Imports for Consumption 1983	1984	1985	1986	1987	World Mine Production (1986)[a]	Current World Reserve Base[b]
Thousand short tons[c]	114	213	251	309	402	1,060	327,902
	(percent)						
Country							
South Africa	17	27	49	58	56	44	17
Australia	75	51	37	32	38	27	16
Brazil	0	0	1	(d)	0	(d)	31
Sierra Leone	0	22	13	6	4	10	1
Soviet Union	0	0	0	0	0	3	2
Other	8	0	0	4	2	16[e]	34[f]

[a]Includes rutile, ilmenite slag production suitable for making rutile substitutes, and synthetic rutile production. Data are estimated.

[b]Includes rutile and ilmenite suitable for making rutile substitutes. Data are estimated.

[c]All data expressed in titanium dioxide content.

[d]Less than one-half of 1 percent.

[e]Includes the United States, which is the largest producer of synthetic rutile.

[f]The most significant other countries are India and Italy, which together have 19 percent of the current reserve base. Italy produced no rutile or rutile substitutes in 1986. India accounted for 5 percent of world production.

Source: U.S. Bureau of Mines.

Table II.6: Antimony

	U.S. Imports for Consumption 1983	1984	1985	1986	1987	World Mine Production (1986)	Current World Reserve Base
Short tons, antimony content	12,885	23,089	20,694	25,401	26,729	64,146[a]	5,175,000
	(percent)						
Country							
South Africa	28	30	14	19	14	13	5
Bolivia	28	11	6	5	5	18	7
China	13	34	39	34	41	26	50
Mexico	7	6	16	17	10	6	5
Thailand	4	4	1	2	1	2	10
Soviet Union	(b)	(b)	0	1	1	16	6
Yugoslavia	0	0	0	0	5	2	2
Other	20	15	24	22	24	17	15

[a]Excludes U.S. production.

[b]Less than one-half of 1 percent.

Source: U.S. Bureau of Mines.

Table II.7: Vanadium

	U.S. Imports for Consumption 1983	1984	1985	1986	1987	World Mine Production (1986)	Current World Reserve Base
Short tons	1,201	2,553	1,605	4,399	3,474	32,200	18,250,000
	(percent)						
Country							
South Africa	4	40	34	37	34	53	47
China	0	0	0	3	1	14	10
Kuwait	0	0	0	0	15	(a)	(a)
Mexico	0	0	2	7	11	(a)	(a)
Soviet Union	0	0	0	0	0	33	25
Venezuela	0	1	8	33	20	(a)	(a)
Other	96[b]	59[c]	56[d]	20	19	0	18

[a]Vanadium is a byproduct of petroleum refining from these countries. They have no vanadium mine production or reserve base.

[b]Canada and Finland provided 35 and 29 percent of U.S. imports, respectively.

[c]Canada, which provided 18 percent of U.S. imports. Other suppliers included, in order of importance, West Germany, Austria, Belgium-Luxembourg, Finland, and the United Kingdom.

[d]Other major suppliers, in order of importance, included Belgium-Luxembourg, Austria, Canada, and West Germany. No single country was a predominant supplier.

Source: U.S. Bureau of Mines.

Table II.8: Andalusite

	U.S. Imports for Consumption 1983	1984	1985	1986	1987	World Mine Production (1986)	Current World Reserve Base
Short tons	(a)	7,500	3,000	5,000	14,000	(b)	(b)
	----------(percent)----------						
Country							
South Africa	(a)	100	100	100	100	(c)	(d)
France[e]	0	0	0	0	0	(c)	(b)

[a]Withheld to avoid disclosing company proprietary data.

[b]No reliable estimate is available.

[c]There are no comprehensive worldwide data on andalusite. The two largest producers are South Africa, with estimated 1986 mine production of 203,900 short tons, and France, with estimated production of 57,300 short tons.

[d]South Africa has known reserves of 56 million short tons.

[e]French andalusite is not considered to be substitutable for South African andalusite for most U.S. users.

Source: U.S. Bureau of Mines.

Table II.9: Cobalt

	U.S. Imports for Consumption 1983	1984	1985	1986	1987	World Mine Production (1986)	Current World Reserve Base
Short tons	8,611	12,655	8,854	6,144	9,760	53,906	9,200,000[a]
	(percent)						
Country							
South Africa	1	1	2	(b)	1	1	(c)
Canada	11	12	18	27	17	5	3
Cuba	0	0	0	0	0	3	22
Norway	4	6	10	15	8	0	(c)
Soviet Union	0	0	0	0	0	6	3
Zaire[d]	45	47	27	6	48	63	25
Zambia[d]	14	15	24	29	15	12	7
Other	25	19	20	23	11	10	40

[a]Excludes Albania.

[b]Less than one-half of 1 percent.

[c]Data unavailable, yet described by a Bureau of Mines' specialist as negligible.

[d]Shipments transported via South African rail systems and ports.

Source: U.S. Bureau of Mines.

Table II.10: Industrial Diamonds

	U.S. Imports for Consumption[a]					World Mine Production (1986)[b]	Current World Reserve Base[c]
	1983	1984	1985	1986	1987		
Thousand carats	24,831	43,491	45,832	45,739	48,550	52,800	1,900,000
	(percent)						
Country							
South Africa	21	18	10	9	(d)	11	8
Australia	(d)	(d)	(d)	(d)	(d)	30	47
Belgium-Luxembourg[e]	2	2	5	5	4	0	0
Botswana	(f)	(f)	(f)	(f)	(f)	7	11
Ireland[e]	47	59	56	49	56	0	0
Japan[e]	6	7	6	12	13	0	0
United Kingdom[e]	7	4	10	9	4	0	0
Soviet Union	2	1	1	(d)	3	12	11
Zaire	3	1	1	3	8	35	18
Other	12	9	10	12	12	5	5

[a]Includes natural industrial diamond stones, miners' diamonds, synthetic and natural powder/dust.

[b]Natural industrial diamonds only.

[c]Estimated.

[d]Less than one-half of 1 percent.

[e]These countries are largely marketing and transshipment points for natural diamonds, having no mine production or reserve base of their own.

[f]Included in "Other" category; unable to be broken out separately.

Source: U.S. Bureau of Mines.

SUPPLY ALTERNATIVES TO SOUTH AFRICA FOR SELECTED STRATEGIC MINERALS

This appendix provides detailed information on chromium, manganese, and platinum-group metals as agreed with the requesters. It also discusses industrial diamonds, a specific form of which has military applications and is produced only in South Africa, and chrysotile asbestos, a specific form of which is produced in Zimbabwe and transported through South Africa.

CHROMIUM

Chromium is essential to the production of stainless steel and superalloys. Its unique qualities are its ability to resist oxidation and corrosion. Chromium is what makes stainless steel stainless. At present there is no substitute for chromium in the production of stainless steel; therefore it is vital to the defense, aerospace, chemical, and transportation industries.

Ferrochromium is the principal alloy produced from chromium and the principal form in which chromium is imported into the United States. Between 1983 and 1986, South Africa supplied an average of 55 percent of the chromium contained in ferrochromium imported by the United States.

The 1988 Bureau of Mines' report (see p.7) stated that:

> "Despite the dependence of the United States on South Africa for much of its chromium supply, other world suppliers of the material exist. In the event of an embargo of South African chromium, a trade pattern adjustment could occur, permitting exports to the United States to continue uninterrupted."

Alternative U.S. suppliers of chromium include Turkey, Zimbabwe, Finland, India, and the Philippines. These five countries accounted for 23 percent of world mine production of chromite ore in 1986. It is expected that most of these suppliers could increase their exports to the United States should the South African supply be unavailable, especially if they were to receive a premium price for their material. The Bureau of Mines' report estimates the 5-year cumulative cost to the United States of an embargo on South African chromium at $150 million.[1]

We interviewed representatives of several of the largest specialty steel producers in the United States, which use the bulk of U.S. ferrochromium imports. All of these representatives considered South Africa to be the most efficient and reliable supplier of ferrochromium in the world. They told us that they had made efforts to locate alternative suppliers of ferrochromium but that these efforts had been unsuccessful. They noted that world ferrochromium producers have been operating at full capacity for close to a year and supply is very tight. Therefore, the present policy of U.S. users is to purchase ferrochromium from wherever it is available.

Industry representatives gave us the following reasons for why they have been unable to obtain alternative suppliers to South Africa.

-- Other producers have domestic needs to fill.

-- Other producers supply Western Europe or Japan, markets that are geographically closer and to which shipping is less expensive.

-- Other producers generally produce low-carbon, more costly ferrochromium which is less desirable to U.S. purchasers.

The Bureau of Mines' report does not address detailed quality concerns. However, a Bureau official responsible for that report told us that the key factor in any embargo scenario is whether or not the user is willing to pay a premium for the alternative supply. If so, the three reasons cited above would become less significant.

Representatives of the U.S. iron and steel industry told us that most U.S. iron and steel manufacturers have sought out secondary sources of the ferroalloys essential to steel production, which include ferromanganese and ferrovanadium as well as ferrochromium,

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[1]An alternative analysis was done by the Bureau of Mines in 1986 which assumed a disruption of South African production of chromium, i.e., South African supplies being unavailable to any world consumer versus simply a unilateral embargo by the United States. The direct economic cost to the United States of a 3-year disruption of chromium was estimated at $3.6 billion. See <u>South Africa and Critical Minerals</u>, Bureau of Mines, (OFR 76-86).

and have met with some success. This is in contrast to the specialty steel industry's reported lack of success in locating alternative suppliers. The effort has been motivated by a fear that U.S. sanctions could be placed on the import of these minerals from South Africa.

Some of the industry representatives offered the opinion that should the United States unilaterally embargo the sale of South African chromite ore and ferrochromium, the industry would weather the storm following a difficult period of disruption, possibly lasting several years and with severe economic costs. Others predicted that "such a ban would cause plant closings, massive lay offs and sharply higher prices in the industry...".

MANGANESE

Manganese is essential as an alloy (principally ferromanganese and ferrosilicomanganese) in steel and cast iron production, providing strength and hardness to the final product. About 90 percent of U.S. manganese consumption is used in metallurgical applications, with the remainder primarily used to produce batteries and chemicals. There is presently no satisfactory substitute for manganese as an alloy in iron and steelmaking.

South Africa was the largest supplier to the United States of manganese in each of the past 5 years, yet it supplied only 22 to 29 percent of total U.S. imports in any year. South Africa is also the principal U.S. supplier of ferromanganese, an intermediate form of manganese used in steel production, providing 39 percent of imports in 1987, followed by France with 33 percent. Furthermore, much of the manganese ore in the ferromanganese processed by France originated in South Africa.

Other major producers of manganese ore and exporters of manganese to the United States are Australia, Brazil, and Gabon, whose annual mine production capacity actually exceeds U.S. annual domestic consumption requirements. While the Soviet Union is the world's leader in manganese mine production, with 32 percent of the world total, the United States has not imported any manganese from the Soviet Union since the 1950s.

The 1988 Bureau of Mines' report concluded that:

> "There is sufficient alternative world manganese mining and ferro and metal processing capacity to offset the loss of U.S. supplies from South Africa.... At present, the U.S. manganese metal processing capacity is underutilized, some of the

unused capacity has been idled since the early 1980's.... A domestic manganese shortage is, therefore, not expected to result from an embargo on manganese from South Africa."

The report continued, however, that the cost of manganese would increase as a result of trade flow adjustments and higher production costs of some alternative suppliers. The estimated direct economic cost of a U.S. embargo on South African manganese was set at $155 million over the 5-year period.[2]

Representatives of the U.S. iron and steel industry told us that most U.S. steelmakers have sought out secondary sources of ferromanganese, which were easier to locate than alternative sources of ferrochromium and ferrovanadium. Brazil was cited as an alternative source, having recently increased production significantly.

PLATINUM-GROUP METALS

The platinum-group metals (PGMs) include platinum, palladium, rhodium, ruthenium, iridium, and osmium, with the first three accounting for about 95 percent of U.S. domestic PGM consumption from 1984 to 1986. The PGMs have several extraordinary properties, such as chemical inertness and excellent catalytic activity. Between 1984 and 1986, about 40 percent of domestic U.S. consumption of PGMs was used in the production of automobile catalytic converters. Increased demand in this end use reflects legislated environmental emission standards and the lack of alternatives for controlling emissions. Other major U.S. uses were in the electronics industry, dental and medical fields, petroleum refining, and chemical production.

Presently there are no feasible substitutes for PGMs in most catalytic applications. Some substitutes are available in dental and electronics applications.

In 1987, 46 percent of U.S. PGM imports came directly from South Africa, with additional South African minerals arriving indirectly through third countries, such as the United Kingdom, Belgium,

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[2]The direct economic costs to the United States of a 3-year disruption of South African manganese production (assuming South African manganese was unavailable to any world consumer rather than the imposition of a unilateral U.S. embargo) were estimated by the Bureau of Mines in 1986 at $1 billion. See South Africa and Critical Minerals, Bureau of Mines, (OFR 76-86).

Luxembourg, and the Netherlands. In 1986, the Soviet Union and South Africa accounted for 49 and 46 percent, respectively, of the world's mine production of PGMs. However, South Africa alone holds 89 percent of the world's reserve base of PGMs. The Soviet Union has virtually all the remainder. A U.S. embargo on South African PGMs would inevitably result in an increased dependence on the Soviet Union as a replacement supplier.

Alternative sources of PGMs would include Canada, Australia, and New Zealand for platinum and palladium and Zimbabwe for palladium. All are nominal producers relative to U.S. demand for PGMs.

According to the 1988 Bureau of Mines' report

> "Alternative world sources to South Africa for platinum and rhodium cannot meet U.S. industrial demand.... If the United States could not import platinum that was mined in South Africa, either directly or through a third country, a major shortage could be expected.... If the United States could not import rhodium that was mined in South Africa, either directly or through a third country, a major domestic shortage could be expected."

No such shortage was predicted for palladium, as domestic supply, recycling, and increased U.S. imports from alternative suppliers, primarily the Soviet Union, were seen to be able to offset a loss of South African palladium supplies.

The Bureau of Mines' 1988 report estimates the 5-year cumulative direct economic cost of a U.S. embargo on South African PGMs at $8.7 billion, or $1.7 billion annually. The United States would also become significantly more dependent on the Soviet Union for platinum, palladium, and rhodium.

We spoke with representatives of the U.S. automobile industry, as they are the primary users of PGMs, and they agreed that production of two PGMs--platinum and rhodium--outside of South Africa is insufficient to meet demand. The automobile industry is particularly dependent on these two metals, using about 35 percent of world platinum and 70 percent of world rhodium for automobile emissions controls. By 1990 the industry is expected to use 80 percent of the world rhodium supply. By 1994 platinum demand is expected to increase 65 percent due to tighter European emission standards.

Tightening emission controls standards would further increase the demand for PGMs. For example, in response to past compliance problems, in 1984 the automobile industry had to substantially increase the amounts of platinum, palladium, and rhodium used in catalytic converters to measurably reduce emissions. Conversely, easing emissions standards to fit non-South African supplies would increase auto emission levels to those existing a decade ago.

Representatives of one U.S. automobile manufacturer, which is the largest user of platinum, palladium, and rhodium in the United States, said their company is principally dependent on a single mine in South Africa for their supplies. They contended that suppliers outside South Africa could not meet 20 percent of their needs. Consequently, this company has not been able to seek other suppliers.

It would be possible to sustain catalytic converter production for some time by using stockpiled supplies. At least one U.S. automobile manufacturer has stockpiled rhodium. There are also private platinum stockpiles estimated at 2 to 3 years production, mostly held in Europe and Japan by traders, bankers, and investors. For the longer term, industry officials acknowledged that recycling was a potentially important source of PGMs, albeit insufficient to replace South African supplies.

A representative of the petroleum refining industry, which uses platinum and palladium as catalysts in making gasoline and jet and diesel fuel, said that the industry recycles almost all of its PGMs. As a result, oil industry stocks are depleted only 1-3 percent every 5 years for platinum and 5 percent for palladium; therefore, the industry demand for these metals is low. One of the petroleum refining processes could use nickel-tungsten catalysts instead of PGMs but another refining process can use no substitute catalyst.

INDUSTRIAL DIAMONDS AND CHRYSOTILE ASBESTOS

Natural industrial diamonds are used for cutting, grinding, and drilling because of their extreme hardness. The mineral services industry, primarily drilling, accounted for about 85 percent of U.S. stone consumption in 1987.

The world diamond market has long been dominated by DeBeers Consolidated Mines, a South African registered trading company headquartered in London, which markets 80 to 85 percent of the world's diamonds. As a result, Ireland, Belgium-Luxembourg, the United Kingdom, and Japan, which accounted for 77 percent of U.S. imports of natural and synthetic industrial diamonds in 1987, are in fact largely marketing and transshipment points for natural diamonds mined in other countries and have no natural diamond mine production or reserve bases. World mine production and reserve bases are centered in Australia, Zaire, the Soviet Union, South Africa, and Botswana.

Industrial diamonds from South Africa can be totally replaced by natural diamonds from other countries and by synthetic diamonds with one exception--the Type-IIB diamond, which is found in only one mine in the world located in South Africa. The Type-IIB diamond represents a very small part of total U.S. imports, but it has a unique defense communication application. There are some reports that a synthetic substitute will be available.

Asbestos is a fibrous mineral that has been used chiefly in construction materials, such as asbestos-cement pipe and sheet and roofing products. Due to the discovery and publicity of asbestos-related health concerns, total U.S. imports of chrysotile asbestos decreased by 52 percent from 1983 to 1987. The predominant import source of chrysotile asbestos is Canada, which supplied an average of 94 percent of U.S. imports over the 5-year period.

There is, however, a particular strategic grade of chrysotile asbestos mined in Zimbabwe which is shipped mostly through South Africa. This particular grade of asbestos is used in the construction of rockets, missiles, and submarines. While it represents a very small percentage of U.S. asbestos imports, it appears to be difficult to replace at this time. A Bureau of Mines' specialist told us that potential alternative sources of this grade of asbestos are a deposit in the United States and one in Canada, though there is presently no production at either. It is also conceivable that the necessary quantities of asbestos could be shipped out of Zimbabwe via alternative transportation routes (especially by air) as the Bureau of Mines' report suggested for cobalt.

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