Presidential Address: Platinum Perspectives

by Dr L.A. Cramer*

Introduction

Platinum metal was first utilized by the Inca civilization in South America where it was found in alluvial deposits along the San Juan and Atrato rivers that lie between the Andean mountain range in Colombia and the Pacific Ocean. The nuggets found in these rivers average between 77% and 86% platinum, 7%–8% iron and small amounts of copper, gold and other Platinum Group Metals (PGMs). The Incas often alloyed platinum with copper to increase its workability and fabricated various ornaments from it. With the arrival of the Spanish in the early 1700s, platinum was labelled a nuisance for the Spanish in their quest for alluvial gold because it concentrated with the gold and had to be removed by either extended amalgamation or by hand sorting. It was at this time that platinum received the root of its current name for the Spanish referred to it as platina del Pinto, platina being the somewhat derogatory diminutive of plata (silver). Pinto was a river in Colombia where the Spanish first distinguished it. The English eventually adopted 'platina' and it is only in recent times that the Latin name platinum has been accepted as the metal's common English name. From its first introduction to European scientists in 1740, platinum was unappreciated because of its brittle nature and difficulty of working and as a result had little commercial value. Its ability to be dissolved in gold did lead to some counterfeiting of gold bullion and even to the debasement of gold currency. Debasement of gold was such a large problem that the King of Spain barred trade in the metal and insisted on all platinum being sold to the crown. However, by the late 1700s scientific interest was increasing and a market for the metal began to develop. The King of Spain was paid 2 Spanish dollars/pound for platinum but demand was soon exceeding supply and the blackmarket via Jamaica fetched 10 Spanish dollars/pound. Estimates of supply vary but a generally accepted figure is 1 000 to 1 200 pounds/annum. Not until 1786 did the Spaniard Don Fausto and his French counterpart Chabaneau develop a method of purifying platinum and making a malleable platinum that could be easily worked and fashioned into objects of art. A good example of this is the chalice made in Spain by Chabaneau's method and presented to Pope Pius the VI by King Charles III in 1789; this now resides in the Treasury at St. Peter's in Rome. After whetting the world's appetite for platinum, the Spanish industry was destroyed during the Napoleonic wars and the metallurgical techniques developed for working with platinum were lost with the inevitable scattering of records and individuals. When Spain left its South American interests and Colombia became a republic, the metal became more freely available. However, chemists and metallurgists had to start virtually from scratch to develop economic and practical methods for purifying and fabricating the metal. This second surge of technical development was to be centred in London and greatly assisted by the French Rochon and Dutch Ingenhousz whose platinum waistcoat buttons created a lot of interest. When supplies became available from Russia in the early 1800s, progress in the science of the PGMs and their uses developed quickly. Wollaston identified palladium and rhodium; Tennant discovered iridium and osmium. The four principal European houses that took up commercial exploitation of platinum metal began operations between 1812 and 1827 and based their processes on the work of Knight and Thomas Cock. But it was not until the use of platinum boilers for the manufacture of concentrated sulphuric acid became common industrial practice that large amounts of platinum were utilized commercially. Sulphuric acid was in demand for the purification of gold from silver in the refining process at most mints at that time. One of the companies involved in this business, Johnson & Matthey (1860), a recognized name in the platinum industry, grew out of Johnson & Cock formed in 1837 (William John Cock, the second son of Thomas). The metal used in these fabrications was made from platinum sponge, which was forged into metal, a process used by Johnson and Matthey until 1931. An indication of the growth of the platinum business is given by Johnson & Matthey records of sales; about 16 000 oz in 1860, rising to 88 000 oz in 1888. At the same time, scientific inquiry continued. J.W. Dobereiner of the University of Jena first explored platinum's catalytic properties in some detail and his colleague J.J. Berzelius coined the term catalysis to describe the properties observed. K.K. Klaus, the respected Russian PGM scientist, discovered and named ruthenium (a latinized name for Russia) in 1845.

By the late 1800s, platinum had become not just a scientific curiosity or a unique metal for decoration of art but a commercial proposition. Johnson & Matthey had quickly become a refiner of gold and a fabricator of platinum products, particularly the production of sulphuric acid stills for making concentrated acid. Heraeus[1851], founded by W.C. Heraeus, had started as a supplier to the Hanau jewellery industry and refiner of their scrap metals but quickly started to compete in the fabrication of platinum stills or vessels.

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Much later, in the early 1900s, C. Engelhard, a brother-in-law to Dr W. Heraeus, would found the American-based precious metal refiner and fabricator, Engelhard Metals.

Perhaps it is best to leave the development of the uses for platinum and briefly examine the source of platinum group metals across the globe. The early discovery of platinum in Colombia never led to a large platinum industry there; the alluvial deposits were insignificant. The 1800s saw almost all of the platinum supplied from Russian deposits in the Ural Mountains where larger alluvial deposits were available. However, in the late 1800s, exploitation of nickel in Canada's Sudbury area produced significant amounts of metal as a by-product. The early 1900s saw the discovery of the two most important sources of PGMs. Dr Hans Merensky discovered and delineated the great Bushveld Igneous Complex in South Africa and the Norilsk Nickel deposit was discovered in northern Russia. Recently, some production of these metals has come from the Stillwater complex in Montana, USA and from the Great Dyke in Zimbabwe. Platinum concentrations in these ores vary significantly. Southern Africa typically has values of 0.1 oz/ton, Stillwater ores can be up to 6 oz/ton and the richer areas of the Norilsk orebody can be as high as 50 oz/ton. Furthermore, platinum to palladium ratios in these ores vary considerably. Broadly speaking, the northern hemisphere orebodies have platinum to palladium ratios of 1:3, whilst the western part of the Bushveld complex and the Great Dyke area have ratios of 2.5:1. The eastern part of the Bushveld Igneous Complex has ratios of closer to 1:1. But in all cases the PGMs are associated with nickel or nickel-copper ores and are found in rather low concentrations.

Thus, PGM supply has evolved from the mining of alluvial deposits with relatively pure nuggets of metal, to by-products of the nickel industry, and only with the advent of the Bushveld complex and the increased demand in the early 1900s to primary mining for PGMs (albeit in a low-grade Ni-Cu orebody). This South African orebody now supplies more than 75% of the world's platinum and 40% of the world's palladium. Furthermore, the Bushveld Igneous Complex contains the large majority of the world's PGM reserves. Estimates of South Africa's portion of the world resource base range from 60% to 90% of known platinum reserves.

History of the SA mining industry

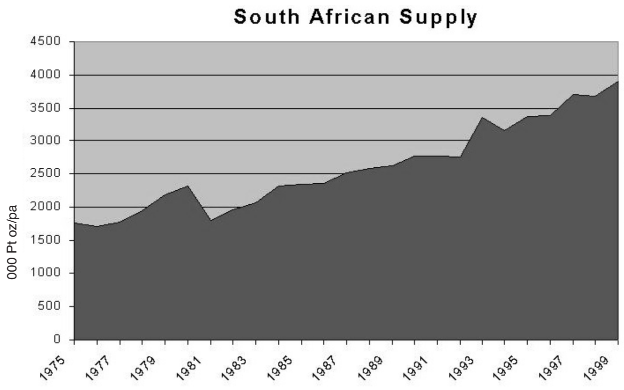
In 1924 when the Afrikaans farmer, A.F. Lombaard, discovered a heavy grey metal in his gold pan on the farm Maandagshoek in the eastern Transvaal he quickly contacted renowned geologist Hans Merensky. Merensky identified the metal as platinum and in subsequent years delineated the famed Bushveld Igneous Complex. This geological feature hosts two reef horizons that contain economic levels of PGMs; the Merensky reef and the UG2 chrome reef (Upper Group 2). Within this geological feature lies the largest known single source of PGMs in the world. Both reefs are currently being mined for PGMs. This period saw a flush of platinum mining companies being floated, some of which survived through the World War I and the Great Depression, and saw the demise of the platinum jewellery industry as the metal was made strategic and all use in commercial ventures was curtailed. Two of the early companies, Potgietersrust Platinum and Waterval Platinum merged in 1931 to form Rustenburg Platinum Mines, the world's largest platinum mining company. In 1997, Rustenburg Platinum Mines, Lebowa Platinum Mines and the new Potgietersrust Platinums became wholly owned subsidiaries of Anglo American Platinum Corporation (Amplats). Amplats then became the world's largest single supplier of platinum with a present capacity of some 2 million oz/annum or about 40% of the demand. Amplats currently plans to increase production to some 3.5 million oz/annum by 2006. Impala Platinum and Lonhro Platinum are the world's second and third largest producers with capacities of some 1.1 million oz and 0.7 million oz respectively. Together, these three South African mining companies totally dominate supply to the platinum market, with >70% of the world's supply and generated in their last business year approximately R16 billion in export earnings, employed 90 000 people and paid R1.25 billion in taxes to the South African government.

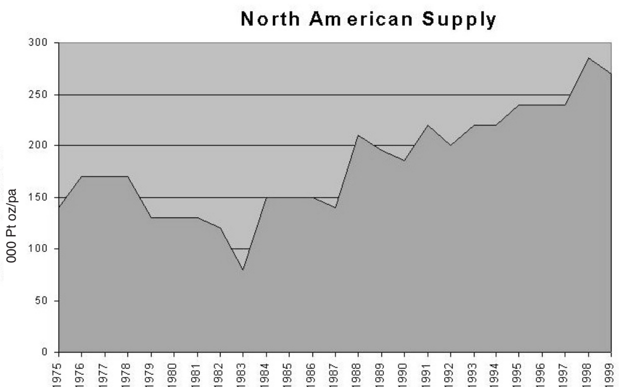
The South African mining companies began mining the South African PGM deposits utilizing their developed gold mining skills. Hence, the first PGM operations were based upon traditional narrow reef gold mining techniques and gravity concentration to capture the high-grade platinum minerals. This quickly progressed to milling and flotation operations to improve overall recoveries. Initially, various minerals processing concentrates were sent overseas for refining to firms such as Johnson Matthey. In the mid-1950s some local refining of nickel-copper mattes from blast furnace operations was carried out and by the 1980s all base metals associated with platinum ores was refined in South Africa. Precious metal refining began in South Africa in the 1960s and from the early 1990s all South African platinum production was refined inside the country. It has taken just 65 years for the total production technology to be transferred from Europe and for the industry to generate sufficient capital and sales volume to justify the additional steps in the added-value chain. No doubt, further added-value investments will be made as the economic drivers for such investments manifest themselves. Additional investments in the value-added chain require a number of elements for economic success. The principal ingredients are sales volumes of the fabricated metals, technical know-how and skills and, importantly, an entrepreneurial environment of low levels of regulation and taxation.

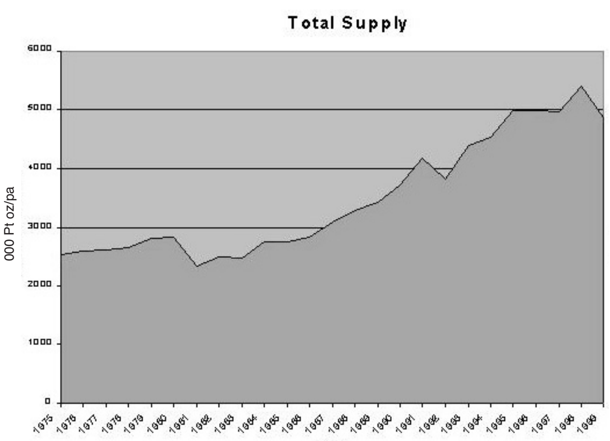
World supply

The supply of platinum has shifted from Colombia in its infancy to Russia in its youth and on to South Africa in its prime. With correct management, South Africa will still be the focal point in platinum supply when the industry reaches a mature phase of development. The largest supply of PGMs is derived from sulphide ores, not alluvial deposits, with the North American and Russian supplies being by-products of the nickel market and South Africa being primary suppliers. Thus, supply is somewhat dependent upon the demand for nickel as almost 20% of world's supply arises as a by-product of nickel mining. Nickel supply and demand will determine the availability of PGMs from this source and sustained low nickel prices can reduce supply from this sector quite significantly.

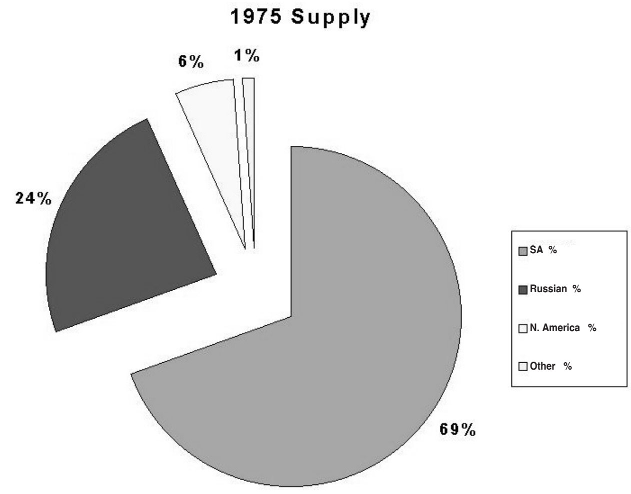
World supply of platinum is shown for the past twenty years in the following graphs:

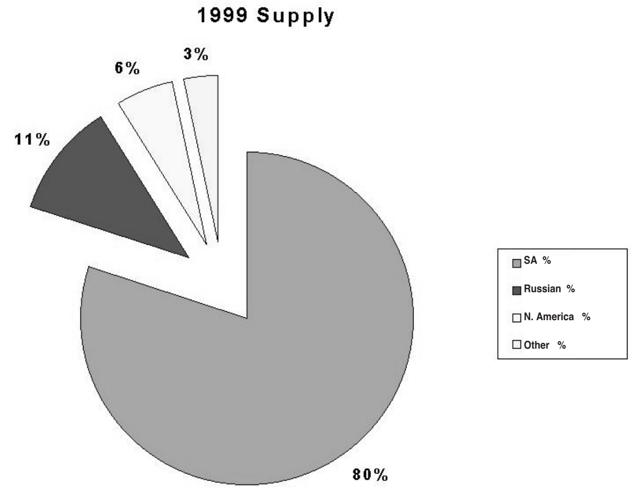






Market share has shifted slightly toward South African producers in the past twenty-five years as shown in the following pie charts.



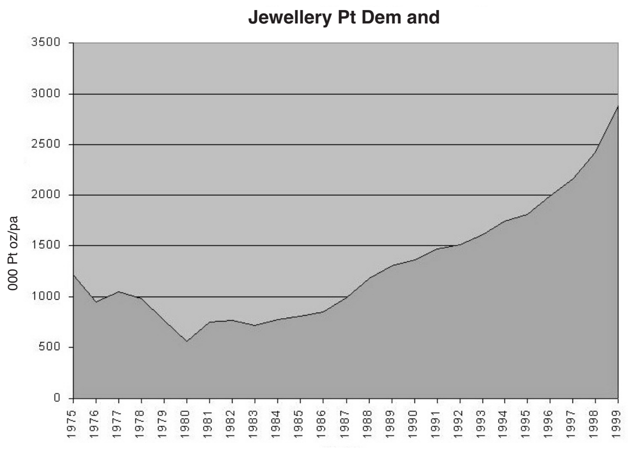


Future supply growth can be expected to continue to be centred in southern and South Africa. The only known reserves of significance being in the South African Bushveld Complex and in Zimbabwe's Great Dyke. Current high prices and positive market forecasts are fuelling considerable exploration activity, mainly in Canada and to a lesser extent in the USA, Australia, New Zealand and Russia. Whilst some positive reports on PGM deposits are coming from Canada, no large new deposits seem imminent. Thus, for the medium-term future at least, platinum supply growth will have to come principally from South Africa.

Market demand

Of course supply growth has to be built upon the growing demand for platinum worldwide. In a market of 5.6 million oz annum (1999), the largest segment—jewellery—consumed 2.88 million ounces. This segment has recently overtaken the autocatalyst market, which although stable, now runs second at 1.18 million ounces (net of recycle). Other industrial uses account for a further 1.36 million ounces and investment demand is insignificant at 0.18 million ounces.

The jewellery market has been growing very satisfactorily for a number of years but had been particularly concentrated in Japan where it gained a foothold because of the post-war regulation of the use of gold. The past few years have seen major growth in the jewellery market in China, partly for the same reason but also fuelled by the growing affluence of a segment of the Chinese community; almost 150 million Chinese can now be considered to be in the world's economic middle class. The rate of growth in China has reached a phenomenal 60%/annum over the past several years; and in 1999 absorbed 950 000 oz or one-third of world jewellery demand. Growth in the USA has also been rapid and is making significant inroads into the bridal market where it fulfils 20% of the demand. Unfortunately, the jewellery market is highly price sensitive, as can be seen in the demand graph in the early 1980s when prices moved sharply upwards. Platinum metal reached US $800/ounce in 1981 and jewellery market demand slumped badly. Platinum must compete in this market not only with gold, white gold and silver but also with the many other luxury items that attract disposable income. As a result, the jewellery market requires constant promotional support to remain vibrant. South African producer support for the Platinum Guild International (PGI) has been particularly important in this regard. Without the activities of this organization, the stability of the Japanese market would have been lost and the growth in the Chinese and USA markets would not have occurred. Average growth rates of some 7% have been achieved, resulting in a tripling of platinum's share of the world jewellery market in the past 15 years. Future growth may well extend geographically into other emerging economies such as India and South America where large populations and a growing affluence may create increased demand. However, this must receive additional promotional support via organizations such as the PGI.



Industrial markets are geographically concentrated into the First World countries and can be segmented into several categories, as below:

- Chemical industry 0.25 M oz
- Electronics industry 0.35 M oz
- Petroleum industry 0.20 M oz
- Glass industry 0.35 M oz
- Other 0.30 M oz.

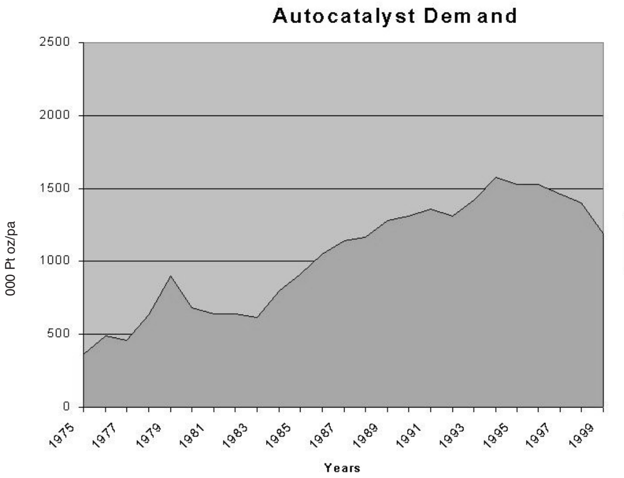
Chemical uses include biomedical, coatings, ceramics, and catalysts. Electrical uses include contacts, pastes, cobalt-platinum alloys for hard disks, and fuel cells. Petroleum refining uses platinum in a number of catalysts. Platinum's excellent high temperature properties are used in glass fibre manufacture and the production of optical glass. The large varieties of other industrial uses include crucibles, thermocouples, spark plug tips, biomedical devices, oxygen sensors and platinum-based coatings for jet turbine blades.

Autocatalyst demand in the Western world has been driven by the strong desire for a cleaner environment; the large majority of petrol and diesel vehicles produced in the world today have PGM-based catalysts fitted to reduce the exhaust of carbon monoxide, hydrocarbons and nitrous oxides. The legislation to bring about these cleaner vehicle exhaust emissions has been, and continues to be, incrementally tightened from its inception in the 1970s. It is this demand which first brought the platinum industry out of its boom and bust history and into a more mature and stable market. However this demand has been flattening owing to the combined effect of catalyst recycling and the substitution of platinum by its once cheaper sister metal, palladium. The use of platinum is supported somewhat by the increased demand for lean-burn petrol engines and for diesel engines, where its catalytic properties are preferred, and the demand from the developing countries where platinum is more tolerant of the higher sulphur fuels utilized.

The use of palladium in autocatalysts has grown by some sixfold in the past five years. This shift by the large automobile manufacturers into the previously lower-cost sister metal is giving rise to serious imbalances between the supply and demand ratios of platinum and palladium. The world's largest reserve of PGMs (the Bushveld Igneous Complex) contains platinum to palladium ratios of about 2.3:1, this is balanced somewhat by reserves in Russia and in North America where the ratios are 0.3:1. However, it is likely that the long-term reserve ratios lie between 2.0-2.5:1, whereas current consumption is approaching 0.60:1. The present supply of palladium is heavily dependent upon the sale of metal from Russian stockpiles. Unless demand alters, this stock will be exhausted in the medium term and a gross market distortion will follow. Supplies from the Russian stockpile have typically been about 25%–30% of market demand; without adjustments to demand, the loss of this supply, will create significant price distortions. In fact, some of the market volatility that has occurred in late 1999 and early 2000, fuelled by temporary legislative disruptions to the Russian supply may be reflecting that understanding already.

The major automobile manufacturers are shifting a portion of their demand towards platinum as the catalytic agent because high prices for palladium and the spectre of increasingly constrained supplies command a re-evaluation of their catalyst formulations. General Motors announced a shift to platinum in May 2000 and other major automobile manufacturers appear to be following suit. The swing away from palladium is a strongly positive demand opportunity for platinum and for the South African producers in the longer term.

The industrial market for platinum relies upon the unique physical and chemical properties of the metal. Platinum has excellent corrosion-resistant characteristics, high strength, good creep resistance and a wide range of catalytic properties that, despite its price, makes it the metal of choice in

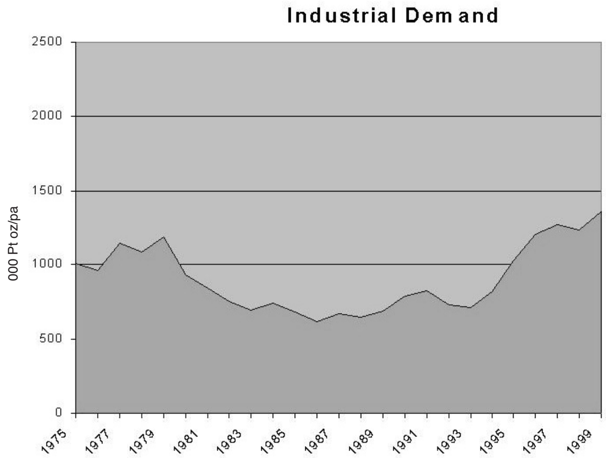


innumerable industrial applications. Accordingly, the use of platinum in industry tends to be very specific and technologically-based and this requires continued research and development to find new uses and expand consumption.

Several areas of the industrial market—for example, the petroleum catalyst market are in a mature phase. Others are growing with the general advance of technology such as the magnetic alloy utilized in the computer revolution's hard drives and manufacture of high-quality glass screens. Information-storage requirements continue to expand at rapid rates, fuelled by the growing use of computers for video and audio applications. The use of platinum in hard disks might be expected to rise from its current 250 000 ounces/annum to some 500 000 oz by 2003. Industrially, the ability to recover and recycle platinum is often a major contributor to its competitiveness. Despite its unique properties and the ability to recycle the metal, platinum will always be under threat of substitution because of its relatively high price.

The greatest long-term growth in industrial demand is expected to come from the development of the proton exchange membrane (PEM) or solid polymer fuel cell. These cells use platinum to catalyse the reaction between oxygen and hydrogen and produce electricity directly from that reaction. Fuels cells have been in use since the beginning of the NASA space programme but it was only with the advent of the PEM cell that sufficient power density was achieved to economically power a motor vehicle. Within the last few years, fuel cell development has gathered a great deal of momentum and the technical and economic barriers are falling rapidly. Almost all of the major motor manufacturers are committed to commercial fuel cell cars within the next five years; some like Daimler Chrysler are intent on having a commercially available vehicle before then. The chairman of Ford Motor Company, William C. Ford Jnr., has publicly stated that the fuel cell is the death-knell of the internal combustion engine and will end its 100-year reign.

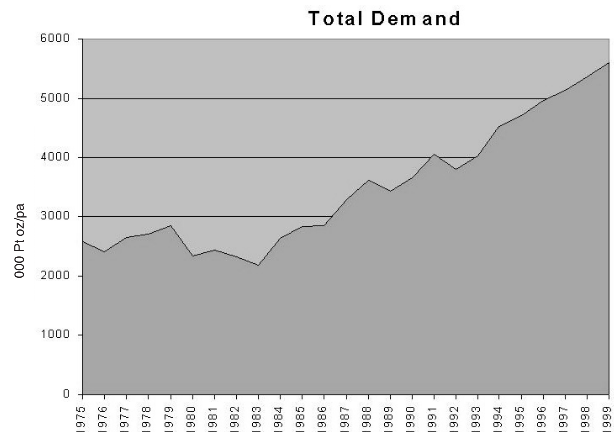
Demand in this area is again driven by the strong desire for a cleaner environment and by the legislation in First World countries designed to ensure that environmental targets are met. The fuel cell in motor vehicles eliminates exhaust pollution entirely as the exhaust contains only water vapour. Low levels of carbon dioxide are produced in the manufacture of the fuel during the reforming process. Platinum usage in these equivalent zero-emission vehicles (EZEVs) will be greater than in the current petrol-powered cars with exhaust catalysts and thus will lead to an increase in platinum demand within the transportation sector.

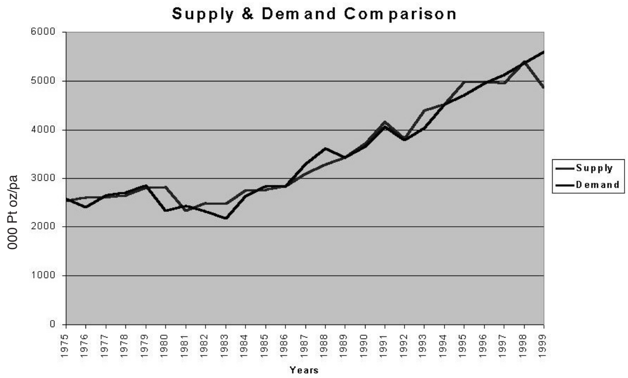


The investment market is dependent upon the rarity and intrinsic value of platinum but, like the jewellery market, requires continued promotional spending. Activity waxes and wanes, with price volatility and currency speculation, influencing prices at the extremes of the market. Thus, investment activity tends to drive prices both higher and lower than they would otherwise be at the peaks and troughs of the market; from the producer viewpoint, this increased volatility negatively impacts upon the industry.

Broadly speaking, the platinum market can be seen as a two-part market, in which jewellery and investment demand are created, while autocatalyst and other industrial uses are derived. Historically, the South African primary platinum industry has become increasingly active in the created demand areas but has left the derived demand sector development largely to the fabricators (Engelhard, Heraeus, Johnson Matthey, Degussa) and, to a lesser extent, to the customers of fabricated products.

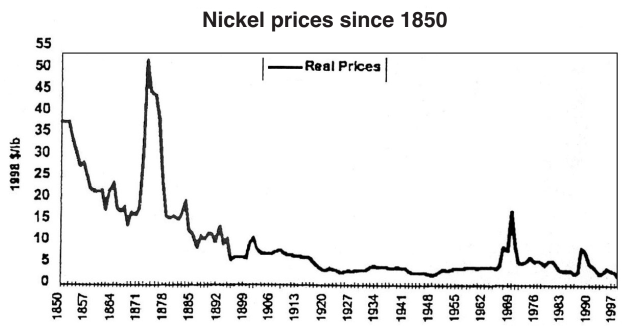
The past 16 years have seen a fairly steady growth rate in platinum demand of some 6.2% per annum. At current demand levels, this growth in demand is equivalent to a mine the size of Amplats' new Eastern Limb development (Maandagshoek) every six months.

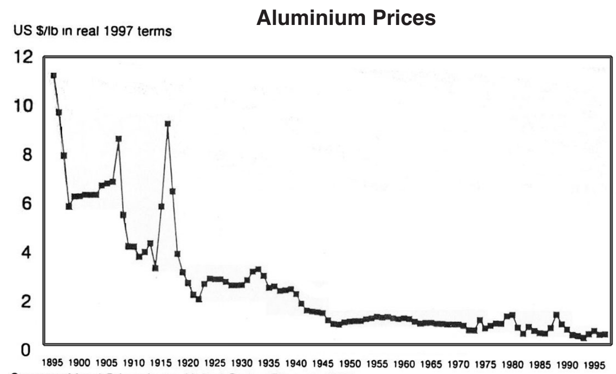




Future challenges for the South African industry

The South African PGM industry may soon eclipse the gold industry as the country's number one foreign exchange earner and the future of market demand looks bright. However, the platinum lining has a few clouds as well. The industry costs structures are heavily weighted to the mining operation. Operating costs can be typically 65%–75% mining, 8%–12% concentrating, <10% smelting and about 10% refining. Extraction efficiencies are also lowest in the mining and concentrating core operations; typically between 80%–90% for each segment of the operation. The mining operation remains essentially as it was 50 years ago, with a heavy reliance upon a large number of unskilled men who travel daily to the stopes, drill, blast and move the ore to the shaft system. Wages have accelerated at an average of between 15%–20% per annum since the early 1970s and can be expected to continue to be under upward pressure in the future. Many mines are approaching shaft head working costs that are more than 60% fixed by labour; this situation is crying out for technical innovation and a great leap forward. Ore reserves on the Western Limb of the Bushveld Igneous Complex are getting deeper and the less profitable UG2 reef is being treated as a greater proportion of the mined tonnage. Ventilation and refrigeration costs are increasing with depth, as are the capital costs of reaching these deeper orebodies. The deeper orebodies imply greater rock pressures and stresses and, thus, higher safety risks and increased virgin rock temperature. On the relatively virgin Eastern Limb of the Bushveld Igneous Complex, the historically more lucrative Merensky orebodies tend to be of a lower grade and less attractive than the UG2. The UG2 in the east also has lower platinum to palladium ratios that, with the historic price structure for the two metals, favoured developments on the Western Limb. The Eastern Limb also lacks infrastructure such as water, power distribution, good roads and established communities; this makes mining in these areas more capital intensive greenfields investments and reduces the returns for shareholders. The Achilles heel of the platinum mining industry in South Africa is its high mining costs and, in this respect particularly, its high proportion of labour in those costs. The industry must break out of the low level of training, the unskilled job content, and large numbers required underground—if not for survival at the lower end of the cost curve, then at least to reduce the exposure of men to underground conditions. Although the difficulties in automating narrow reef mining on which platinum production depends are not to be understated, the technological breakthrough must be made. Indeed, it is possible that industry will be forced to innovate and raise the productivity of mining labour because of the current HIV/Aids crisis. Estimated infection within the mining employees ranges from 25%–40%. The accelerating deaths from this infection level are just beginning to occur and all realistic projections show that within the next four to five years presently infected employees will become debilitated and die. The luxury of vast numbers of unskilled labour to be used in the present archaic mining methods will be gone.





Sources: Metal Prices in the United States Through 1991, US Bureau of Mines. 1993, US Dept. of Commerce, Metallstatistik - Metallgesellschaft

Of the same order of importance is the low ore extraction rate from the reserve and the relatively low metallurgical efficiencies in the concentrators. Concentrator technology has been reliant upon comminution and flotation since the early 1920s and, although developments have and continue to occur within these technologies, no radically new technology has been applied. In parallel with the developments in extraction efficiency, the high capital cost of new concentrator operations must be reduced; innovative new equipment must be applied at large capacities to achieve the benefits of economies of scale. Simplicity of design must be balanced with a high level of process control and mechanical reliability must be improved to achieve sustainable low-cost but efficient operations.

Skilled labour in technical and management positions is highly mobile and a significant proportion has expatriate roots. Any deterioration in the South African social milieu can easily lead to a rapid exodus of such highly skilled manpower. Only stable social and economic conditions coupled with intensive investments in the training of more local men and women can deter this threat in the longer term.

Commodity prices and, in particular, metal prices have a strong tendency to fall in real terms over time. Prices fall because man is innovative and self-interested; the profit motive and a need for achievement drive him. He will strive to develop better technologies that achieve higher margins and greater returns. Technical advance leads to lower-cost production and further cost pressure to innovate. This cycle of innovation is one of the contributors to the efficiencies of the free market system, creating an ever-downward spiralling cost and price arena in real terms. This is clearly demonstrated by the price graphs for aluminium and nickel, both of which show declining real term prices. Over the past 30 years for instance the average decline in real prices for copper and nickel has been 4%/annum. This has occurred despite a growth in demand in both cases. In the case of nickel, growth rates of 3.5% have been achieved over the same 30-year period. Platinum and its sister PGMs are not likely to escape this trend over the long term. Short-term price spikes such as those being experienced now will occur from time to time as the market reaches an imbalance, but new entrants and innovation will bring profit margins back to normal levels in the medium to long term. Thus, reaching and remaining at the lower end of the cost curve will govern survival in the industry; here, the margins for shareholders and other stakeholders will be highest. The high profits of today create the opportunity to invest in the long-term competitiveness of the business through well-managed as well as focused research and development programmes. These must be designed specifically in the case of the platinum industry to reduce the high costs of mining narrow reefs, particularly at depth, and to improve extraction efficiencies from the *in situ* primary ore. An improvement in mining or concentrator extraction efficiency of 1% for the South African industry is equivalent to some R500 million (current prices) in annual revenue; current extractions from *in situ* reserves to smelter feed are a paltry 75%–80%. Thus an industry prize of some R10 billion/annum awaits technical innovation.

What advantages and improvements will arise from non-explosive mining methods, robotics, process control, knowledge of flotation chemistry, new hydrometallurgical process routes, and automated or remotely controlled mining equipment?

Investment into and the close management of these target areas are critical to the long-term survival of the industry. One need only look to South Africa's gold mining industry for an example of an industry that has not innovated fast enough to meet the falling real prices.

The challenge for CEOs and executive management in the platinum industry is to develop and implement research and development strategies that are as well-founded and executed as the marketing strategies that brought to life the jewellery market and rode the wave of environmental legislation so successfully. Mining is a long-term business that requires an equally long 30-year vision of technical innovation, and the competitive edge available through its pursuit. Now more than ever, as a cursory review of history demonstrates, it is a case of innovate and profit—or die. It is

Platinum Market Statistics from Johnson Matthey *Platinum 2000*

Demand Item	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Autocatalysts	360	490	455	630	900	680	640	650	645	840	980	1140
Autocat recycle	0	0	0	0	0	0	0	10	30	45	70	90
Chemical	345	280	380	340	345	260	250	260	245	260	225	195
Electrical	225	240	280	200	240	210	185	170	175	190	200	180
Glass	65	95	110	190	250	140	100	85	105	140	140	90
Investment	0	0	0	0	0	160	195	160	155	320	430	325
Jewellery	1210	950	1050	985	765	560	755	765	715	775	810	850
Petrol refining	165	90	120	170	160	130	140	65	20	15	15	20
Other	210	255	255	185	190	190	165	170	150	135	100	130
Total	2580	2400	2650	2700	2850	2330	2430	2315	2180	2630	2830	2840
Price $/oz	165	170	165	270	430	670	470	330	420	360	350	470
Total other Ind.	1010	960	1145	1085	1185	930	840	750	695	740	680	615
Autocatalyst-recycle	360	490	455	630	900	680	640	640	615	795	910	1050
Industrial	1010	960	1145	1085	1185	930	840	750	695	740	680	615
Investment	0	0	0	0	0	160	195	160	155	320	430	325
Jewellery	1210	950	1050	985	765	560	755	765	715	775	810	850

Demand Item	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Autocatalysts	1245	1325	1450	1520	1570	1550	1700	1870	1850	1880	1830	1800	1610
Autocat recycle	105	160	175	210	215	245	285	290	320	350	370	405	425
Chemical	195	160	160	205	240	215	185	190	215	230	235	280	315
Electrical	180	185	195	205	180	165	175	185	240	275	305	300	390
Glass	120	130	140	135	120	80	70	160	225	255	265	220	200
Investment	490	630	160	200	410	255	305	395	345	240	240	315	180
Jewellery	990	1180	1305	1365	1470	1510	1610	1740	1810	1990	2160	2430	2880
Petrol refining	55	50	75	120	150	120	100	90	120	185	170	125	115
Other	120	120	115	120	135	150	180	190	225	255	295	305	335
Total	3290	3620	3425	3660	4060	3800	4040	4530	4710	4960	5130	5370	5600
Price $/oz	555	530	509	472	376	360	383	405	423	397	396		
Total other Ind.	670	645	685	785	825	730	710	815	1025	1200	1270	1230	1355
Autocatalyst-recycle	1140	1165	1275	1310	1355	1305	1415	1580	1530	1530	1460	1395	1185
Industrial	670	645	685	785	825	730	710	815	1025	1200	1270	1230	1355
Investment	490	630	160	200	410	255	305	395	345	240	240	315	180
Jewellery	990	1180	1305	1365	1470	1510	1610	1740	1810	1990	2160	2430	2880

Platinum Market Statistics from Johnson Matthey *Platinum 2000*

Supply Item	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
RSA total	1760	1710	1780	1950	2180	2320	1800	1960	2070	2310	2340	2350
USSR sales	600	690	640	490	460	340	370	380	290	250	230	290
North America	140	170	170	170	130	130	130	120	80	150	150	150
Other world	30	30	20	40	30	30	30	30	40	40	40	40
Total supply	2530	2600	2610	2650	2800	2820	2330	2490	2480	2750	2760	2830
RSA%	69.6	65.8	68.2	73.6	77.9	82.3	77.3	78.7	83.5	84.0	84.8	83.0
Russian %	23.7	26.5	24.5	18.5	16.4	12.1	15.9	15.3	11.7	9.1	8.3	10.2
N. America %	5.5	6.5	6.5	6.4	4.6	4.6	5.6	4.8	3.2	5.5	5.4	5.3
Other	1.2	1.2	0.8	1.5	1.1	1.1	1.3	1.2	1.6	1.5	1.4	1.4

Supply Item	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
RSA total	2520	2580	2620	2760	2770	2750	3360	3160	3370	3390	3700	3680	3900
USSR sales	400	440	550	720	1100	750	680	1010	1280	1220	900	1300	540
North America	140	210	195	185	220	200	220	220	240	240	240	285	270
Other world	40	50	60	65	70	120	130	140	100	130	120	135	160
Total supply	3100	3280	3425	3730	4160	3820	4390	4530	4990	4980	4960	5400	4870
RSA%	81.3	78.7	76.5	74.0	66.6	72.0	76.5	69.8	67.5	68.1	74.6	68.1	80.1
Russian %	12.9	13.4	16.1	19.3	26.4	19.6	15.5	22.3	25.7	24.5	18.1	24.1	11.1
N. America %	4.5	6.4	5.7	5.0	5.3	5.2	5.0	4.9	4.8	4.8	4.8	5.3	5.5
Other	1.3	1.5	1.8	1.7	1.7	3.1	3.0	3,1	2.0	2.6	2.4	2.5	3.3

equally incumbent upon the South African government to ensure that its policies and legislation create an environment in which the platinum industry in South Africa can flourish. Consider the recent annual statistics for the top four producers in SA as follows:

- ➤ Tons milled 48.3 million
- ➤ Platinum ounces produced 3.88 million
- ➤ Permanent employees 88 200
- ➤ Foreign exchange earnings R16.3 billion
- ➤ Capital expended R2.45 billion
- ➤ Taxation paid R1.25 billion.

These statistics reflect the importance of the platinum industry to the South African economy.

Government must act so as to facilitate stable growth of the industry; often in the past, boom periods have seen heavy investment in the industry, followed by oversupply and the consequent very low returns on the capital invested. South Africa can ill afford such extravagance, as maximum growth must be received from each rand invested. If capital is placed in marginal platinum operations that flood the market with metal and reduce prices, thus receiving a low return, that capital could have been better invested in another area of the economy to the betterment of South Africa in general. Such boom and bust conditions, accompanied by wide price variations send negative signals to the users of PGMs, who would naturally prefer stability of supply and price. Instability will send users to look for substitutes and to seek a means of reducing their consumption. Overall, South Africa and the individual platinum producing companies will profit the most from stable, measured growth in the market for PGMs. Individual companies must make the capital investments necessary to expand and to fill the anticipated supply gaps timeously, by investing successfully in the technologies required for future competitiveness, and by financially supporting the development of new markets for the various metals. Government must fulfil its role by continuing to honour mineral rights and by taxation and regulatory structures that encourage investments in the capital-intensive mining industry. Such should be the partnership between the platinum industry and the South African government.

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