SPECIAL REPORT

The role of South Africa as a supplier of strategic minerals

By A D Owen

What is the possibility that the government of South Africa will use exports of strategic minerals as a source of leverage in the face of growing pressure from the international community?
In this paper the role of South Africa as a supplier of strategic minerals is assessed in the context of demand, supply and world trade, and the attendant risks for consumer nations of relying on a single major source for their essential raw materials.

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INTRODUCTION

In recent years, international condemnation of South Africa's white minority government and its policy of separate "development" for different racial groups has become more vocal and more extensive. However, demands by black African nations for more aggressive forms of international action — such as trade embargoes — have been opposed, in general, by the major Western industrialized nations who tend to favour the "constructive dialogue" approach. Even the USSR appears to offer only tacit support to calls for embargoes and isolationist policies, seemingly preferring a relatively stable minority white government to the prospect of the political and economic instability which has plagued many of South Africa's hostile neighbouring states.

For many years South Africa has had an impressive record as a reliable supplier of a wide range of mineral commodities, but over the past decade political considerations have slowed up the flow of external medium and long term capital to its industry, while existing and potential customers are viewed with some disfavour by many nations of the world. As increased levels of external economic and financial pressure are being brought to bear on the South African government over its apartheid policies and its apparent desire to retain effective control over Namibia, mounting internal strife in the black communities is threatening the internal security of the nation. Major supply disruptions of South Africa's mineral industry are now becoming a distinct possibility. In 1985, the labour situation became very delicate, with unrest in the Cape Province and official and unofficial disputes at several of the large gold mines. New black unions began pushing for substantial wage increases and an end to the statutory "scheduled person" barrier to black advancement in the mines.

The speed with which relatively minor supply disruptions (perceived or actual) affecting a major producer can impact upon market sentiment was well illustrated in January 1986 when the black workforce at Impala Platinum Mines, South Africa's second largest producer of platinum group metals, began an illegal strike over pay and conditions. The company management responded by dismissing some 23 000 of the total black workforce of 30 000. The immediate outcome of these events was a sharp rise in the price of platinum, for which South Africa accounts for 80 per cent of the world's requirements, driven by a potential supply shortfall and the possibility of the disruption spreading. Although remanning of the mine was started immediately, some commentators estimate that the strike and the company's precipitate riposte to it could cost Impala up to one-quarter of 1986 platinum production.

While the above event was, in retrospect, a relatively minor skirmish, the potential for more prolonged and hence more damaging labour unrest in South Africa is very evident. Although not intended as a comparison to the current or future situation in South Africa, it is interesting to note that when civil war broke out in the Shaba Province of Zaire in 1978, a spectacular rise in the price of cobalt — for which Zaire at the time accounted for 63 per cent of the world's requirements - almost pushed it into the realm of a precious metal. The "sellers price" rose from 6.85 USD/lb in February 1978 to 20.00 USD/lb eight months later, while the free market price had rocketed to 43.00 USD/lb by late 1978.

Between them, South Africa and the USSR possess the vast bulk of known reserves of a number of basic minerals and, combined, frequently account for a substantial proportion of world production of these minerals. It appears, however, that the USSR does not possess enough surplus capacity to allow its excess production, after meeting COMECON requirements, to have any marked impact on the Western World, the exceptions being the supply of oil (although this has diminished in recent years), and to a lesser extent gold, platinum, and diamonds. In a number of markets, such as platinum and diamonds (the latter being sold into the CSO network in London), the USSR appears to accept South African price leadership to ensure that, on its erratic forays into the market, it does not have to compete during periods of weak demand.

In this paper, the role of South Africa as a supplier of strategic minerals is assessed in the context of prevailing patterns of demand, supply, and world trade, and the attendant risks for consumer nations of relying on a single major source for their essential raw materials.

STRATEGIC MINERALS

A "strategic" mineral may be defined as one that is required to supply the military, industrial, and essential civilian needs of a nation during a national emergency, and is not found or produced by that nation in sufficient quantities to meet such needs.

Such a definition is somewhat vague, however, since the term "national security" can encompass a vast range of catastrophes, with the impact on specific minerals varying according to the particular circumstances of each event. In addition, the minerals that enter the category of strategic under this definition will differ from country-to-country. Nevertheless, there is general agreement — c f Hargreaves and Fromson[1], Radetzki[2], Van Rensburg and Bambrick[3], Weston[4] — that, for the major industrialized nations of the OECD - viz: the Federal Republic of Germany, France, Japan, the UK, and the USA-six minerals can be classified as having a high strategic rating: chromium, cobalt, copper, gold, manganese, and platinum group metals. For four of these six minerals South Africa, either alone or combined with the USSR, accounts for the bulk of the world reserve base and current production capacity. The strategic roles of these four minerals — chromium, gold, manganese and platinum group metals — are examined in this paper together with vanadium, which has been included in the analysis because of its strategic nature in Western Europe and Japan, which are completely dependent upon imports for their domestic supplies.

Table 1 gives 1983 world reserve base data for these five strategic minerals, sub-divided into the South African reserve base and the reserve base for the World Outside the Centrally-planned economies Area (WOCA). Other major sources of reserves are also given. Note that Southern Africa (i e South Africa plus Zimbabwe in this case) contains 87 per cent of the world's chromite reserves, while South Africa in its own right contains vast quantities of reserves of the other four minerals. When combined with the USSR's reserve base, however, it is evident that these two nations hold the major share of world reserves. South Africa's reserve base as a percentage of the WOCA reserve base is of importance due to the Soviet Union's erratic behaviour in world trade in these commodities. In any analysis of strategic minerals, the latter's share of reserves and production capacity should not be considered as a reliable supply source for Western nations.

Table 1

Reserves of five strategic minerals
(at year end 1983)

	Chromite (kt)	Gold (M troy/oz)	Manganese (kt)	Platinum group (M troy/oz)	Vanadium (kt)
1. South African reserve base	825 000	800	2 600 000	970	7 800
2. WOCA reserve base	1 778 000	1 200	3 100 000	1 000	10 880
3. (1)/(2)	46 %	67 %	84 %	97 %	72 %
4. World reserve base	1 814 000	1 450	3 600 000	1 200	16 600
5. (1)/(4)	45 %	55 %	72 %	81 %	47 %
6. Other sources	Zimbabwe (42 %)	USSR (17 %)	USSR (14 %)	USSR (17 %)	USSR (25 %)
(per cent of world reserve base)	India (4 %)	USA (7 %)	Gabon (5 %)		USA (13 %)
	USSR (2 %)		Australia (4 %)		China (10 %)

Source:
U S Bureau of Mines, 1985.

The reserve base for any mineral is the in-place demonstrated (i e measured plus indicated) resource from which reserves are estimated. The reserve base includes those resources that are currently economic, marginally economic, and some of those that are currently subeconomic. Reserves are that part of the reserve base that could be economically extracted or produced at the time of determination. Reserves include only recoverable materials.

Unfortunately the distinction between reserves and resources lacks general uniformity and allocation of a deposit to either category is often a fairly subjective assignment.[5]. For example, the manganese reserve base for South Africa corresponds to ore with a minimum manganese content of 30 per cent. If the cut-off criterion had been 20 per cent, then an addition amount approaching 2 Gt could have been added to the total. In addition, a further recoverable 2 Gt is known to be contained in nodules, with an estimated 25 per cent manganese content, in the north-east equatorial Pacific.

Table 2 lists 1983 production levels of the five strategic minerals for South Africa and other leading producer nations.[6] The important figures here are those given in row 3, which discount production from the centrally planned economies countries. South Africa produced at least half of the total WOCA production of four of these five minerals in 1983, the exception — manganese — giving a misleadingly low figure due to substantial industry over-capacity in that year. South African mines capacity for manganese production in 1983 actually represented almost 40 per cent of the WOCA capacity, but its domestic manganese industry was only operating at 38 per cent of its total capacity due to poor demand.

With such a significant proportion of the WOCA requirements of these five minerals being supplied by South Africa, the possibility of supply interruptions and the havoc they could cause has encouraged most of the major consumer nations to establish stockpiles to cover such a contingency. The US strategic stockpile was designed to hold an inventory of strategic minerals equivalent to three years of forward consumption, allowing for recycling, substitution, and the development of subeconomic reserves, but for most minerals current inventory levels are well short of this goal. The EEC nations and Japan have also adopted strategic stockpiling policies but on a much smaller scale.

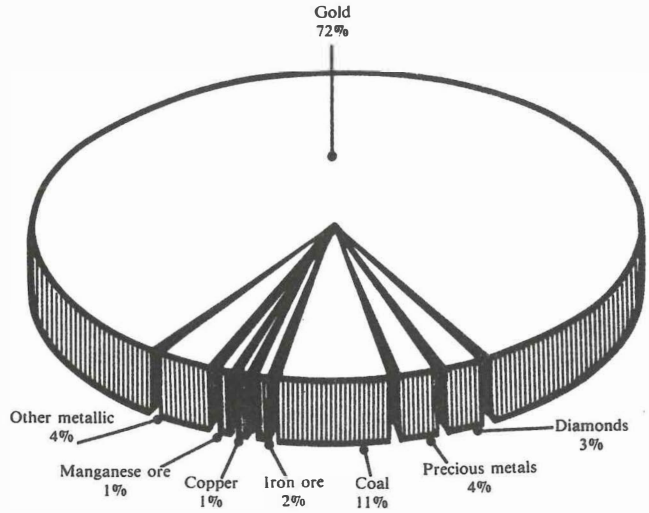
An additional method for securing supply from a dominant producer is by long-term contractual agreements supported, if necessary, by diplomatic and financial pressures, with the threat of military intervention as a last resort. Over-reliance on foreign supplies of a mineral can, however, be reduced to some extent by taking appropriate action with respect to:

Table 2

Production of five strategic minerals (1983)

	Chromite (kt)	Gold (M troy/oz)	Manganese (kt)	Platinum group (M troy/oz)	Vanadium (kt)
1. South African production	2 232	21.8	1 110	2.6	8.1
2. WOCA production	4 540	5.9	4 330	3.0	15.0
3. (1)/(2)	49 %	61 %	26 %	87 %	54 %
4. World production	7 959	44.5	7 980	6.6	29.0
5. (1)/(2)	28 %	49 %	14 %	39 %	28 %
6. Other sources (per cent of world production	USSR (31 %) Albania (11 %) India (5 %) Turkey (5 %) Zimbabwe (5 %) Brazil (4 %) Philippines (4 %) Finland (3 %)	USSR (19 %) Canada (5 %) USA (4 %) Brazil (4 %)	USSR (39 %) Brazil (11 %) Gabon (11 %) Australia (8 %) China (6 %) India (6 %)	USSR (55 %) Canada (4 %)	USSR (33 %) China (16 %) Finland (11 %) USA (10 %)

Source:
U S Bureau of Mines, 1985.



Mineral export sales from South Africa 1984.

- The identification of domestic reserves and resources, since the latter are likely to become reserves in times of national emergency;
- Research into the possible substitution of more readily available minerals for the strategic minerals;
- Enhanced supply through recycling of scrap materials.

COMMODITY PROFILES

An individual assessment of the five strategic minerals introduced above will now be presented, together with comments on current trends in the relevant South African industry and an assessment of the potential risks involved for consuming nations of any interruptions to the supply of these minerals.

Chromium

Chromium is one of the industrial world's most important strategic and critical minerals, with a wide range of uses in the metallurgical, chemical, and refractory industries. Chromium's use in iron, steel, and nonferrous alloys enhances hardness and resistance of corrosion or oxidation, and as such it is one of modern industry's essential and versatile elements.

Chromium is obtained chiefly from chromite, or ferrous chromite, which is classified into three general grades — metallurgical, chemical, and refractory — depending on the chromium content of the ore. Chromium's major use is in the production of stainless steel which, by definition, contains at least 12 per cent (and may contain up to 36 per cent) chromium. Seventy per cent of all chromium metal is employed in stainless steels and twentyfive per cent in specialized alloy steels for the chemical, aerospace, and power generating industries. Chromium pigments for use in paints and ink represent the largest use of chemical grade chromite, which is also used for leather tanning and as a corrosion inhibitor. Refractory grade chromite is crushed with magnesite in the manufacture of refractory bricks.

Reserves

Combined, South Africa and Zimbabwe account for 87 per cent of the world's reserves of chromite. Little is known about the USSR's reserve position and the current estimate is probably very conservative. It should be noted, however, that world reserves of chromite are measured in millions of tonnes and are considerable relative to current consumption. At current rates of production, world chromite reserves would last for about 400 years. Thus the reserve bases of the non-Southern African producers are, in absolute terms, considerable even though they only amount to a very small percentage of the world's reserve base.

Production

In 1983 South Africa and the USSR accounted for 28 per cent and 31 per cent respectively of world chromite production. The former's share of the WOCA production in the same year was 49 per cent. The following year, however, saw a growth in chromite production, stimulated by a revitalized stainless steel sector of the Western World's steel industry, and in 1984 South African production of chromite is estimated to have risen to 3 Mt, with an estimated world total of almost 9.2 million tonnes. Thus in 1984, South Africa accounted for 33 per cent of world production, with the USSR accounting for 27 per cent. Other, relatively minor, producers, in 1983 are given in Table 2.

World trade

Ferrochrome now tends to be the main form in which chromium is traded as the emphasis in ferrochrome production shifts from the chromium consuming nations to the chromium producing nations. For example, in the USA there is now only one domestic producer of ferrochrome, Macalloy Inc, a company that has essentially been kept in existence by government contracts to convert chromite to ferrochrome for the US strategic stockpile.

The USA, the EEC, and Japan all rely heavily on South African ferrochrome imports for the bulk of their metallurgical chromium requirements, with smaller amounts from the Philippines, Turkey, and Zimbabwe. Supplies of chromite from the USSR are erratic.

Recycling

Chromium — containing alloys and industrial wastes return small quantities of secondary chromium to the market. However, only stainless steel scrap is a sizable source of supply. Purchased scrap represents about 10 per cent of US domestic industrial chromium demand. Collection and processing costs, however, hinder economic recycling on a large scale.

Substitutes

There are no adequate substitutes for chromium for stainless steel production, but chrome free substitutes, at a higher cost, are available for most other uses.

Risk assessment

The EEC and the USA are almost entirely dependent upon imports of chromium, chiefly from South Africa, Zimbabwe, and the Philippines. Long supply lines from these nations make transportation of this high bulk, high volume product a particularly vulnerable link in the steel production chain. As a consequence, consuming industries maintain large stocks of ore. US Government stockpiles contain about a three year emergency supply in recognition of the vulnerability of these long supply routes during a military emergency, and the long history of supply interruptions during times of civil and political unrest in the producing nations. Japan and many Western European nations have recently bought unspecified amounts of chromium to hold in their strategic stockpiles.

The South African chromium industry

In response to the growth in world demand for ferrochrome in 1984, South Africa's major ferrochrome producers were operating at near full-capacity following a period of lean years, and plans for capacity expansion have been made. South Africa's readily extractable and vast reserves, coupled with relatively cheap electrical power and labour, allow it considerable potential benefits from any expansion of world demand for chromium.

Profits of the ferrochrome producers are closely guarded secrets. Nevertheless, the rand's weakness gave profits a considerable boost in 1984. Competition in the export chrome ore market, however, is very intense and consequently dollar-denominated prices are relatively weak.

Gold

Gold has been considered a precious metal since ancient times, and the search for gold has stimulated world exploration and world trade for more than 60 centuries. Most of the gold that is fabricated (i e commercial not bullion, gold) today goes into the manufacture of jewelry (about 20 per in the Western World). However, because of its superior electrical conductivity and resistance to corrosion, and other desirable combinations of physical and chemical properties, gold performs critical functions in computers, communications equipment, spacecraft, jet aircraft engines, and a host of other products.

Gold was long considered essentially a monetary metal, and most of the bullion produced each year went into the vaults of government treasuries or central banks. Since the late 1950's, however, the flow of gold to fabricators and private investors has exceeded acquisitions for monetary purposes and since 1968, when the major industrial nations agreed to abstain for a time from further governmental acquisition of newly mined gold, the metal has become essentially a free market commodity and prices have been allowed to move in response to supply and demand.

The use pattern for gold will probably not change much in the remaining years of this century. Although reduced use of gold is possible because more efficient ways to utilize it are continually being devised, no metal or alloy substitute has all of gold's desirable properties.

Reserves

World gold reserves are estimated at 1 450 M troy oz, which is sufficient for about 30 years of mining activity at current levels. South Africa accounts for 55 per cent of these reserves, with relatively minor shares of 17 per cent and 7 per cent for the USSR and USA respectively.

Production

Total world production since the beginning of recorded history is estimated at about 3 G oz, about two-thirds of it mined in the past 60 years. South Africa has been the source of 40 per cent of that gold, but nearly all countries have at some point in their history reported at least some production of gold.

By historical standards, the level of world gold production in 1983 was very high (only 1970 with production at 47.5 M oz was higher) mainly as a result of large increases in production capacity following the 1980 price explosion. South Africa accounted for almost half of the world's gold production in 1983, with the USSR, Canada, USA, and Brazil also featuring as major producers. South African gold mines were operating at 93 per cent of capacity in 1983, with a corresponding figure of 91 per cent for the world as a whole.

World trade

The major part of South Africa's newly mined gold (and much of the gold sold by the USSR) is traded through banks and dealers in Zürich, Switzerland, although London remains the traditional centre for "price fixing". Soviet sales of gold, however, are erratic and only amounted to 2 M oz in 1983. Gold future markets exist in Chicago, New York (COMEX), London, Winnipeg, Sydney, Tokyo, Singapore and Rio de Janeiro.

Recycling

Precious metal refiners throughout the world recover gold from scrap. In the USA, about one-half of the scrap comes from current manufacturing operations ("new" scrap), and the remainder comes from old scrap in the form of items such as discarded jewelry and dental materials. Old scrap has, over recent years, been the major domestic source of supply of refined gold in the USA.

Substitutes

Although reduced use of gold is possible because more efficient ways to utilize it are continually being devised, no metal or alloy substitute has all of gold's desirable properties. Higher prices lead to some substitution but often at a cost in performance. Platinum and palladium substitute for gold to some extent, but their use is influenced by price relationships and estblished consumer preference for gold.

Risk assessment

Worldwide, the use pattern of gold will probably not change much in the remaining years of this century. Jewelry is expected to remain the dominant use for fabricated gold. World reserves are more than adequate to cover expected demand.

The Treasuries of all Western nations carry extremely large stocks of gold and thus there is little need for strategic stockpiles. For example, the US Treasury had stocks of bullion amounting to about 263 M oz at yearend 1983. The availability of gold in times of national emergency, therefore, appears to be assured.

The South African gold industry

For some time the dollar price of gold has reflected, to a large extent, the strength of the US currency. Over recent years, the appreciation of the US dollar against the currencies of all of its major trading partners has led to a weakening in the dollar price of gold. The severe depreciation of the rand since 1983, however, has led to record rand-denominated gold prices. In turn this has given an incentive for increased levels of capital and exploration expenditure, and has also enabled the mining of lower-grade ores.

Though the industry is in an expansionary phase, it has major labour problems. Black trade unions have made it clear that they are no longer prepared to accept mandatory inferior status for their members. The problem is that the entire apartheid system stems from the mining industry's original desire for cheap unskilled migrant labour. Pressure is now building up for blacks to be allowed to reach positions of authority in the industry and, like whites, to be allowed to live with their families whilst employed by the mines rather than as single men in large compounds. South Africa's complex racist society makes resolution of these simple demands extremely difficult.

Over recent years, gold has accounted for almost half of South Africa's annual export revenue. Its domestic economy, therefore, is particularly vulnerable to declining gold prices which, to date, have been largely avoided by a rapidly depreciating rand. The revenue earned from gold mining also provides a major source of revenue for the South African government which, facing a contracting economy, set the surcharge on mine income tax at 25 per cent in 1985 (1983 = 15 per cent).

Manganese

Manganese is a silver-white brittle metallic element which as such has no significant use. It is, however, essential to iron and steel production which consume a high percentage (about 95 per cent) of all manganese produced and for which there are no practical alternatives. Manganese is utilized mostly in an intermediate form. The high-grade metallurgical ore is generally smelted to produce ferro-manganese or silico-manganese which is then added to the steel furnace for the removal of excess sulphur and oxygen. The resultant product displays improved strength, toughness, and resistance to abrasion. Improved metallurgical technology, however, has resulted in recent years in an overall reduction in consumption of manganese by the steel industry. The lower grade manganese ores are generally used in the production of pig iron.

A relatively small amount of manganese is used as an alloying element with several nonferrous metals, chiefly aluminium. Minor quantities of manganese are consumed in the chemical industry and in the making of dry cell batteries, for which certain specific ores are used.

Reserves

Manganese is the cheapest of the metallic elements used to alloy with iron and is one of the more abundant elements in the Earth's crust. At current rates of consumption, reserves of manganese are adequate for over 100 years, although their geographic distribution is very asymmetric. 72 per cent of the world's reserves are located in South Africa, with the USSR accounting for a further 14 per cent. With such a large reserve base, however, even countries with relatively small reserves, such as Brazil (2 per cent of world reserves), China (1 per cent), and India (1 per cent), have in absolute terms substantial deposits. At current prices there are no reserves of manganese ore in the USA, Japan, or the EEC.

Unquantifiable amounts of manganese lie beneath the sea bed in the form of nodules (which also contain significant quantities of cobalt, copper and nickel), but the existing price structure for manganese will almost certainly prevent any commercial exploitation of these reserves in the foreseeable future.[7]

Production

Production of manganese is more evenly spread over the world than manganese reserves, with the eight largest producers of manganese - the USSR, South Africa, Brazil, Gabon, Australia, China, India, and Mexico — accounting for about 97 per cent of world production. The USSR is responsible for almost 40 per cent of annual mine production, but this quantity is used almost exclusively for domestic purposes.

In 1983 South Africa only accounted for 14 per cent of world production (26 per cent of the WOCA production) of manganese, which reflects the impact of fierce international competition and, to a limited extent, restricted sales opportunities based on political considerations. In addition, unlike chromium, manganese has not benefitted from higher levels of economic activity in 1983/84. Manganese sales are slow as a result of slack demand for steels used in the construction and heavy engineering industries, and there exists considerable under-utilized production capacity world-wide. In 1983 South African production of manganese was just 38 per cen to capacity, with a corresponding world figure of 68 per cent.

World trade

Manganese is internationally marketed as ore, ferroalloy, metal, dioxide, chemicals, and others, of which the greatest tonnage is ore. South Africa and Gabon are the leading sources of supply for the USA and the EEC, with the latter also taking major quantities from Brazil and Ghana.

Despite being the world's largest single producer of manganese ore, the USSR is a net importer of high grade metallurgical manganese ore with supplies coming from Australia, Brazil, and Gabon. Plans to expand domestic capacity to avoid imports are well advanced.

Recycling

Processing of metal scrap specifically for recovery of manganese is insignificant. Manganese is recycled as a constituent of iron and steel scrap, but the primary purpose is to reclaim iron. Manganese is recycled in the aluminium industry as a component of certain manganese-bearing alloy scrap.

Substitutes

Substitution for manganese in the production of iron and steel has not been achievable by any practical method since manganese use in steelmaking became common over a century ago. Alternative materials that are possible substitutes are substantially less cost effective and/or do not produce the same metallurgical effect. Thus the demand for metallurgical manganese is relatively price-inelastic. Substitution for manganese is possible in some of the minor applications in chemicals and for batteries.

Risk assessment

Manganese is essential for the production of steel, and no economic substitutes have been found for this end use. Thus continued supply of manganese is absolutely vital to any defence effort as well as to maintenance and growth of the World's industrial economies.

Security of manganese supply has been of prime concern to the major industrialized nations for many years, but of these nations only the USA has established a considerable manganese stockpile. In 1984, quantities of stockpile — grade manganese ores and alloys held in the US National Defence Stockpile were more than sufficient to meet the goal of a three year national emergency supply.

The USA also has a strategic concern in the decline of its domestic ferroalloy industry, where it has fallen much below self-sufficiency in capacity for producing manganese ferroalloys. This situations differs from that in Japan and Western Europe where many countries are self-sufficient and are actually net exporters. The domestic manganese ferroalloy industries of these countries, and particularly the USA, are threatened, however, by the growing trend in ore-producing countries, especially South Africa, to produce and export ferroalloys themselves.

Since among the WOCA nations South Africa is the largest producer of manganese ore, and has the largest ore reserves by far, a concern exists as to possible disruptions in supply from that country because of either international or external political developments.

The South African manganese industry

The country's two manganese producers, Samancor and Associated Manganese (Assmang), have benefitted strongly from the world's economic recovery and the weakness of the rand over the past couple of years. However, these benefits were derived less from the sales of manganese ore and alloys than from sales of ferro-chrome. Manganese sales have been slow as a result of slack demand for steels used in the construction and heavy engineering industries, and excess capacity remains high.

Platinum-group metals (PGM)

The platinum group comprises six closely related metals: platinum, palladium, rhodium, ruthenium, iridium, and osmium, which commonly occur together in nature and are among the scarcest of the metallic elements.

The platinum-group metals have become critical to industry because of their unparalleled physical and chemical properties. In the USA, over 95 per cent of the PGM consumed each year are used in industry. The metals are refractory, are chemically inert toward a wide variety of materials even at high temperatures, and display excellent catalytic activity. These properties are the basis for the principal uses, as catalysts in the chemical, petroleum refining, and automotive industries, and as corrosion-resistant materials in the chemical, electrical, glass, and dental-medical industries. There are no viable substitutes in the majority of applications for the most important metals in the group; platinum and palladium, although gold and silver have some minor role as substitutes.

Demand for PGM from Western industrialized nations is likely to increase at a relatively rapid rate over the years to 2000, with the electronics sector providing the major growth via the telecommunications and aero-space industries. In addition, the introduction by the EEC of controls over automobile exhaust emmissions similar to those currently operating in Japan and the USA is likely to give a major boost to the demand for platinum.

Reserves

South Africa possesses 81 per cent of the world's platinum group reserve base, with 17 per cent in the USSR. The remaining two per cent is distributed over the USA and Canada. Thus 97 per cent of the WOCA reserve base is in South Africa. These reserve data are extremely large, however, relative to current consumption, amounting to a reserve life of almost 200 years at current rates of mining. Thus, even the "small" US and Canadian reserves are very significant in the context of current demand.

Production

In 1983, South Africa, the USSR and Canada accounted for virtually all of the world's primary supply of PGM, although the latter has only accounted for about five per cent of the total in the past few years. South Africa has produced about two thirds of all platinum, while the USSR has produced about two thirds of all palladium in recent years. As a consequence these two countries exert a strong influence on the price of these two commodities and some form of collusive pricing and supply agreement appears to exist.

World trade

The major portion of South African production of PGM is refined in South Africa, with the balance being shipped to the UK for refining. The USA and Japan currently consume about two-thirds of the world's PGM production, with Western Europe and the USSR dividing most of the remainder.

Soviet sales to Western nations have been declining over recent years and this leaves South Africa in a dominant position. In 1985 South Africa supplied 85 per cent of the world's primary supply of platinum, Canada four per cent and the USSR eight per cent.

Recycling

PGM are recovered principally from petroleum catalysts, chemical catalysts, and glass fibre bushings. Smaller amounts are recovered from used and new automotive catalytic converters, electronic scrap, jewelry, laboratory crucibles, and dental materials. Of the annual US supply of PGM, about 10 per cent is secondary metal. The current market price, however, does not encourage secondary recovery and consequently a large scale recycling industry does not, at present, exist.

Substitutes

In automotive catalysts, platinum, palladium, and rhodium have had no competition from substitutes in recent years, probably due to the relatively small amount used per converter.

In petroleum refining, molybdenum and chromium can substitute for PGM, but only by sacrificing yield and catalyst life. Since most of the PGM used in the petroleum industry are recycled with little loss, the need to find PGM substitutes has not been very evident.

Silver and gold substitute for platinum and palladium in electrical end uses, depending on relative prices.

Risk assessment

The USA, the EEC, and Japan import essentially all of their supply of primary PGM, chiefly from South Africa. Not only does the import of these metals from just one nation have strategic implications, but the net outflow of dollars (about 600 M USD for the USA in 1983) adversely affects the balance of payments for these countries. US dependency will be reduced when the Stillwater complex in Montana commences operations in mid-1987, but even when it reaches full capacity, it will only be able to supply 10 per cent of US domestic requirements around 1990. The development of the USA's considerable resources of PGM awaits considerably higher prices to make their extraction economically viable.

In an emergency, part of the large pool of PGM in use in domestic industry could, after some delay, be reallocated to essential strategic uses. In some industries the supply could be extended by more frequent recycling. In addition, regulations limiting the amount of automobile pollution could be relaxed, reducing or eliminating the need for catalytic converters containing PGM. Gold, which has fewer critical industrial uses than PGM, could substitute for PGM in several uses.

The US strategic stockpile carries about six months supply of platinum and one and a half years of palladium at current rates of consumption. These figures represent about 35 and 40 per cent respectively of the desired level of strategic stocks of these two minerals.

The South Africa PGM industry

Platinum prices have been relatively weak over recent years (although prices have risen rapidly during 1986), but the substantial decline of the rand has yielded South African producers substantial gains on their US dollar-denominated sales contracts, and a major industry expansion is current underway. In general, however, the actions of South Africa's three major producers — Rustenburg, Impala, and Western Platinum — are veiled in secrecy, thus fueling rumours of producer collusion in the international market.

Automobile industry use of rhodium produced increased demand in 1984 with prices rising by almost 100 per cent (from 316 USD to 616 USD per troy ounce), while ruthenium prices rose from 29 to 107 USD per troy ounce, a rise of 269 per cent! Demand for these two commodities appears to have put great pressure on both stocks and production capacity.

Vanadium

The principal use of vanadium is as an alloying element in steel. The addition of small amounts of vanadium, often less than 0.1 per cent, to an ordinary carbon steel can significantly increase its strength and improve both its toughness and ductility. Such high-strength low-alloy (HSLA) steels are attractive for highrise buildings, bridges, pipelines, and automobiles because of the weight savings obtained. Over 90 per cent of vanadium consumption in the USA, the EEC, and Japan is used in the manufacture of steels, and consequently the industry's fortunes monitor those of the steel industry. Vanadium is also used as an alloying agent to strengthen titanium. Vanadium aluminium alloys of titanium are widely utilized in aircraft parts, while oxides and chlorides of vanadium play important roles as catalysts in the production of sulfuric acid and key intermediate organic chemicals.

Vanadium rarely occurs in deposits that can be mined economically for the element alone. It is usually produced as a byproduct or coproduct of another element, such as iron, uranium, or phosphorus. Lesser amounts are being recovered from clays, petroleum residues, and spent catalysts.

Vanadium is traded as the ferro-alloy (50—60 per cent vanadium), the pentoxide (minimum 98 per cent purity), and as slags of various grades and origins. Vanadium forms such a minor constituent in most ores that the high cost of transporting concentrates containing vanadium must be reduced by locating processing plants as near to the mine site as possible.

Reserves

Vanadium ores are widely distributed around the world and the current reserve base is vast, being sufficient to meet over 400 years of consumption at current levels. Almost half of these reserves are located in South Africa, with a further 25 per cent in the USSR and 13 per cent in the USA. The EEC and Japan, however, have negligible reserves and consequently vanadium is of considerable strategic importance to them.

Production

World production of vanadium in 1983 was relatively low, reflecting high inventory levels and depressed prices as a result of a drop in the demand for steel. In 1983, South Africa accounted for 54 per cent of the WOCA production of vanadium, and 28 per cent of the world total. Other major producers were the USSR, China, Finland and the USA. Although the USSR is largely self-sufficient in vanadium it enters into very little trade outside the COMECON countries. China is now recognized as a more or less constant source of vanadium for the Western World.

The growth in steel production in industralized nations in 1984, however, encouraged production to rise to almost 35 000 tonnes, which represented a considerable improvement on the 1983 total, but substantial excess capacity still exists on a worldwide basis.

World trade

It is widely believed that South Africa and the USSR operate a covert price agreement on vanadium entering world trade, but the emergence of China as a major producer has served to undermine this collaboration. South Africa effectively controls the market and the growing integration between mining and ferro-vanadium production puts the country at an advantage given its reserves of cheap labour and coal.

Between 1980 and 1983, 44 per cent of US vanadium imports came directly from South Africa. Additional material was processed in Western Europe and then imported as ferro-vanadium or pentoxide. Japan and the EEC nations are almost entirely dependent upon imported supplies of vanadium, with the former taking 60 per cent of its requirements from South Africa in 1983. Any extended cutback in South African production would seriously upset the balance between supply and demand in the Western World. Sizable, near-term deficits could only be offset by material from China or the USSR.

Recycling

Several hundred tons of vanadium are recovered annually in the USA and Japan from spent catalysts. However, most of this vanadium is of primary origin. Cobalt-molybdenum-based catalysts, which come from oil refineries and have been poisoned by vanadium contained in the crude petroleum, form the bulk of the processed catalysts.

A large portion of the vanadium contained in tool steels is recycled. Vanadium is also recycled as a minor component of other scrap iron and steel alloys that are recovered primarily for their iron content.

Almost one quarter of the total vanadium produced in the USA, and all of it produced in Japan, is now being recovered from petroleum residues, ashes, and spent catalysts.

Substitutes

Steels containing various combinations of other alloying metals can be substituted in some situations for steels containing vanadium. Columbium, molybdenum, titanium, chromium, manganese, and tungsten can all substitute for vanadium to some degree. However, all of these substitutes have some technical or economic drawbacks. In addition, many of them are classified as having a high strategic rating themselves.

Risk assessment

Vanadium is classified as a strategic and critical material because of its significant import dependence and essential use in equipment for defense, energy and transportation.

In the USA, more than half of the vanadium mined is recovered as a co-product with uranium. The weak demand for uranium over recent years, however, has led to many mine and mill closures, and the development of a number of new mines has been postponed. This could create a much higher degree of dependence for the USA on South African and Chinese imports during the 1990s if the situation does not change.

The US strategic stockpile contains very low stocks of vanadium, although industry stocks are very high following the recent period of depression in the steel industry.

The extraction of vanadium from Caribbean oils, chiefly from Venezuela, is a major potential source of additional supplies, but the large-scale investments required to develop the process await recovery of the market and strenghthening prices.

The South African vanadium industry

The steel boom of 1984 has encouraged expansion of production, although excess capacity remains a problem. The rand's dramatic decline against the dollar has had the effect of boosting domestic revenue receipts considerably. A current source of concern, however, stems from the possible entry into the market of considerable supplies of Chinese material, which would (again) depress prices.

SUMMARY AND CONCLUSIONS

South Africa has a mineral based economy, and the major part of its annual total export revenue has been derived from mineral (chiefly gold) exports for many years. It is the chief supplier to the USA, the EEC, and Japan of the minerals required to support the industrialized base of these nations. Minerals such as chromium, manganese, and platinum for which economically viable substitutes do not exist, alternative sources of supply are negligible, and for which assured availability can genuinely be described as essential to the national security of Western nations. The industrialized nations of the Western World have been heavily dependent upon South Africa for the supply of their strategic minerals to such an extent that any major disruption of supply (by way, for example, of prolonged strikes by black miners or a comprehensive trade embargo) is likely to generate spiralling prices and severe shortages. While inventories may be sufficient to offset any short-term ill effects, they would certainly not be sufficient to cover requirements until additional sources of supply, now rendered economic by the greatly increased prices, were forthcoming. Whether countries such as China and the USSR would be willing to expand exports to take financial advantage of this situation is uncertain, as the benefits of such an action must be weighed against the loss of political advantage that could be gained by withholding supplies from the WOCA nations.

The possibility that South Africa could use its exports of strategic minerals as a source of political leverage in the face of growing pressure from the USA and Western Europe to settle its internal disputations is unlikely. South Africa is heavily dependent upon the export revenues generated by these minerals not only to pay for essential imports but also as a source of government revenue. In the past, South African mining companies have had an excellent record for reliability and the cost of jeopardizing this reputation is likely to be severe.

In view of their heavy dependence on South Africa for the five strategic minerals considered here, it would appear prudent for industrialized nations to take a number of steps to encourage a more diverse range of sources of supply.

There are a number of possibilities:

- The establishment of *national resource evaluation projects* for strategic minerals aimed at discovering and evaluating additional resources. Action should be taken to ensure that, in the event of national emergency, the lead time required to bring such resources (now reserves following the expected price increases) into production has a time horizon compatible with the level of inventories held in the strategic stockpile (e g the possibility of ocean mining to recover manganese from deep sea nodules).
- An increased emphasis on the *research and development of alternative, less strategic, minerals* as substitutes for those of great strategic value. This may however entail not only an added materials cost but also an enormous capital requirement to modify existing processing procedures.
- Increased emphasis on recycling as a means of augmenting domestic supplies of these minerals.

The critical element in any scenario concerning the impact of long-term supply disruptions for strategic minerals is time. National security considerations dictate that inventories should be held in sufficient quantities to ensure sufficient supplies until expanded production from new and existing sources can adequately meet demand. The optimal mix of inventory accumulation, resource evaluation, research and development into substitution, and recycling policies must obviously be based on the relative costs of each course of action. Such insurance costs are likely to be minor, however, compared to the turmoil that would result if a serious supply disruption occurred and precautionary measures were non-existent.

Notes:

[1] D Hargreaves and S Fromson, *World Index of Strategic Minerals,* Gower, Aldershot (Hampshire, England), 1983.

[2] M Radetzki, "Strategic Metal Markets", *Resources Policy,* December 1984, pp 227—240.

[3] W C J van Rensburg and S Bambrick, *The Economics of the World's Mineral Industries,* McGraw-Hill, Johannesburg, 1978.

[4] R Weston, *Strategic Materials,* Croom Helm, London and Sydney, 1984.

[5] See van Rensburg and Bambrick, *Supra,* Chapter 2, for extended discussion on this subject.

[6] At the time of writing, 1983 data were available for all minerals considered in this study. In addition, preliminary estimates for 1984 production of these minerals were available for certain countries. In the text which follows, the 1984 estimates have been cited, wherever possible, to augment the 1983 data.

[7] J P Clark and M P Neutra, "Mining Manganese Nodules: Potential Economic and Environmental Effects", *Resources Policy,* June 1983, pp 99—109, provides a more detail account of the economic feasibility of mining these nodules. ■