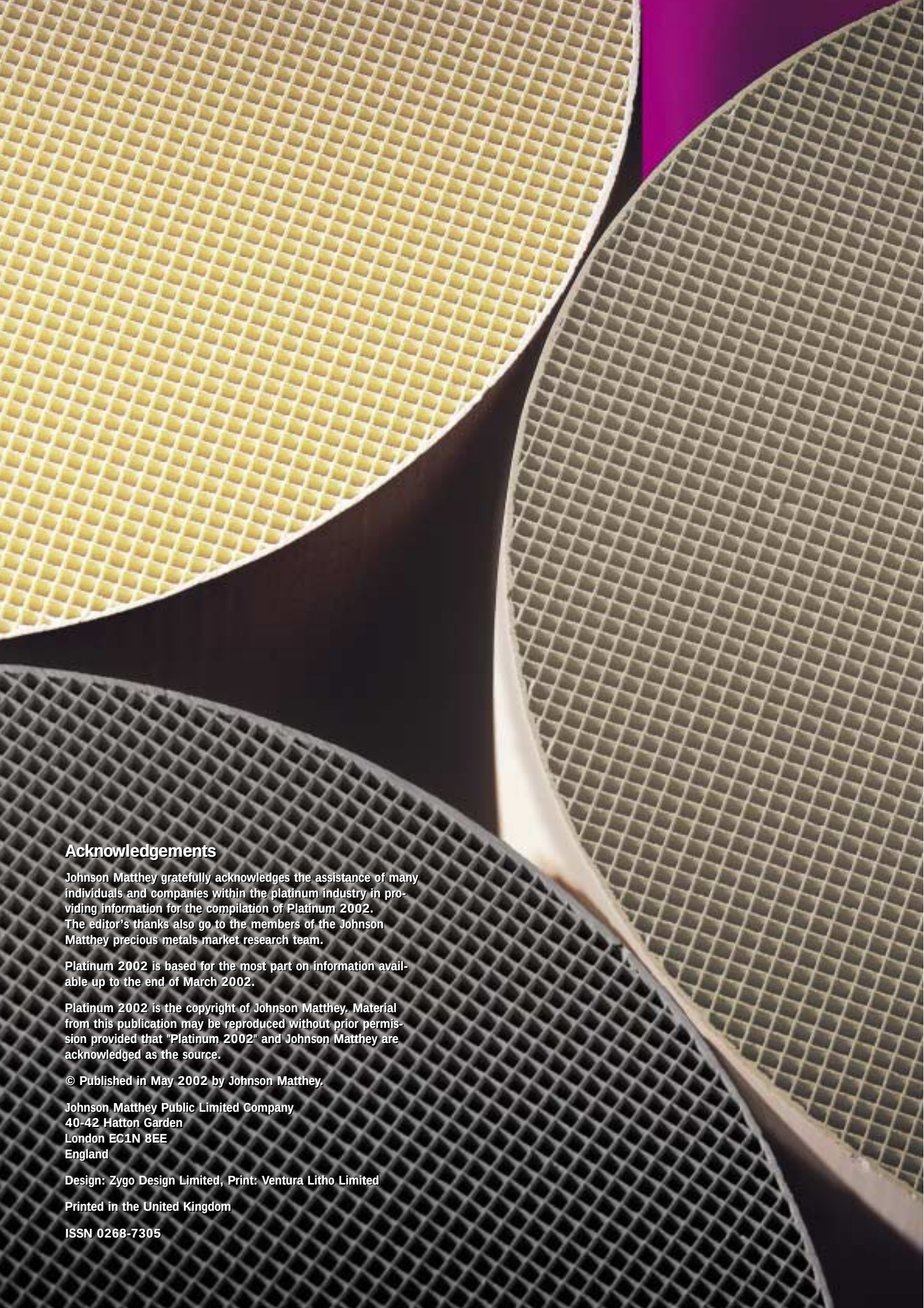
Platinum 2002

Johnson Matthey



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Platinum 2002 is based for the most part on information available up to the end of March 2002.

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Platinum 2002

edited by Tom Kendall

Special Reports

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Johnson Matthey

Summary & Outlook

Platinum

- **Demand for platinum rose by 8 per cent in 2001 to 6.15 million oz, exceeding the 6 million oz level for the first time.**
- **Auto industry purchases of platinum were up by a third as diesel cars gained market share in Europe and platinum was substituted for palladium in some gasoline autocatalysts.**
- **Jewellery demand fell by 10 per cent as another record year in China was outweighed by sharp declines in Japan and the USA.**
- **Growth in industrial demand for platinum slowed to 2 per cent as increased use in glass production, petroleum refining and dental alloys was partly offset by lower demand from the electronics sector.**
- **There was a return to positive investment demand last year, although net sales were small.**
- **Supplies rose by 11 per cent with increases from all mining regions.**
- **Despite the generally positive statistics, the average price for platinum fell by 3 per cent compared to 2000 as negative sentiment about the world economy gathered strength in the second half of the year.**

Platinum Supply and Demand
'000 oz

	2000	2001
Supply		
South Africa	3,800	4,100
Russia	1,100	1,300
North America	285	350
Others	105	110
Total Supply	**5,290**	**5,860**
Demand		
Autocatalyst: gross	1,890	2,520
recovery	(470)	(520)
Jewellery	2,830	2,550
Industrial	1,490	1,520
Investment	(60)	80
Total Demand	**5,680**	**6,150**
Movements in Stocks	(390)	(290)

Overview

Demand for platinum exceeded 6 million oz for the first time in 2001, rising by 470,000 oz to 6.15 million oz. Although supplies also increased, by 570,000 oz to 5.86 million oz, the market remained in deficit. However, the difference between supplies and demand of 290,000 oz represented the nearest to a balanced market since 1998.

The largest growth sector was the auto industry, where demand for platinum in **autocatalysts** increased by a third to reach 2.52 million oz. In the European car market, the share taken by diesel engines rose to 36 per cent and this, coupled with the imposition of Euro Stage III emissions regulations on all vehicles from January 2001, boosted platinum use. There was also an increase in demand worldwide as a result of substitution of platinum for palladium in some catalysts and, in North America, further stock building by auto companies that expect to increase their use of platinum in future.

Demand for platinum in **jewellery** fabrication fell for the second successive year, dropping by 280,000 oz to 2.55 million oz, its lowest level since 1998. China consolidated its position as the world's largest platinum jewellery market as demand rose by 18 per cent to a record 1.3 million oz. However, lower retail sales and a further rundown of stocks of platinum jewellery led to a 33 per cent fall in Japanese demand. There was also a 26 per cent decline in consumption by the jewellery trade in North America as sales fell back in response to the weaker US economy.

Industrial demand rose by 2 per cent to 1.52 million oz. There was more investment in Asia in new plants to produce fibreglass and glass for liquid crystal displays. This, and increased use of platinum in dental alloys and biomedical applications, outweighed a fall in the use of the metal in computer hard disks caused by declining sales of computers as consumers reduced expenditure on electronic goods.

Investment demand remained relatively weak, although sales of American Eagle bullion coins in the

A growing range of platinum chain designs is available to consumers

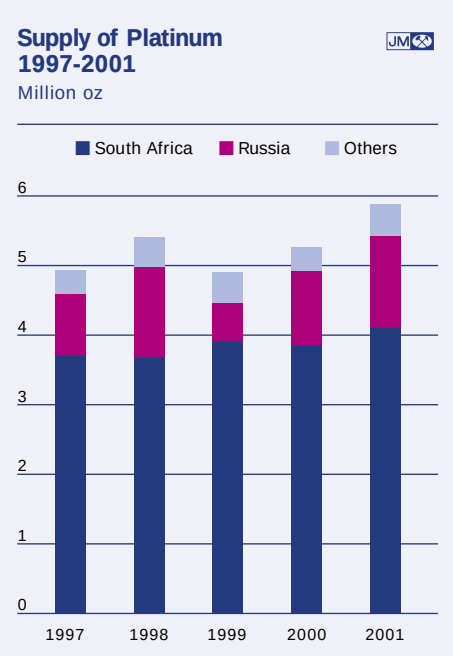
fourth quarter of the year were the highest since mid 1999. Demand for large investment bars in Japan improved in the second half of 2001 as the price fell, helping to bring total investment demand to 80,000 oz.

Supplies of platinum rose by 570,000 oz to 5.86 million oz. South African supplies topped 4 million oz for the first time as metal began to flow from the various expansions and new projects that have been started in recent years. Shipments from Russia increased in the second half of 2001; over the whole year, Russian supplies of platinum rose by 200,000 oz to 1.3 million oz.

Buoyed by the cumulative supply deficit that has built up over the past four years, the platinum **price** rose to a peak of $645 in mid January 2001, its highest level since April 1987. For the first six months of 2001 the price remained firm, averaging almost $600 throughout the period. Thereafter, sentiment turned against the metal as concern about the world economy deepened. Long positions on TOCOM and NYMEX were liquidated and short positions were opened. The weight of this selling in the futures markets drove the price down to a low of $406 in early October. Solid industrial and jewellery demand and the usual end of year concerns about Russian export quotas for the following year then firmed the price, which ended 2001 at $477.

Supply

Sales of platinum from **South Africa** rose by 8 per cent to 4.1 million oz in 2001, as metal became available from several new projects. Most of the existing producers expanded their output, although Northam was hit by industrial action in August and September and produced less than in 2000. The South African mining industry was sheltered from the decline in the dollar price of platinum by substantial depreciation of the rand: on 20 December the price of platinum in rand reached an all time high of over R6,000 per oz. Output from the South African platinum mines should increase by close to 10 per cent in 2002, with growth accelerating over the next few years as more projects are brought on stream.



The largest increase in production of refined platinum in 2001 came from Anglo Platinum, up 13 per cent at 2.11 million oz. During the year Anglo announced three further projects that will enable it to reach its target output of 3.5 million oz by 2006. These were an extension of the Bafokeng Rasimone mine onto the adjacent farm of Styldrift, a new mine at Twickenham on the Eastern Bushveld, and a joint venture with Lonmin downdip of the latter's Eastern Platinum mine.

Output from Impala Platinum's original mining lease area on the Western Bushveld remains about 1 million oz. However, sinking of the first decline shaft at its new Eastern Bushveld mine at Marula Platinum (formerly known as Winnaarshoek) is scheduled to begin this year. The company is also continuing to progress its plans to increase throughput at its refinery by taking metal from the reopened Crocodile River mine, operated by its subsidiary Barplats, and from other producers such as Aquarius and SouthernEra in South Africa, and Zimplats and Mimosa in Zimbabwe. Impala holds an equity stake in all of these companies except SouthernEra.

Following the launch of its Pandora joint venture with Anglo Platinum in April last year, the third largest South African producer, Lonmin, announced in November an acceleration of its existing expansion plans. The company now intends to produce 870,000 oz of platinum a year by 2003, rather than in 2008 as previously planned.

Feasibility studies for several other new projects were either begun or announced during 2001 by various mining companies. Some relate to potential expansions of existing operations and others to possible new mines. It is clear that the continued depreciation of the rand and the relative strength of the platinum market compared with those for many other metals, have combined to make the development of platinum mining in South Africa an attractive proposition.

Russian sales of platinum rose by 200,000 oz last year to 1.3 million oz. The familiar delays in presidential approval of export quotas and licences limited sales in the first quarter of the year and it was not until April that significant amounts of metal began to flow to the West. Shipments of platinum by Almaz accelerated in the second half of the year, perhaps to maintain revenues from sales of pgm in the face of sharply declining prices for, and reduced shipments of, palladium.

In June 2001 Vladimir Putin signed a decree that transferred responsibility for granting export quotas from the President to the Russian Government. This was expected to simplify and speed up the annual quota approvals, but in the early part of 2002 there was little sign that such a result had been achieved. Once

again, it was not until March that quotas were approved, and in early April Almaz still appeared to be awaiting the granting of the necessary export licence from the Ministry of Economic Development and Trade in order to commence shipments.

Although Almaz remains the sole exporter of pgm from Russia, export quotas for platinum have been granted to a wider group of organisations in 2002. Norilsk has a five year quota, the alluvial platinum producers of the Far East of Russia have their own, single-year quotas for the first time, and several domestic banks have also been granted quotas. With a limited internal market for platinum, these banks do not have much access to metal, but the new arrangements will give secondary producers an alternative option to the State Treasury, Gokhran, when selling the metal they recover. However, the impact of the change on total Russian exports in 2002 is likely to be small.

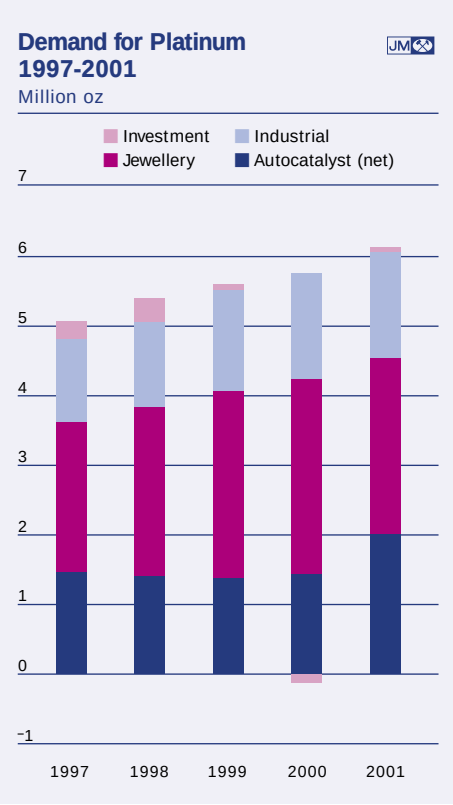
Supplies from **other western** mines increased by 18 per cent in 2001. Sales of platinum by Stillwater were up by 21 per cent to 121,000 oz, reflecting a significant improvement in mining and milling rates at its Nye mine and a small contribution from its new East Boulder operation. In Canada, output increased at Inco, Falconbridge and North American Palladium.

Demand

Purchases of platinum by the auto industry rose sharply in 2001. A burgeoning diesel car market in Europe was the main cause, but substitution of palladium by platinum in some **autocatalysts** fitted to gasoline vehicles also added to demand, which was up by a third to 2.52 million oz.

The use of platinum in autocatalysts soared by 55 per cent in Europe, despite production of cars increasing by only 1 per cent in 2001. Sales of diesel cars continued to grow and last year comprised 36 per cent of all new car sales in Western Europe. This growth in market share was accompanied by a significant increase in platinum loadings on diesel catalysts to meet the new Euro III regulations. To ensure compliance with these tough standards some companies initially employed heavy loadings of platinum; these may be thrifted in future as catalyst technology improves. Diesels now account for about 70 per cent of platinum demand in the auto sector in Europe, which last year surpassed 1 million oz for the first time.

Despite their success in Europe, diesels have yet to make significant inroads into the auto markets of most other regions of the world. In particular, the relatively low cost of fuel in North America renders the superior fuel efficiency of diesels less important. Increased demand for platinum in the auto sector outside Europe last year was, therefore, mainly due to changes in the pgm mix used on gasoline autocatalysts. Some auto makers also added to their platinum inventories, in the expectation of using more of the metal in future.



The dramatic increase in the price of palladium in 1999-2000 caused many automakers to set in place programmes aimed at reducing their palladium consumption. Last year saw the beginning of changes arising from these developments, with many companies increasing the proportion of platinum in some of their catalyst systems in order to reduce the palladium content. This was particularly pronounced amongst US owned auto companies, which had moved most heavily towards palladium. With the palladium price now beneath that of platinum, it is uncertain as to what degree these changes will be sustained or advanced in future.

A second consecutive year of decline in world **jewellery** demand occurred in 2001, with consumption falling by 10 per cent to 2.55 million oz. In addition to continued weakness in Japan, demand fell in North America as consumers cut back on purchases of luxury goods in the face of the declining US economy. In contrast, demand for platinum in China rose to 1.3 million oz, firmly establishing the country as the world's leading consumer of platinum for jewellery.

In contrast to most countries in the world, the Chinese economy continued to grow strongly last year. This provided a sound foundation for further growth in purchases of platinum jewellery, but the year was not without difficulties. As in late 2000, during the first half of last year the price of platinum was around $600 and most Chinese jewellery manufacturers found their profit margins on platinum items had been severely eroded. Unable to pass higher costs on to retailers, some decided to switch to making white gold products. However, the Chinese public remained enthusiastic about platinum jewellery and, as the metal's price dropped in the second half of the year, jewellery makers were able to return to platinum to satisfy this.

The latest generation of diesel cars is proving to be very popular in Western Europe, driving demand for platinum

Retail sales of platinum jewellery fell again in Japan last year. Reduced consumer spending had a substantial effect on sales of platinum fashion jewellery, with the numbers of necklaces, bracelets and earrings sold all sharply down. Sales of engagement and wedding rings also fell as the number of marriages dropped compared with the prior, millennium year. Just as in 2000, manufacturers, wholesalers and retailers responded to the continuing difficulties in the Japanese economy by cutting back inventories. The combined effect of lower retail sales and reductions in stocks was a 33 per cent fall in demand for platinum in Japan to 710,000 oz in 2001.

The US economy was already in noticeable decline long before the tragic events of 11 September last year. For example, jewellery sales over the Christmas 2000 period were lower than had been expected, and the US jewellery trade began 2001 with high stocks of finished goods: this resulted in reduced demand for platinum by jewellery fabricators in early 2001. With consumer spending on luxury items dampened by a slide in US equities and increasingly weak economic prospects the trade remained gloomy until the Christmas 2001 season, when retail sales improved significantly. For the year as a whole, demand dropped by 26 per cent to 280,000 oz.

The jewellery markets in Europe were mixed in 2001. Demand in Germany was depressed, reflecting a weak economy. In Italy, which is heavily influenced by its reliance on export markets, consumption fell in response to lower orders from the USA and Japan. Demand continued to grow in the UK, where the weight of platinum jewellery submitted for hallmarking increased by close to 10 per cent. In Switzerland too, platinum use increased, for both watch making and the manufacture of other jewellery items.

Industrial demand for platinum rose again in 2001, but by just 2 per cent to 1.52 million oz. Chemical and electrical industry demand fell, but there were increases elsewhere, especially in the glass and petroleum sectors and for use in dental alloys.

The largest decrease in platinum use in the industrial sector last year was in the manufacture of computer hard disks. With magnetic layers made from alloys containing platinum used in virtually all hard disks now manufactured, demand was directly influenced by the fall in purchases of computers last year.

There was significant investment in new plants employing platinum in the manufacture of various glass products in 2001. Much of the investment occurred in China and other parts of the Far East; in Europe and North America demand was weak. Investment in equipment to manufacture high purity glass for liquid crystal displays (LCDs) continued in Japan and South Korea. Demand in China came from capacity additions for cathode ray tube (CRT) manufacture for televisions and desktop computers, as well as an increase in fibreglass production.

Demand for platinum in the petroleum sector increased by 15,000 oz as incremental additions to existing refining capacity were made in North America and Asia. In other applications, a move from palladium to gold dental alloys in several regions added to platinum demand since this metal is present at levels of up to 10 per cent in some high-gold alloys.

Once again, sales of small **investment** products were dominated by the US Mint's platinum Eagle. Sales of bullion coins totalled 34,400 oz in 2001 and were particularly strong in the fourth quarter. Sales have remained firm in the early part of 2002, and in the first quarter were up by 14 per cent on the same period in 2001. There was also continued interest in platinum last year from numismatists in the USA who purchased 19,244 oz of proof platinum Eagles. Although some bullion coins and bars were sold back to the market by investors who took the opportunity afforded by high prices to realise profits, net sales of coins and small investment bars in 2001 are estimated to have been 50,000 oz, up slightly on the previous year.

In the first half of 2001 holders of large platinum bars in Japan continued

to sell back to the market, just as they had done in the previous year. But, as the price fell from July onwards, purchases began to outweigh sellbacks. For the year as a whole, we estimate that demand was a net positive 30,000 oz.

Outlook

After two years of deficits, the platinum market moved closer to balance in 2001 as demand increased at a slower rate than supplies. Demand for platinum is expected to rise once again this year. The main driver is likely to be the auto industry, as sales of diesel-powered vehicles in Europe increase and more manufacturers worldwide add platinum to gasoline vehicle autocatalysts to reduce their dependence on palladium. These two positive factors will, at least partly, be counterbalanced by an expected decline in auto sales. Although they have remained relatively strong in historical terms, often supported by financial incentives to buyers, sales are currently expected to be around 5 per cent lower in 2002 than those of last year.

Growth in the demand for platinum in industrial applications flattened in 2001, as the effects of a slowdown in world economic activity became more pronounced. Substantial stimuli by governments, especially in the USA after the events of 11th September 2001, may well reduce the length and intensity of the current dip in the economic cycle. However, although economic indicators in the first quarter of 2002 have been positive in most regions (with the notable exception of Japan) it is too early to be sure if the recovery is firmly based.

Jewellery demand in China was remarkably robust in 2001, despite the high price of platinum during the first half of the year. With lower prices ruling, demand increased during the second half of the year, and has continued to be strong in the first quarter of 2002. There is therefore a good chance that Chinese demand will increase again this year.

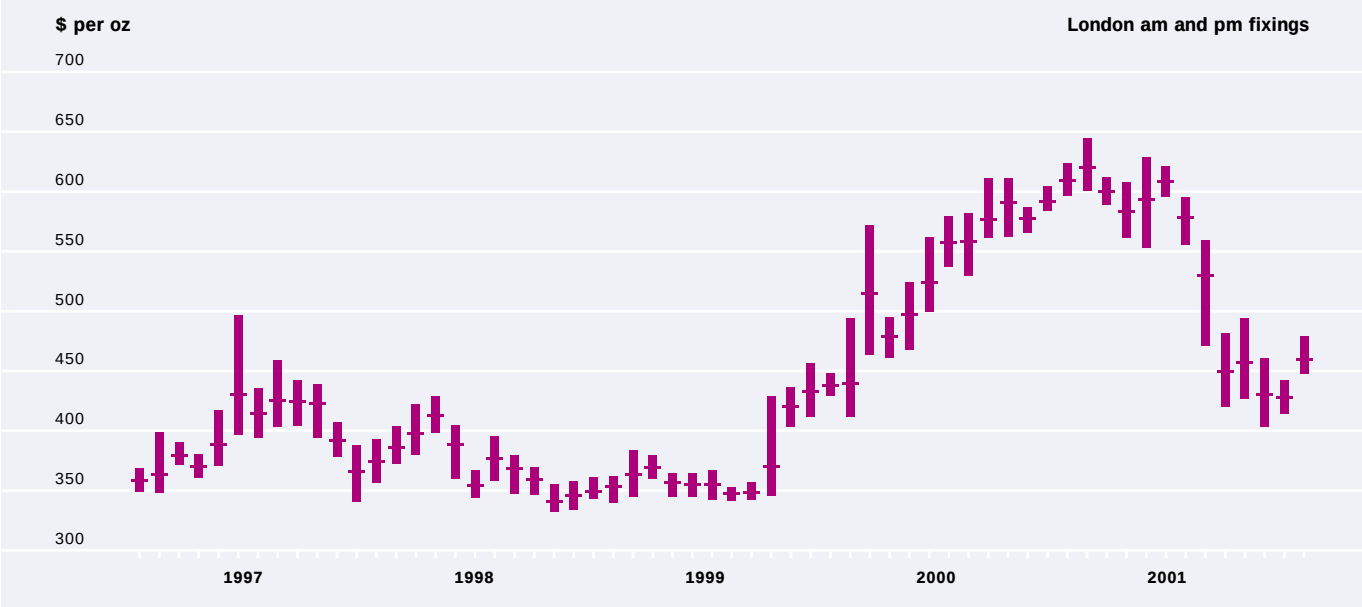
The prospects in Japan are less auspicious, with the country still struggling to escape the economic problems that have plagued it for much of the last decade. Other jewellery markets may recover in 2002: for example, following a better than expected Christmas 2001 sales season, US jewellers appear to be rebuilding stocks of finished platinum jewellery.

Western supplies of platinum should increase by up to 10 per cent as expansions in South African mining capacity come on stream. Assuming they keep up with their plannned schedules of development, South African mines should produce around 350,000 oz more than in 2001, with Anglo Platinum being the main contributor to the increase.

Delays in the granting of export quotas again held back Russian sales of platinum in the first quarter of this year. However, quotas were authorised in March and, at the time of writing, supplies were expected to start flowing during April. The full year level of Russian sales is, as always, difficult to forecast but, with government stocks now thought to be low, it is likely to be similar to current production.

With both supply and demand predicted to be moderately higher in 2002, the market is expected to remain tight and, therefore, the price of platinum should remain firm. The price sensitivity of jewellery demand is expected to set limits on both the upper and lower levels of the platinum price, which for the next six months we expect to remain in the range $480 to $580.

Monthly High, Low and Average Prices of Platinum 1997-2001



Palladium

- **Demand for palladium fell by 25 per cent as users responded negatively to the high prices of recent years.**
- **Auto industry purchases of palladium declined by 9 per cent as some auto makers used metal from inventories.**
- **Demand from the electronics industry collapsed to just under a third of its previous level as component manufacturers used metal from stocks to meet much of their sharply reduced requirements.**
- **Substitution of palladium in dental alloys continued and demand in this sector fell by a further 18 per cent.**
- **Demand for other applications of palladium fell by 5 per cent in 2001.**
- **Total supplies declined by 6 per cent as a 17 per cent fall in Russian sales was partly offset by increases from western mines.**
- **The price of palladium hit an all time high of $1,094 in January but then fell steadily to a low of $315 in October before recovering to $440 at the year end.**

Palladium Supply and Demand
'000 oz

	2000	2001
Supply		
South Africa	1,860	2,010
Russia	5,200	4,340
North America	635	850
Others	105	120
Total Supply	**7,800**	**7,320**
Demand		
Autocatalyst: gross	5,640	5,110
recovery	(230)	(290)
Dental	820	670
Electronics	2,160	700
Other	570	540
Total Demand	**8,960**	**6,730**
Movements in Stocks	(1,160)	590

Overview

The dramatic rise in the price of palladium came to an end in 2001. Demand for palladium almost doubled from 1994 to 1999, but the increase in the price was even sharper, climbing from $284 as recently as May 1999 to a peak of $1,094 in January last year. Price-induced substitution of palladium by other metals began to take its toll in 2001 and was exacerbated by a severe slump in the electronics market. As a result, the market switched from the deficits of recent years to a surplus of 590,000 oz.

The most significant decline in palladium demand occurred in the **electronics** industry. Manufacturers of components began 2001 with high stocks of products and a subsequent reduction in consumer purchasing of finished goods in the first quarter of the year led to a severe slowdown in manufacturing. Makers of multi-layer ceramic capacitors were hit hard by the slump and purchased very little palladium in the second and third quarters of the year, deciding to make use of stocks of metal built up in earlier years, and only returning to the market to a limited degree in the final quarter. Other users in the electronics sector suffered similarly with the result that demand for palladium by the industry fell by over two thirds to just 700,000 oz.

Demand for palladium from the auto industry was down by 530,000 oz to 5.11 million oz. The use of the metal in **autocatalysts** fell for the first time since 1988, mainly due to substitution by platinum based catalysts. In addition, some auto companies are believed to have used metal from stocks to mitigate financial pressures arising from reduced profit margins in many of their retail markets for light-duty vehicles.

Despite the fall in the price during the year, demand for **other applications** continued to weaken as more users switched from palladium to other metals in the chemical, dental and petrochemical sectors.

Supplies of palladium from Russia in 2001 fell to 4.34 million oz, the lowest level since 1995. The early months of the year saw large shipments of Russian palladium into Switzerland, although it is doubtful whether all the metal was sold to consumers. In August, as the price continued to weaken, Norilsk Nickel, the only primary producer in Russia, ceased spot sales of the metal in order to halt the slide. At the end of October it was reported that Almaz had recommended to all Russian holders of palladium that they should stay out of the market until prices recovered to higher levels.

Sales of palladium by South Africa rose by 150,000 oz to 2.01 million oz, mainly due to increased output at Anglo Platinum as its expansion plans began to bear fruit. North American supplies rose by 215,000 oz to 850,000 oz as output at Stillwater and North American Palladium increased sharply and Falconbridge recovered from a seven month strike.

Sales from the US Defense Stockpile were again significant in 2001, with the Defense Logistics Agency (DLA) selling 194,185 oz of palladium. The majority of this metal was sold in the first quarter of the year. The weakening of the market by the time the agency's new fiscal year commenced in October caused the DLA to adopt a more cautious sales policy, with the result that only 14,100 oz were sold in the last quarter of 2001.

Delays in Russian exports and an illiquid market drove the palladium **price** to a record London fix of $1,094 in January 2001. However, as supplies increased and demand weakened the price tumbled to $750 by early March. After a brief rally it then fell steadily to a low of $315 in early October. Reduced selling then helped to firm the market, and during the last two months palladium staged a moderate recovery to end the year at $440.

Supply

Russian sales of palladium in 2001 are estimated to have fallen by 17 per cent to 4.34 million oz, the lowest level since 1995. Norilsk Nickel, which in 1999 received a ten-year export quota for palladium, continued to sell the metal through a mix of contract and spot sales during the first half of the year. However, in August, with the price falling in the face of weak demand, the company announced its intention to cease spot sales and it seems likely that only contract material was shipped for the rest of the year.

Uncertainty surrounds the shipments of Russian palladium into Switzerland in February and March last year. Initially, it was reported that Swiss customs officials had said that the 1.91 million oz of metal imported in February had come from a toll free storage in Zurich where it had been stored for a long time. Although this statement was subsequently withdrawn, it seems likely that the metal had been held outside Russia for sale or loan purposes by either the Ministry of Finance or the Central Bank. Although offerings of palladium on the London fix increased noticeably at around this time causing a decline in the palladium price, we do not believe that all of the metal imported into Switzerland was sold into the market. Had this been so, the fall in the price would have been much greater.

Supplies from **western mines** grew by 15 per cent to 2.98 million oz in 2001 as South African and North American miners made progress with their expansion plans. An 8 per cent increase from South Africa was due largely to increased output by Anglo Platinum, while a 34 per cent rise in North American supplies was mainly shared between Stillwater and North American Palladium.

The main sources of South African pgm – UG2 ore (foreground) and Merensky Reef (behind)

Western supplies should rise by a similar amount this year with all the major primary producers scheduled to increase their output through expansions set in motion in recent years. The largest improvements in output are again likely to come from Anglo Platinum, Stillwater and North American Palladium.

Demand

For the first time since 1988 the use of palladium in **autocatalysts** fell last year. There were also some reductions in stocks; as a result, purchases by the auto industry fell by 530,000 oz to 5.11 million oz. Many companies that had turned to

palladium based catalysts to meet increasingly stringent limits on hydrocarbon emissions responded to the increasing price of the metal by thrifting their catalyst systems. This was achieved by improved catalyst technology, often involving the addition of platinum or, in some cases, rhodium.

Despite the fall in palladium use in autocatalysts in 2001, demand was the third highest on record and the metal seems certain to remain an important component of catalyst systems. Tighter regulations introduced in Europe, Japan and the USA in recent years severely restrict emissions of hydrocarbons and most auto makers are likely to continue to use catalysts containing palladium to meet these standards.

What is less clear is whether the auto industry's attitude to the long term use of palladium has been permanently affected by the extreme volatility in the price experienced over the last few years. In addition, the problems of export quota and licence approvals in Russia, the principal supplier of palladium, have contributed to perceived instability in supply, even though Norilsk Nickel has long term agreements to export its output.

Many auto companies, especially in the USA and Japan, responded to these considerations, and to their own expectations of higher usage of palladium, by building strategic stocks of the metal. We believe that some auto makers used metal from these inventories last year, although not to the degree we forecast in the Platinum 2001 Interim Review. The level of stocks still held in the industry is uncertain.

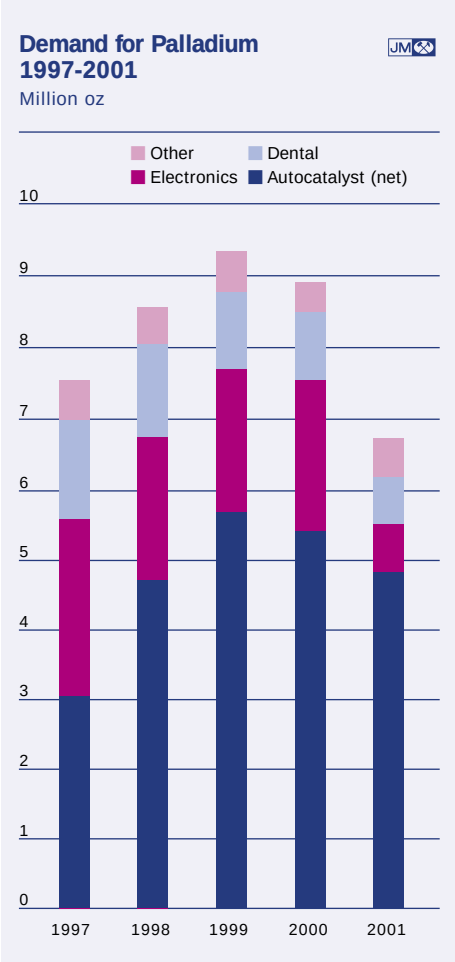
In the **electronics** industry, demand fell by 68 per cent to 700,000 oz in 2001. Production of multi-layer ceramic capacitors (MLCC) fell by 27 per cent, while the amount of palladium used in producing these MLCC fell even further, by 45 per cent. With the future use of palladium continuing on a downward track, manufacturers of MLCC are also believed to have run down their stocks of palladium substantially last year.

In other sectors of the electronics industry such as hybrid integrated circuits and plating, demand for palladium also fell last year. The high price of the metal may also have stimulated enhanced recovery of palladium from electronics scrap, but this was offset by a fall in overall scrap availability as businesses and consumers deferred replacement of existing products to conserve cash.

The **dental** sector experienced an 18 per cent decline in palladium consumption in 2001 to 670,000 oz. Further substitution of palladium in dental alloys by either gold or base metals occurred, especially in Europe. A decline was also seen in the USA, although in the second half of the year, as the palladium and gold prices began to converge, some US alloy makers stabilised or even increased their use of palladium.

Demand in Japan, where a government-backed health insurance scheme supports the use of a dental alloy containing 20 per cent palladium, was less damaged by the high price of palladium. But here, the general economic malaise, and cutbacks by the government in healthcare funding, led to a lower level of dental treatment and demand for palladium fell accordingly.

Demand for palladium in **other industrial** applications and in **jewellery** fell by 5 and 6 per cent respectively in 2001. The decline in the jewellery sector arose as manufacturers strove to reduce the palladium content of both platinum and white gold alloys. In the petroleum industry the substitution of palladium in hydrocracking catalysts by base metal alternatives advanced, although the amounts of metal released were smaller than in 2000. Demand from the chemical industry for palladium catalysts used to make vinyl acetate monomer also fell as investment in new plants slowed.



Outlook

Demand for palladium fell by almost a quarter in 2001 as substitution with other metals advanced in the auto, electronics and dental sectors. The degree to which such substitution proceeds further will have a major impact on the long term outlook for the palladium market.

Many auto companies that had moved strongly into palladium based catalysts over recent years responded to the increasing price of the metal by undertaking research and development programmes to reduce their dependence on it. These are now beginning to bear fruit and demand is likely to fall again in 2002 by at least as much as last year. However, with palladium now trading below platinum there may be an

incentive for some companies to return to using palladium, especially if future supplies of the metal have been secured through contractual arrangements.

The long term impact of a dramatic $1 billion write-down of its pgm stock by Ford in January 2002 is still difficult to determine. In March, the company disclosed that its usage of palladium in 2002 would be less than half that of 2000 and that it is in the process of reducing its stocks. Ford stated that it planned to reduce its holdings by making sales to the market, to the extent that the market can absorb the metal in an orderly fashion. With total demand falling, this will be a difficult process.

Demand for palladium in the electronics sector in 2001 fell below 1 million oz for the first time since 1982. The electronics industry has shown some signs of recovery in early 2002 but activity is still well below the levels of 1999 and 2000. With manufacturers' strategic stocks having been depleted in 2001 there appears to be scope for increased demand for palladium from the electronics industry this year. It seems probable that demand will again exceed 1 million oz, but the prospects for consumption much above this level in future seem slim.

Last year saw a 13 per cent fall in the use of palladium in other non-automotive applications. Demand is unlikely to fall much further as those uses that are most price sensitive have already seen significant substitution of palladium, and current lower prices may help stabilise consumption in the chemical, dental, jewellery and petrochemical sectors.

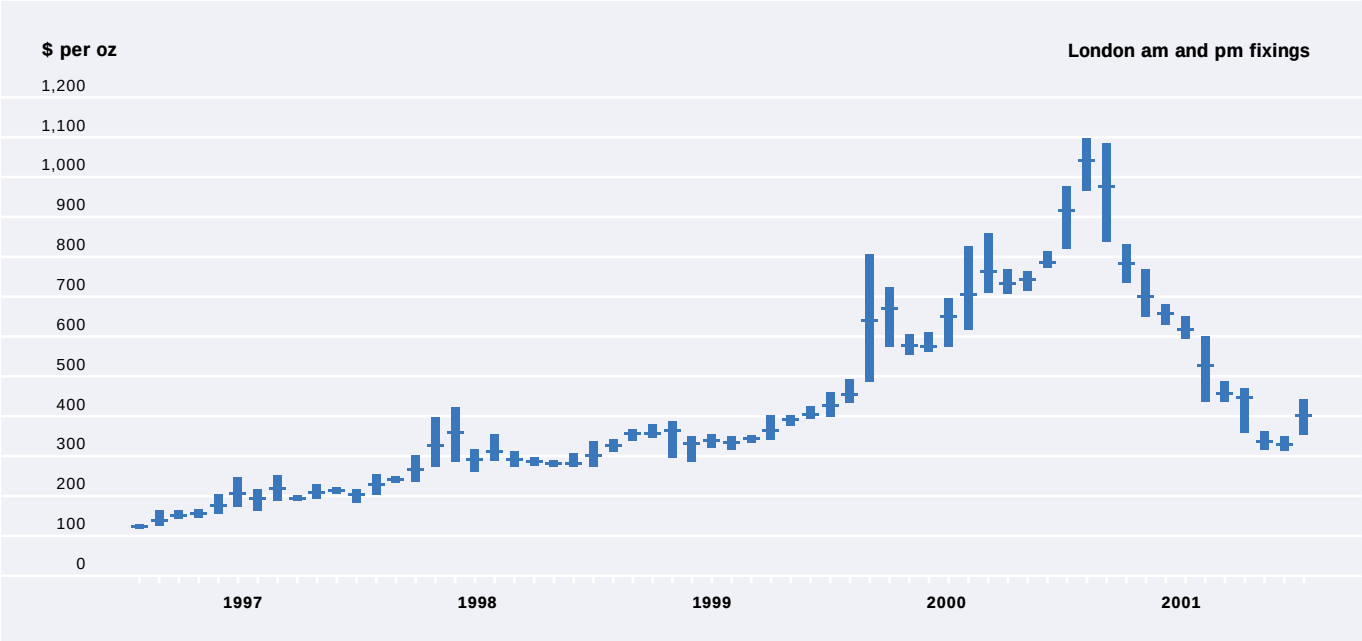
Supplies from western mines grew by 380,000 oz last year and are expected to rise by a similar amount in 2002, as expansions at mines in South Africa and North America come on stream.

This year's Annual Materials Plan for the DLA could enable the agency to sell all the remaining palladium in the US Strategic Stockpile (528,000 oz at the beginning of 2002). However, only 57,000 oz were sold in the first three months of the year and it seems unlikely that the DLA will sell the full amount if the palladium market continues to be weak.

At the time of writing this review, negotiations between Almaz and western buyers of palladium for new contracts in 2002 were reported to be at an early stage, and Russian sales to date appeared to have been minimal. Although representatives of Norilsk Nickel have stated that sales in 2002 will be tailored to a level likely to maintain the price in a range of between $400 and $600, it is unclear whether any contracts have been signed at this level.

With demand for palladium almost certain to fall again in 2002, the gap between consumption and mine production that has existed since the mid 1990s may virtually disappear. Consequently, unless the Russians restrict their sales of metal for the rest of the year to the level of Norilsk's production, another significant surplus is likely. The Russians may have the power to keep the price in their desired corridor by limiting sales but, after a prolonged absence from the market, their eventual return will be likely, initially at least, to exert downward pressure on the price. Assuming this will happen during our forecast period, we predict that palladium will trade in a range of $250 to $400 for the next six months.

Monthly High, Low and Average Prices of Palladium 1997-2001



Supplies, Mining and Exploration

South Africa

In 2001, sales of platinum from South Africa rose by 8 per cent to 4.1 million oz, as expansions by most existing producers added to output. Palladium shipments rose at a similar pace to total 2.01 million oz, but supplies of rhodium fell to 452,000 oz following sales from stocks the previous year.

The largest contribution to last year's increase in platinum supplies came from Anglo Platinum, which reported a 13 per cent improvement in refined platinum production compared with the previous year. Output at Impala was boosted by the reopening of the Crocodile River mine, while expansion at Lonmin resulted in a rise of 9 per cent in the company's platinum production. The small Kroondal mine benefited from a 50 per cent increase in capacity which came on stream in mid year.

The South African platinum industry has been sheltered from the decline in dollar pgm prices by the depreciation of the rand. While the platinum price in dollar terms retreated by over a third during 2001, the metal's rand value moved in the opposite direction, rising by 33 per cent to reach an all-time record of over R6,000 per oz on 20th December.

A period of strong rand pgm prices has left most existing producers with large surpluses of cash with which to finance expansion programmes, while it has become easier for new entrants to raise funding for platinum projects in South Africa. As a result, last year saw a further acceleration of the industry's expansion drive. Anglo Platinum confirmed three more major projects, including a joint venture with Lonmin Platinum. The latter revealed plans to bring forward its own expansion programme, while Impala announced the Two Rivers joint venture with Anglovaal Mining. Among the smaller producers, Aquarius Platinum proceeded with plans to begin mining at Marikana in 2002 and at Everest in 2004, while SouthernEra advanced the start-up of production at its Messina project. If all planned projects come to fruition, platinum output in South Africa will exceed 6 million oz per annum during the second half of this decade.

PGM Supplies: South Africa
'000 oz

	2000	2001
Platinum	3,800	4,100
Palladium	1,860	2,010
Rhodium	457	452

JM

Anglo Platinum

Refined platinum production at Anglo Platinum was a record 2.11 million oz in 2001, up 13 per cent from 1.87 million oz the previous year. This reflected a 9 per cent increase in the milling rate to 26.8 million tonnes of ore, an improvement in metallurgical efficiencies, and reduced stocks of unrefined platinum in the processing pipeline. Palladium output rose by 11 per cent to 1.05 million oz, while that of rhodium was up 21 per cent to 200,000 oz.

Much of this increase came from an improved performance at the group's established operations, but new projects also began to contribute significant amounts of metal. Expansions of UG2 mining at Amandelbult and Lebowa reached full annual production rates, while production continued to build at the Bafokeng Rasimone Platinum Mine (BRPM). However, the latter has fallen behind plan due to geological difficulties that have delayed the development of underground ore reserves. In order to provide additional mill feed, near-surface UG2 and Merensky ore has been mined from open pits, while a new decline has been constructed to access shallow Merensky reserves sufficient for three years of mining.

Anglo Platinum intends to produce 2.35 million oz of platinum in 2002, as other expansion projects come on-stream. At Rustenburg Section, a significant addition to capacity is underway, with the development of a new concentrator to process UG2 ore from both existing shafts at Rustenburg and a new mine on the farm Waterval. Construction of the concentrator was completed in February 2002 and the project is scheduled to reach full production in mid 2002. Planned output is 395,000 oz of platinum per annum.

The new Maandagshoek mine on the Eastern Bushveld should also add to output this year, with operations scheduled to commence during the third quarter. At full production, due to be achieved in 2003, the mine will contribute 162,000 oz of platinum annually. At Union Section, a UG2 project yielding 94,000 oz of platinum per annum is due to start up this year, while the Pandora joint venture with Lonmin has begun operations on a limited scale (see page 15).

View across a section of the processing plant at Aquarius's Kroondal mine

Anglo Platinum has announced two other major projects that will enter production during the period to 2006. In July 2001, the group announced that it had reached a joint venture agreement with the Royal Bafokeng Nation, under which capacity at BRPM would be doubled through an extension of mining onto the farm Styldrift. Full production of 250,000 oz of platinum per annum is planned for 2006.

Another new mine is to be constructed at Twickenham on the Eastern Bushveld. Announced in September 2001, this operation will mine and process 250,000 tonnes of UG2 ore per annum, with output expected to reach 160,000 oz of platinum and 176,000 oz of palladium annually by 2005.

Impala Platinum

Output from the Impala lease area totalled 993,000 oz of refined platinum during 2001, virtually unchanged compared with the previous year. A rise in the head grade was offset by a decline in mill throughput, mainly caused by problems during the commissioning of the company's new UG2 concentrator. The plant began to operate in late 2001, allowing Impala to begin processing its surface stockpiles of ore; this should make a modest addition to production in 2002. However, there are no plans to expand platinum output, which is expected to remain at around the 1 million oz level for the foreseeable future.

At the Crocodile River mine, in which Impala owns an 83 per cent stake through its subsidiary Barplats, the refurbished concentrator began operations in January 2001 and a total of 795,000 tonnes of ore were milled last year. Production of metal in concentrate totalled approximately 37,000 oz of platinum, 16,000 oz of palladium and 6,000 oz of rhodium.

The current location of mining at Crocodile River is Maroelabult, where ore is being extracted via an open pit. Underground operations here are scheduled to commence in 2002, and reserves in this area are sufficient to support a production rate of 50,000 oz of platinum per annum for four years. In order to extend the mine life, Impala is evaluating the possibility of exploiting ore in the original workings (which were mothballed in 1991) or developing reserves elsewhere on the lease area.

Barplats has a second platinum project, Kennedy's Vale, at which exploration is continuing. A feasibility study should commence during 2002.

Sinking of the main decline at Impala's Marula Platinum project (formerly known as Winnaarshoek) is scheduled to get underway this year, and production is planned to start by December 2003. The mine's target output is around 175,000 oz of platinum per annum, but there is thought to be potential to double production at a later stage. Impala has signed an agreement under which Mmakau Mining and other black empowerment groups will take 20 per cent of the project.

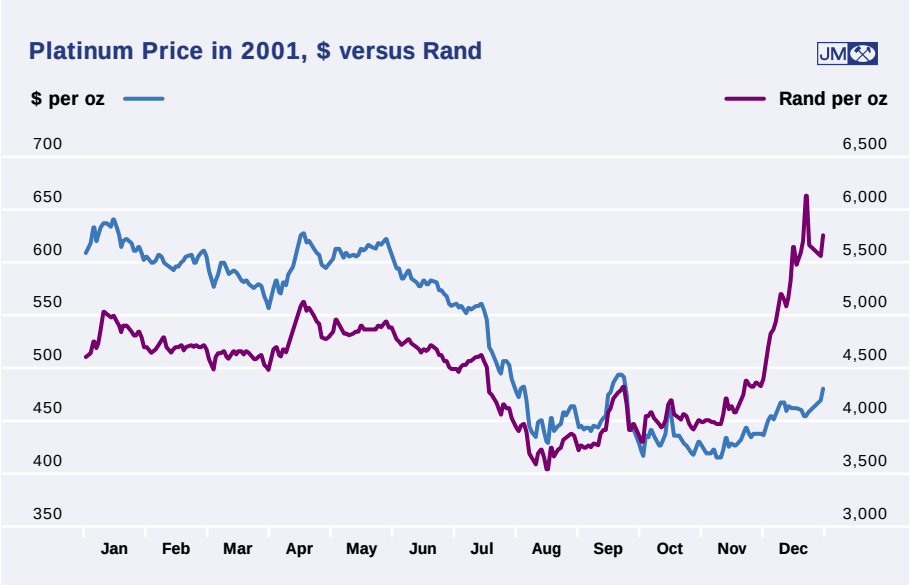
Impala also has minority stakes in two other pgm ventures in South Africa. These are discussed in more detail under the section on "Other Projects in South Africa" on page 16.

In addition to refining pgm from its own projects, Impala has entered agreements with several other producers to buy, refine and market their pgm. These include Aquarius and SouthernEra in South Africa, and Zimplats and Mimosa in Zimbabwe. Assuming that these companies' projects are brought into production as planned, Impala expects that by 2006 it will be refining around 2 million oz of platinum annually (including toll-refining of some 150,000 oz of secondary metal).

Lonmin Platinum

Refined pgm production at Lonmin Platinum reached record levels in the year to September 2001, reflecting recent investment in new milling and hoisting capacity. Despite some geological problems (including a major collapse of ground which delayed the commissioning of a new shaft), underground ore production rose by 2 per cent to 10.1 million tonnes; meanwhile, mill throughput was supplemented by ore from surface stockpiles and rose by 10 per cent to 10.52 million tonnes. As a result, output of refined platinum was up 9 per cent to 717,000 oz. Output of palladium and rhodium also rose strongly, reaching 324,000 oz and 102,000 oz respectively.

In November 2001, Lonmin



announced a major acceleration of its expansion programme. The company now intends to reach its target production level of 870,000 oz of platinum a year during 2003, rather than in 2008 as previously planned. A rapid build-up in production will be achieved by mining near-surface Merensky Reef and UG2 ore via open pits, with two new concentrators being built to process this material. In addition, Lonmin plans to bring forward increases in underground production at some of its shafts.

Lonmin will also benefit from increasing production at its Pandora joint venture with Anglo Platinum. This project, announced in April 2001, involves the exploitation of ore reserves owned by Anglo Platinum, downdip and east of the existing Eastern Platinum workings. Mining began in April 2002, but total output during the first two years of operation will be small, at less than 10,000 oz of platinum. Production will then build rapidly, reaching 230,000 oz of platinum a year in 2008. Each of the joint venture partners is entitled to a 50 per cent share of the metal.

Northam Platinum

The mining and milling rate at Northam rose substantially in the first six months of 2001, following the commissioning of the company's UG2 expansion project, but operations during the second half were affected by a five week strike during August and September. Total mill throughput was up 14 per cent compared with 2000. However, there was a sharp decline in the average pgm content of the ore due to increased production from the UG2, which at Northam typically has a mill head grade of under 4 grams per tonne, compared with around 6 grams per tonne for the Merensky Reef. As a result, total production of platinum group metals and gold in concentrate was virtually unchanged compared with the previous year, at 268,000 oz.

Output during 2002 is expected to be at record levels as the company benefits from a full year's production from the UG2 expansion and improved output of Merensky ore. We believe that combined pgm and gold production should exceed 300,000 oz this year, with platinum output approaching 200,000 oz.

The South Pit at Anglo Platinum's PPRust operation

Aquarius Platinum

At the Kroondal mine, a 50 per cent expansion of milling capacity was completed in June 2001. As a result, production in concentrate increased substantially to 113,000 oz platinum and 53,000 oz palladium last year. Kroondal will continue to ramp up production during 2002, and is expected to attain its target rate of 240,000 oz of pgm per annum during the year.

Aquarius has a second pgm project, Marikana, located 8 kilometres west of Kroondal, which is expected to come into production towards the end of this year. Plant construction began in early 2002, and mining is scheduled to get underway in June, ahead of the commissioning of the concentrator towards the year end. Although some concentrate may be obtained this year, we do not believe that any refined pgm will be generated from Marikana until 2003. Full production is planned to be around 160,000 oz of pgm per annum.

A third project, at Everest on the Eastern Bushveld, is currently the subject of a $2 million feasibility study. A drilling programme was completed during 2001, and the company intends to sink a short decline shaft in order to mine a bulk sample of ore for metallurgical testing. This decline is intended eventually to form part of the mining infrastructure at Everest. If the results of the feasibility study are favourable, mining could begin in 2004 and, at full capacity, annual production could be as high as 240,000 oz of pgm.

SouthernEra

At SouthernEra's Messina mine, small-scale production of pgm concentrates commenced during 2001. Although the main shaft and concentrator are still under development, the company is making use of a second, existing shaft to begin mining ahead of the commissioning of the main project. The first concentrate shipment from Messina occurred in September 2001, but total pgm output last year was very small.

In September 2001, SouthernEra announced that it had secured R345 million in debt financing to complete the redevelopment of the main Messina mine. Sinking of the principal shaft was completed in February 2002, and hoisting

is scheduled to start in mid year. The project is expected to begin commercial production during the final quarter of this year, following the commissioning of the concentrator in September. Production is planned to total around 160,000 oz of pgm and gold per annum once the mine reaches full capacity.

SouthernEra believes there is potential to expand the Messina mine beyond this level, and is examining the possibility of mining on the Doornvlei Section, 12 kilometres east of the current project. Existing infrastructure includes an incline and a vertical shaft, each developed to a depth of 100 metres. A bankable feasibility study is expected to be complete by mid 2002.

Other Projects in South Africa

In May 2001 it was announced that Anglovaal Mining (Avmin) and Impala Platinum had acquired the right to mine pgm on the farm Dwars Rivier, on the Eastern Bushveld near the town of Lydenburg. The partners have formed the Two Rivers joint venture to develop and operate a new underground mine, with Anglovaal as the majority shareholder (55 per cent) and project operator. Initial plans envisage a mining rate of 1.4 million tonnes per annum, yielding 160-170,000 oz of pgm; a feasibility study is currently underway in order to verify the optimal design and production rate for the mine, and is due for completion during the second half of 2002.

Avmin already produces small amounts of pgm from the Nkomati base metals operation in Mpumalanga province, in which it holds a 75 per cent stake. During 2001, sales of pgm from this mine totalled around 30,000 oz. A feasibility study of an expansion has been completed and a decision on whether to proceed is expected this year. It is believed that this could boost pgm output to around 80,000 oz per annum.

Meanwhile, Impala has also formed a joint venture with the Australian company Pan Palladium covering the Volspruit and Zoetveld farms (the Grass Valley project) 15 kilometres south of Potgietersrus on the northern limb of the Bushveld, and the Nonnenwerth property 70 kilometres north of Potgietersrus.

The first phase of a feasibility study on an open pit mine at Grass Valley is now underway, and further exploration drilling and metallurgical testing are scheduled to take place this year.

UK-based Cluff Mining also has a number of pgm prospects in South Africa, which were acquired through a phased acquisition of a South African company, Sperrylite Resources, during 2000 and 2001. Cluff now holds the rights to four PGM exploration properties on and around the Bushveld Complex: Blaauwbank (Blue Ridge), Loskop, Fonte Verde and Blue Sky North. At the end of last year, Cluff announced that it intended to begin a feasibility study of Blue Ridge during 2002.

Russia

Sales of palladium by Russia in 2001 are estimated to have fallen by 17 per cent to 4.34 million oz. Although there were large shipments of Russian palladium into Switzerland in the first quarter of the year, we do not believe that all of this metal was sold to consumers during 2001. In August, Almaz halted spot sales of palladium in an effort to support the price. Subsequently, shipments of platinum and rhodium accelerated, with the result that estimated platinum sales for the full year increased by 18 per cent to 1.3 million oz. Supplies of rhodium, at 125,000 oz, exceeded production, but were lower than in 2000, when a large amount of metal was sold from stocks.

The usual early-year delays in authorising export quotas for pgm again affected Russian sales in 2001. In the event, President Putin signed the relevant documents in March and shipments of platinum and rhodium began soon afterwards.

The situation with palladium was more complex. From the beginning of the year, Norilsk Nickel was able to export this metal under a ten-year quota and licence granted in 1999. However, it seems unlikely that Norilsk was behind the exceptionally large shipments of Russian palladium into Switzerland in February and March, which amounted to almost 2.2 million oz. It was initially reported that Swiss customs officials had said that these shipments were transfers from a local vault where the metal had been stored for some time. Although this story was subsequently denied by the Swiss authorities, it still seems probable that the metal formed part of a stock held locally by either the Ministry of Finance or Central Bank of Russia.

The imports into Switzerland coincided with substantial offerings in the market, especially at the London fixes, and with a large increase in market liquidity that suggested that some of the metal had become available for lending. The palladium price also fell sharply, though not as much as would have occurred had all the 2.2 million oz been sold into what was already a weakening market.

In June 2001 a new presidential decree "On the procedures of imports and exports from the Russian Federation of precious metals and precious stones" was signed by President Putin. This

PGM Supplies: Russia
'000 oz

	2000	2001
Platinum	1,100	1,300
Palladium	5,200	4,340
Rhodium	290	125

Norilsk Nickel smelter on the Kola Peninsula

decree includes numerous changes to the existing procedures, but the most notable for pgm is that the power to grant export quotas passed from the President to the Russian Government. Although quotas will continue to be set annually, provision is made for exceptional individual long-term quotas for up to five years. In March 2002 Norilsk Nickel was granted such quotas for platinum and rhodium, to add to its existing ten year quota for palladium.

The decree allows a wider range of banks, miners and producers to apply for quotas to export refined pgm, but re-emphasises that all such exports of pgm are to be carried out only by Almaz. The alluvial platinum producers of the Far East of Russia were granted export quotas in their own right for the first time in 2001, but it appears that they must continue to renew these annually.

During 2001, Norilsk Nickel made further progress in the modernisation of its mining and refining operations at Norilsk in Siberia and on the Kola Peninsula. In September it announced that contracts worth $250 million had been signed with Outokumpu to construct a new concentrator at Norilsk, replacing the present facility that was built in 1948, and to expand the concentrator at Talnakh. These improvements should enable Norilsk to treat more disseminated ore and to process tailings from mining in earlier years, allowing the company to increase its output of pgm without expanding production of nickel and other base metals. In January 2002 it was announced that Outokumpu would also begin the reconstruction of the Nadezhda smelter at Norilsk, with completion scheduled for 2005.

In December last year Norilsk signed loan and grant contracts with the Nordic Investment Bank to modernise its metals subsidiaries on the Kola Peninsula. In return for a grant of $31 million from the Norwegian Government and a ten-year loan of $30 million from the Bank, Norilsk will invest $35 million of its own funds to modernise its Kola operations. Although important for the local economy and to reduce pollution in the region, these investments will have far less impact on pgm production than those in Siberia.

Current production levels at the alluvial producers in the Far East of Russia – at Kondyor and Koryak – are believed to be lower than in the late 1990s. There have been several indications that Koryakgeologodobycha, which exploits deposits in Kamchatka, has been increasing its emphasis on gold, rather than platinum. At Kondyor, in Khabarovsk, the production of platinum is thought to have stabilised at a level beneath the maximum obtained some years ago.

North America

North American supplies of platinum rose by 23 per cent to 350,000 oz during 2001, while those of palladium were up 34 per cent to 850,000 oz. These increases reflected expansions of pgm mining at Stillwater and North American Palladium, and higher output of pgm as a by-product of nickel mining by Inco and Falconbridge.

Canada

Canada's only primary producer of pgm is the North American Palladium mine at Lac des Isles in Ontario. During 2001, the company completed an ambitious expansion programme, with the commissioning of a new 15,000 tonne per day concentrator at the beginning of June. Although the build-up in production has been slower than planned, due to some unexpected bottlenecks in the crushing and flotation circuits, the company processed 2.66 million tonnes of ore last year, nearly three times its throughput in 2000.

With the increase in concentrator capacity, the mine is now able to process ores with a much lower pgm content, and average grades have therefore fallen sharply – the head grade during the second half of 2001, following the commissioning of the new mill, fell below 2 grams per tonne. This compares with a typical grade of 3-5 grams per tonne before the expansion. Last year, palladium output was also affected by low recoveries during the initial months of operation at the new plant. As a result, palladium production rose by only 34 per cent, to 127,500 oz, despite the trebling of the milling rate.

In January 2002, North American Palladium announced that it had revised this year's mining plan in order to improve profitability. The quantity of ore and waste extracted from the open pit is to be reduced, and additional mill feed

PGM Supplies: North America
'000 oz

	2000	2001
Platinum	285	350
Palladium	635	850
Rhodium	17	23

will be sourced from existing ore stockpiles (which at the end of 2001 totalled 6.4 million tonnes grading 1.33 grams of palladium per tonne). This will enable mill throughput to be sustained at the planned level of 5.475 million tonnes per annum. Although the average grade will decline again this year, output of palladium is expected to rise significantly and is likely to be close to 200,000 oz.

Significant quantities of pgm are also produced in Canada as by-products of nickel mining by Inco and Falconbridge. Since the late 1990s, Inco has rationalised its Sudbury mining operations, focusing on higher-grade, lower-cost orebodies, with the result that pgm output has risen steadily. Last year, additional pgm came from the Copper Cliff North mine, where a zone of ore grading 16.4 grams per tonne of pgm and gold was brought into production in the last quarter of 2000. Total refined pgm output at Inco was 405,000 oz, up 18 per cent compared with the previous year; this figure includes small quantities of pgm recovered from semi-processed materials purchased from other mining companies. The company expects pgm production in 2002 to be at a similar level to last year.

At Falconbridge's Sudbury operations, striking employees returned to work on 23rd February 2001, following a seven month stoppage. Full mine production of 50,000 tonnes of ore per week was achieved by June, and the mines operated continuously throughout the remainder of the year. As a result, nickel output from Sudbury was up 9 per cent last year, while there was also a 6.5 per cent rise in production from Falconbridge's second Canadian nickel mine, at Raglan in northern Quebec. These increases were reflected in higher output of pgm during 2001. In addition, metallurgical problems led to a build-up in stocks of unrefined metal during 2000; the release of this metal from the refining pipeline is believed to have boosted pgm output last year.

USA

Refined pgm output from Stillwater Mining Company increased sharply last year. At the company's Stillwater Mine at Nye, recent investment in overcoming underground bottlenecks was reflected in a significant improvement in mining and milling rates. A total of 912,000 tons of ore was processed through the concentrator, up 21 per cent compared with 2000, though this was partly offset by a slight fall in the overall head grade to 0.62 oz per ton. Palladium output rose by 18 per cent to 388,000 oz last year, while platinum production was up 16 per cent at 116,000 oz.

A further 17,000 oz of palladium and 5,000 of platinum were produced from low-grade development ore during the final stages of development at the company's East Boulder project. The mine is scheduled to begin stoping operations during the first half of 2002, and ore production is planned to reach 1,000 tons per day by mid year. Grades at East Boulder are expected to be somewhat lower than at Stillwater, at around 0.5 oz per ton.

The decline in the palladium price during 2001 affected Stillwater Mining Company more seriously than other pgm producers, because of the relatively high cost of its underground operations, a lack of cash, and the need for further substantial capital investment to complete its expansion programme. As a result, in November last year the company announced that its expansion targets had been reduced. Plans for a further 20 per cent increase in production at the established Stillwater mine have been put on hold, with mine output to be maintained at around 2,500 tons of ore per day, while the target mining and milling rate at the new East Boulder operation has been halved to 1,000 tons per day.

The Falconbridge Raglan mine site in northern Quebec

Exploration in North America

Rises in platinum and palladium prices in recent years have stimulated a surge in exploration projects in Canada and the USA. Most are still at a very early stage, but among those which have reported

results from exploration drilling are a number of joint ventures with established mining companies.

Anglo Platinum has funded five phases of drilling at Pacific North West Capital's River Valley project to the east of Sudbury, earning itself a 50 per cent interest in the joint venture. An initial resource estimate has been calculated, totalling 12.7 million tonnes grading 1.39 grams of platinum and palladium per tonne, with a platinum:palladium ratio of about 1:3. Mustang Minerals also has a project at River Valley; exploration is being funded by Impala Platinum, which has the right to earn a 60 per cent interest in the venture. Mustang has established a second joint venture, this time with Falconbridge, covering its East Bull Lake prospect west of Sudbury.

Impala has also entered agreements with two companies exploring in the Birch Lake area of the Duluth Complex, located in northern Minnesota.

Zimbabwe

Supplies of platinum from Zimbabwe were small in 2001, at about 15,000 oz. However, output is set to rise significantly over the next two years, with the start-up of the Ngezi project and expansion of the existing Mimosa mine.

During 2001, Zimbabwe's only functioning platinum mine, Mimosa, continued to operate at an annual production rate of around 15,000 oz of platinum. An expansion programme has been under consideration for several years and is finally expected to get underway during 2002. Finance has been raised through the sale to Impala of a 35 per cent stake in Mimosa Mining Company for $30 million; this should provide most of the capital necessary to raise platinum output to around 70,000 oz per annum.

Platinum output from Zimbabwe will be augmented this year by the start up of a second mine, Zimplats' Ngezi open cast project. Funds for the mine's development were secured in March 2001, again with the involvement of Impala, which acquired a 30 per cent stake in Zimplats' subsidiary Makwiro Platinum Mines (which owns the Ngezi project and the former Hartley Platinum mine) at a cost of $30 million. The South African bank ABSA agreed to provide a further $30 million in debt finance. In addition, Impala and ABSA have each purchased a 15 per cent equity interest in Zimplats itself.

Infrastructure development at Ngezi was completed in December 2001 with the commissioning of an ore crusher and the opening of a new road which links the mine site with the processing plant at the former Hartley Platinum mine (now known as the Selous Metallurgical Complex). Mining at Ngezi commenced during the final quarter of last year, and the first smelter matte was produced in January 2002 following recommissioning of the concentrator and smelter at Selous. Matte from the project is to be shipped to Impala in South Africa for refining.

Zimplats expects Ngezi to reach full production of 183,000 tonnes of ore per month in May 2002; this should yield around 208,000 oz of pgm a year. The company is considering an expansion of pgm output through an extension of open cast operations, and possibly via a limited reopening of the underground mine at Hartley.

Other Projects

Higher platinum and palladium prices since the late 1990s have been reflected in a wave of exploration for new, economic pgm deposits. The majority of these projects appear to concern relatively low-grade palladium deposits which may not be viable at lower prices. However, several have progressed beyond the initial stages of exploration and are now at the feasibility study stage.

In June 2001 it was announced that Lonmin was to pay A$7.8 million for an 11.8 per cent stake in the Australian company Helix Resources NL. In addition, the two companies entered an agreement under which Lonmin can earn a 50 per cent interest in Helix's Munni Munni project by funding a feasibility study and providing technical assistance. The Munni Munni project is located near Karratha in Western Australia, and previous exploration work led to an initial resource estimate of 9.2 million tonnes of ore grading 2.9 grams of pgm plus gold per tonne. Like most deposits outside Southern Africa, the deposit is palladium-rich, with a platinum:palladium ratio of about 1:1.5.

Lonmin has also bought a 39 per cent interest in Platinum Australia Limited for A$12 million. These funds will be used for a full feasibility study of the company's Panton Platinum-Palladium project, where a resource of 33.6 million tonnes grading 2 grams per tonne was estimated in April 2001. Unusually, the platinum and palladium values appear to be about equal.

The Arctic Platinum Partnership, a joint venture between Gold Fields and Outokumpu, is exploring for pgm in northern Finland. A feasibility study is currently underway and is scheduled for completion in late 2002. In January 2002 the joint venture announced that it had identified resources totalling 152.5 million tonnes at an average grade of 2.3 grams per tonne, with a platinum to palladium ratio of about 1:3.

PGM Supplies: Zimbabwe & Others
'000 oz

	2000	2001
Platinum	105	110
Palladium	105	120
Rhodium	3	4

Platinum

Autocatalyst

Demand for platinum in autocatalysts reached an all-time high in 2001, rising by 33 per cent to 2.52 million ounces. In Europe, demand exceeded 1 million oz and was driven by a strong rise in sales of diesel cars. Tighter emissions regulations and a move back towards platinum from palladium by several auto makers also had a significant effect worldwide; North American demand, for example, jumped 27 per cent despite a sharp fall in new vehicle output.

Europe

Use of platinum in autocatalysts surged by 375,000 oz or 55 per cent last year in Europe to 1.055 million oz. This remarkable increase was achieved even though Western European production of new vehicles rose by only 1 per cent. The leading factor behind the rise in platinum demand was the strong growth in production and sales of diesel cars. In 2001, diesel catalysts accounted for over 70 per cent of auto demand for platinum in the region.

Diesel car sales climbed by 11 per cent to 5.33 million vehicles in Western Europe last year, and increased their market share to 36 per cent. The superior fuel efficiency of diesel-powered vehicles compared with gasoline is a strong selling point in Europe, where fuel costs are relatively high. The improved performance of the latest generation of diesel cars has also contributed to the rise in sales.

For technical reasons diesel autocatalysts use only platinum, whereas gasoline autocatalysts generally use platinum or palladium, in combination with rhodium. The increase in diesel car production, therefore, had a direct influence on platinum demand. In addition, platinum loadings on diesel autocatalysts were increased significantly in order to ensure compliance with European Stage III emissions legislation, which applied to all new vehicles from January 2001.

The price of palladium tripled between the third quarter of 1999 and January 2001. This, coupled with concerns about the stability of supply, caused auto companies to examine their use of palladium in autocatalysts for gasoline vehicles. Several subsequently favoured the use of platinum over palladium, reversing the trend that started in the mid 1990s. New platinum-rich catalysts entered the production stream last year, boosting demand significantly. The switch back towards platinum, however, was by no means universal and many auto makers continue to use palladium based catalyst technology.

In 2002 we expect European autocatalyst demand for platinum to increase as diesel cars gain further market share. The move from palladium to platinum in gasoline catalysts will also continue to influence demand this year.

Japan

Japanese demand for platinum in autocatalysts defied a fall in vehicle production and increased by a fifth to 345,000 oz, the highest level since 1992. Japanese emissions regulations came into force in October 2000 for new models and will be extended to encompass all existing models from September 2002. The stricter regulations resulted in a significant boost to autocatalyst pgm loadings in 2001, increasing platinum demand accordingly.

Platinum Demand: Autocatalyst
'000 oz

	2000	2001
Europe	680	1,055
Japan	290	345
North America	620	790
Rest of the World	300	330
Total	**1,890**	**2,520**

The Japanese Environmental Agency (JEA) has published technical guidelines that propose even greater reductions in emissions. Auto manufacturers have responded by inceasing autocatalyst pgm loadings further on some models for the domestic market, in order to achieve emissions ratings 50 per cent below the current legal limits. This trend is likely to continue in 2002.

In 2001, Japanese car manufacturers reacted to concern about the long term supply and price stability of palladium by using more platinum-intensive catalytic converters on new models. This also contributed to the growth in demand.

All Japanese cars exported to the USA now have to meet the national LEV standards, and some voluntarily meet the higher Californian ULEV (ultra low emission vehicle) limits. As with the domestic market, a higher proportion of export models used platinum based catalysts in 2001.

These positive factors for platinum demand far outweighed a 3 per cent decline in Japanese car production to 8.12 million units.

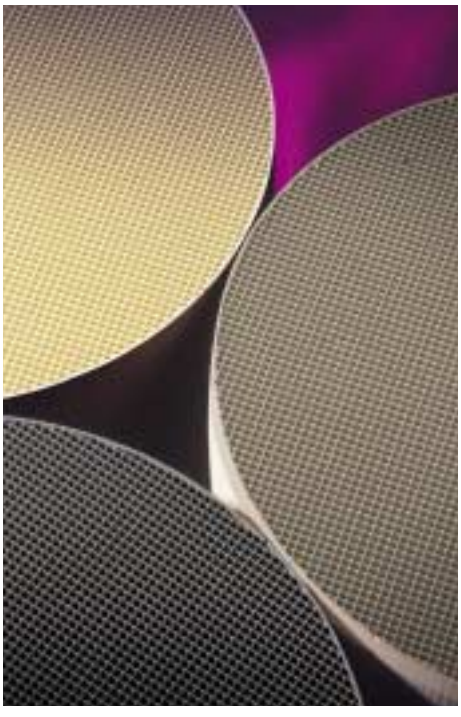
Platinum is used to increase the data storage capacity of computer hard disks

North America

The impact of reduced economic activity on US light vehicle production was pronounced in 2001 – US output slid by more than 10 per cent to 11.49 million cars and light duty trucks, as manufacturers drew down inventories of finished vehicles and imports gained market share.

Despite the weakened vehicle market, total North American demand for platinum in autocatalysts grew impressively, climbing by more than a quarter to 790,000 oz. The move in favour of catalysts utilising platinum in gasoline vehicles had a strongly positive effect on consumption. On top of this, several US-based automakers added to their platinum inventories during the year.

Car manufacturers are already working to meet more stringent US Federal emissions standards for light vehicles (Tier 2) that will start to take effect from 2004, and it is probable that higher loadings of pgm on autocatalysts will be required in some instances. Tighter regulations are also likely to necessitate the widespread use of platinum catalysts on heavy-duty diesel vehicles. This is expected to make a significant contribution to future demand for platinum in the longer term.



Coated and uncoated (top left) diesel autocatalysts

Rest of the World

The increasing control of automobile exhaust emissions had a growing impact on autocatalyst pgm demand in developing countries in 2001. This, combined with rising car sales in China and Brazil, produced a 10 per cent rise in platinum use to 330,000 oz.

Vehicle emission regulations (known as Bharat II) were introduced in nine major Indian cities in late 2000 and 2001, and enforce limits similar to those set by the Euro Stage II standards. Car manufacturers have largely adopted platinum-rich catalyst systems to meet the new limits. In March 2001, a government task force recommended the countrywide adoption of Bharat II standards and the introduction of the next stage of regulation in the seven largest urban conurbations by April 2005. If the proposals are adopted as legislation, this would further boost Indian pgm demand.

China has required all new vehicles to meet Euro Stage I limits since January 2001 and offers incentives for vehicles that meet Euro Stage II rules. As elsewhere, tighter regulations have increased autocatalyst demand for pgm. The Chinese autocatalyst market also benefited from strong sales of light vehicles last year – production and sales rose 16 per cent and 13 per cent respectively, both exceeding 2 million vehicles.

Implementation of South Korean LEV regulations has been deferred from January 2001 until 2003. The Korean legislation will require gasoline cars to conform to the US LEV standards, while diesel cars will have to meet Euro III emissions limits. This is expected to increase platinum loadings on autocatalysts.

South American pgm demand was lifted by the continued recovery in the Brazilian car market. Car sales rose 10 per cent to 1.29 million and production increased by 7 per cent to 1.35 million units. The Mexican car industry, however, was affected by the downturn in the US market. After rising by 29 per cent in 2000, production last year was static at 1.85 million light vehicles.

Platinum Demand: Autocatalyst Recovery
'000 oz

	2000	2001
Europe	(40)	(55)
Japan	(60)	(70)
North America	(350)	(370)
Rest of the World	(20)	(25)
Total	**(470)**	**(520)**

JM

Autocatalyst Recovery

The volume of platinum recovered from the recycling of autocatalysts is estimated to have increased 11 per cent in 2001 to 520,000 oz. North America is by far the leading source of recovered pgm from autocatalysts, returning 370,000 oz of platinum to the market last year.

Higher pgm prices encouraged recyclers to increase collection rates in 2001 and recovery of platinum rose 6 per cent as a result. The rate of increase in platinum recovery is slowing, however, as cars fitted with palladium-rich catalytic converters are being scrapped in increasing numbers in the USA.

Platinum recovery from autocatalysts in Europe reached 55,000 oz in 2001, an improvement of 15,000 oz on the previous year. Compared to the USA, autocatalyst recycling is largely in its infancy in the region. However, European legislation that will require at least 85 per cent of a car's weight to be recycled by 2005 is likely to stimulate greater efforts to recycle autocatalysts.

Higher pgm prices saw platinum recovery increase by 10,000 oz in Japan and 5,000 oz in the Rest of the World region in 2001.

DIESEL CARS & PLATINUM DEMAND

Demand for diesel powered cars in Western Europe has grown remarkably over the last decade. Across the region as a whole, diesels now account for over one third of all new cars sold. Both gasoline and diesel cars are subject to strict limits on pollutant emissions, and both use autocatalysts containing pgm to reduce emissions. However, because diesel and gasoline engines operate under very different conditions, they utilise different pgm-based catalysts. Gasoline autocatalysts utilise platinum and/or palladium in combination with rhodium, whereas diesel autocatalysts currently only use platinum. The increased market penetration of diesels in Europe, therefore, has important implications for future pgm use in the region.

European Diesel Car Sales Have Been Rising Rapidly

The market for diesel cars in Western Europe has experienced phenomenal growth in recent years. In 1995 diesels accounted for 22.6 per cent of new car sales in the region, by 2001 this had risen to 35.9 per cent, equivalent to 5.33 million cars. In Austria, Belgium, France and Spain the penetration of diesel automobiles already exceeds 50 per cent.

The growth in popularity of diesels has been driven by several factors:

- **Performance.** Major technical developments in engine design and engine management systems have vastly improved the overall performance of modern diesel engines for light vehicles. They now compete effectively with gasoline engines in terms of noise and driveability, and offer a feeling of 'power' resulting from high torque at low speeds. As a result of increased demand, car manufacturers are offering a greater number of models with diesel engines.
- **Economy.** The fuel efficiency of diesel engines is significantly higher than comparable gasoline engines. The relatively high cost of both diesel and gasoline in the EU makes fuel efficiency an important consideration for European drivers. For example, in January 2002 the average price of a litre of unleaded gasoline in the region was equivalent to $3.07 per US gallon; in the USA it was around $1.15 per gallon – over 60 per cent cheaper. *

**Source: The Automobile Association Ltd, UK, and the European Road Information Centre, Switzerland.*

- **Tax incentives.** Many European governments tax diesel fuel at a lower rate than gasoline, which reinforces the running cost advantage of diesel cars. In August 2001 diesel fuel was on average 23 per cent cheaper than gasoline in Western Europe, primarily due to taxation differentials.

Diesels also retain their traditional advantages of long life and low maintenance requirements. Although the purchase cost of new diesel cars can be higher than comparable gasoline models, they tend to retain their value better.

Why Do Diesel & Gasoline Autocatalysts Differ?

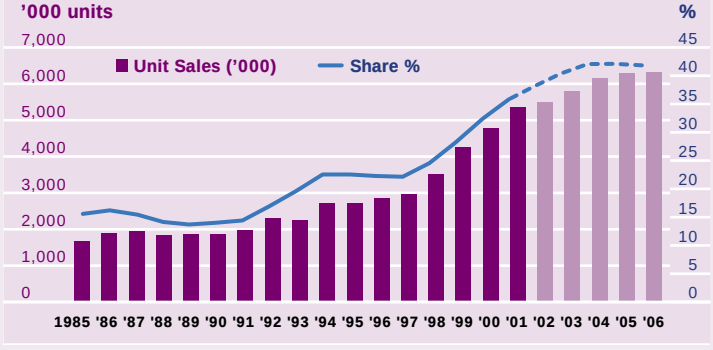
The amounts of air and fuel burnt in a gasoline engine are usually in chemical balance, there being no excess of either. This stoichiometric air:fuel ratio is typically 14.7 parts air to 1 part gasoline.

Under these conditions, and at the quite high temperatures (350-750°C) of the gasoline exhaust gas, platinum and/or palladium oxidise the pollutants carbon monoxide (CO) and hydrocarbons (HC), while rhodium catalyses the reduction of nitrogen oxides (nitric oxide and nitrogen dioxide, termed NOx) to nitrogen. Auto companies, therefore, use catalysts containing platinum and rhodium, palladium and rhodium, or a mixture of all three to meet current gasoline vehicle emissions regulations. These catalytic converters are known as three-way catalysts because they efficiently and simultaneously convert the three pollutants to harmless gases.

In marked contrast a diesel engine always operates with a large excess of air (the air:fuel ratio is typically ~30:1), often referred to as lean-burn operation; three-way catalysts cannot perform under these conditions. It has therefore been necessary to restrict NOx emissions by sophisticated diesel engine control measures and to use an oxidation catalyst to convert excess HC and CO to water and carbon dioxide.

An additional complication comes from the operating conditions of diesel engines that result in low exhaust gas temperatures (120-350°C). To date, only platinum based catalysts have been able to deliver the required

Diesel Passenger Car Sales in Western Europe



Source: DRI-WEFA Global Automotive Group

performance under these operating conditions.

The low temperature of diesel engine exhaust gas also means diesel oxidation catalysts may have to contain higher loadings of platinum than their gasoline equivalents to achieve the necessary conversions of HC and CO.

Future Emissions Legislation May Benefit Platinum

As with gasoline-powered vehicles, diesel cars are subject to increasingly stringent exhaust gas emissions legislation, which drives development of improved combustion processes and increasingly efficient autocatalysts.

The Euro III legislation (effective from January 2000 for new models, and from January 2001 for all existing models) introduced stringent new limits for diesel vehicle emissions for HC, CO, and NOx, as well as for particulate matter (PM).

The permissible limits will be further reduced by the Euro IV regulations, due to enter legislation from January 2005 (see table), and by future Euro V regulations that are currently under discussion.

To meet the lower NOx and PM emissions limits set by Euro IV, and those likely to be introduced under future Euro V regulations, it may be necessary for some diesel cars to be equipped with additional pollution abatement technology. Several options that utilise the catalytic properties of platinum are being developed to meet the challenge.

Technology for Control of Particulate Matter

The nature of the diesel combustion process results in the formation of particulate matter (PM) or 'soot'. Improved engine control and combustion engineering have in recent years dramatically lowered the amount of PM formed by modern light duty diesel engines. Nevertheless, there are some concerns about the health effects of very small particles, and ways of completely eliminating them are being sought.

It is possible to remove virtually all of the PM from diesel exhaust by using a porous ceramic filter. However, the challenge is then to remove the trapped soot from the filter. One means of achieving this is to burn it but the direct reaction of diesel soot with oxygen (air) requires temperatures above 550°C, which do not normally occur in the exhaust gas of diesel cars. However, platinum catalysts can be used to oxidise additional fuel that is injected into the exhaust gas periodically, raising the temperature sufficiently to initiate combustion of the trapped soot.

A more elegant approach for the combustion of trapped soot involves the oxidation of nitric oxide (NO), which is already present in the exhaust gas, to nitrogen dioxide (NO_2) over a platinum based catalyst. The NO_2 produced is a much more powerful oxidant than oxygen, and it starts to burn PM at temperatures as low as 250°C. This concept has been commercialised as the continuously regenerating trap (CRT™) and has already been fitted to many thousands of heavy duty diesel trucks and buses in Europe. In North America and other industrialised regions, these devices are involved in several inner city trials, and sales are growing as their benefits become recognised more widely.

In future, both these approaches to PM reduction may become widely used on diesel cars, and both make use of platinum oxidation catalysts.

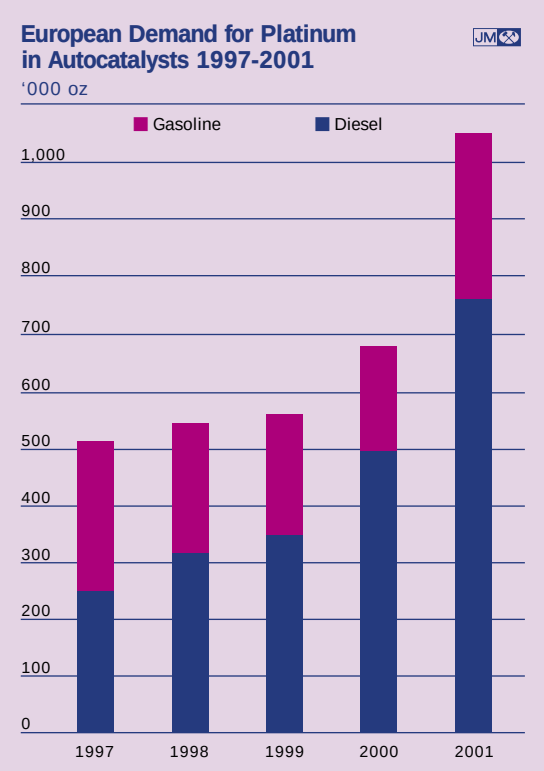
Technology for NOx Control

The oxygen rich environment of a diesel engine's exhaust gas favours the catalytic oxidation of CO and HC to water and CO_2 over the reduction of NOx to nitrogen, but all three emissions must be within the appropriate legislative limits. To date, NOx emissions from diesel cars have been reduced below these thresholds through

European Union Passenger Car Emissions Regulations

	1997 – Euro II		2000 – Euro III		2005 – Euro IV	
Pollutant (g/km)	**Gasoline**	**Diesel**	**Gasoline**	**Diesel**	**Gasoline**	**Diesel**
HC	–	–	0.20	–	0.10	–
NOx	–	–	0.15	0.50	0.08	0.25
HC+NOx	0.50	0.70*	–	0.56	–	0.30
CO	2.20	1.00	2.30	0.64	1.00	0.50
PM	–	0.88†	–	0.05	–	0.025

**Limit was 0.90 for direct injection diesels until 30 Sept 1999 †Limit was 0.10 for direct injection diesels until 30 Sept 1999*
HC = Hydrocarbons; NOx = Oxides of Nitrogen; CO = Carbon Monoxide; PM = Particulate Matter



developments in diesel engine design and combustion technology. These include the use of very high-pressure fuel pumps in sophisticated direct injection systems, which precisely control the volume of fuel injected into the cylinder and produce a finely atomised spray. The delivery of fuel at very high pressure leads to a lower average combustion temperature that moderates the formation of NOx.

A second important way of reducing the amount of NOx formed is the use of exhaust gas recirculation (EGR), where partially oxygen-depleted exhaust gas is mixed with the fresh air that enters through the inlet manifold. This lowers the oxygen content of air in the cylinder, again lowering the peak combustion temperature and so reducing the amount of NOx formed.

There are practical limits, however, to what can be achieved by engine design and by improving the combustion process. In the future, measures such as these may not be able to reduce the formation of NOx to sufficiently low levels. To meet the lower NOx limits set by Euro IV, and those that may be introduced under future Euro V regulations, it might be necessary for some diesel cars to be equipped with additional pollution abatement technology.

One of the most likely catalytic ways of controlling NOx emissions is to chemically retain NOx as nitrate in what is sometimes called a 'NOx-trap'. During normal, lean operation of the diesel engine, NO is oxidised to NO_2 by platinum as the exhaust gas flows through the trap. The NO_2 is then retained in the trap in nitrate form. Periodically, the diesel engine is run richer than normal (with a higher proportion of fuel) for a short time. This produces exhaust conditions under which the nitrate is catalytically reduced to harmless nitrogen and released, regenerating the trap.

In NOx control, therefore, as in PM control, platinum is likely to have a key role. Already NOx-trap technology is used on some lean running gasoline engines. There are challenges for its practical implementation on diesel cars, but good progress is being made in this area.

US Market Yet to Follow European Growth

In the last quarter of 2001, diesels represented 39.8 per cent of Western European car sales. The impact of the growth in diesel car production on platinum demand is clear from the accompanying bar chart. With fuel costs unlikely to decrease significantly in the foreseeable future, the appeal of diesel cars to European consumers seems certain to increase further. Current estimations for the potential penetration of diesels across Western Europe range from 42 to 50 per cent by 2006, exceeding sales of 6 million vehicles annually.

In marked contrast, diesel cars accounted for less than 1 per cent of US light vehicle sales in 2001. US consumers were put off diesel cars in the early 1980s because the first models sold in the USA suffered from poor performance. This negative public perception persists today. However, advances in modern diesel engine performance are not yet recognised widely.

In addition, because gasoline in the USA is typically less than half the price of fuel in Western Europe, fuel economy is not an important consideration for most American consumers when purchasing a new car.

An increase in US national fuel efficiency standards could help to increase the appeal of diesel light vehicles but the Senate rejected the most recent proposals in March 2002.

The penetration of diesels into the US market is further hindered by current Federal vehicle emission regulations. These do not make a distinction between gasoline and diesel automobiles, and require significantly lower NOx levels than those applied under Euro III legislation.

Despite these hurdles, inroads are being made into the US market by the latest diesel cars, and the modern high speed diesel engine is well suited for use in the very popular sports utility vehicles. Nevertheless opinion is divided, even among the leading car manufacturers, about the level of market share that diesels could achieve.

Jewellery

Global demand for platinum in jewellery dropped by 10 per cent to 2.55 million oz in 2001. Demand from China increased to a record 1.3 million oz, a rise of 18 per cent year on year, but high platinum prices in the first half of the year, combined with lower economic activity, had a major impact on fabrication levels in Japan and the USA. Platinum lost market share to white gold in the lower priced sections of these markets, whilst demand in Japan was further affected by substantial liquidation of inventories. European demand fell 11 per cent overall but Swiss and UK fabricators increased sales.

Europe

European demand for platinum in jewellery fabrication slid to 170,000 oz in 2001, affected by the metal's high price in the first half of the year and economic weakness, particularly in export markets. Demand from German and Italian manufacturers fell sharply but UK bridal jewellery fabricators and the Swiss watch industry enjoyed healthy order levels.

Sales in the German jewellery market as a whole were depressed in 2001, reflecting a weaker economy. The platinum sector was further affected by a general move towards the use of cheaper jewellery materials. With the price of platinum relatively high in the first half of the year, there was a significant amount of substitution of platinum with white gold, as well as increased use of non-precious metals such as titanium and stainless steel.

The Italian platinum jewellery industry is largely export led, particularly for manufacturers of lightweight chain products. Orders from the USA and Japan fell substantially in 2001 due to depressed retail demand.

UK demand for platinum for jewellery manufacture increased almost 10 per cent in 2001. Whilst the number of pieces hallmarked grew only moderately, the average weight of platinum per article continued the rise seen in 2000. The UK platinum jewellery market is dominated by bridal products, which are generally less sensitive to price increases.

Swiss fabricators produced considerably more platinum jewellery for export in 2001, boosting platinum demand. The Swiss watch making industry also had a strong year, despite the slowing global economy. The number of platinum watches produced increased by 25 per cent, and sales in Europe – the main initial destination for Swiss-made watches – were particularly strong.

Chinese jewellery accounted for 1.3 million oz of platinum demand in 2001

Japan

Demand for platinum from the Japanese jewellery industry dropped by a third in 2001, falling from over 1 million oz in 2000 to 710,000 oz last year – the lowest level since the mid 1980s. The slump was primarily due to a combination of intensive efforts to reduce inventories of platinum jewellery by both fabricators and retailers, as well as reduced consumer spending.

The situation was exacerbated by the high price of platinum, which averaged over ¥2,300 per gram during the first half of 2001. As the economy worsened and retail sales declined, it became harder for platinum jewellery to compete in the lower price ranges. Wholesalers and retailers responded by focusing increasingly on white gold as a substitute for platinum to satisfy the public's demand for inexpensive white jewellery. Whilst the overall Japanese jewellery market was stable in 2001 in terms of number of pieces sold, platinum's share of the market fell by a fifth to 27 per cent. In contrast, sales of white gold items rose by 21 per cent and those of yellow gold by 10 per cent.

Consumer spending on jewellery in Japan is heavily biased towards pieces under ¥37,500. Platinum items only accounted for 15 per cent of all jewellery bought in this price bracket in the key sales month of December 2001 compared to 20 per cent the previous year. Even in higher value sectors of the market (¥100,000 to ¥400,000 per piece), which had previously been price resilient, sales in 2001 dropped by 10 per cent.

Lower consumer spending had the greatest effect on sales of platinum fashion jewellery – the number of

Platinum Demand: Jewellery
'000 oz

	2000	2001
Europe	190	170
Japan	1,060	710
North America	380	280
Rest of the World	1,200	1,390
Total	**2,830**	**2,550**

necklaces sold fell 26 per cent, bracelet demand dropped 30 per cent, and sales of platinum earrings fell by 26 per cent.

Platinum jewellery manufacturers, wholesalers and retailers all made strenuous efforts to reduce inventories in 2001, in the face of continuing economic uncertainty and consumers' reluctance to buy more expensive jewellery. The amount of old jewellery being returned for melting increased as a result. The impact of stock reductions was to cut demand for platinum alloys for new jewellery fabrication substantially.

With little immediate prospect of a sustained recovery in the Japanese economy, retail sales are unlikely to improve in 2002. Platinum demand from jewellery fabricators, however, may benefit from lower recycling of old stock.

North America

After nine years of steady growth, North American demand for platinum in jewellery fell by 100,000 oz to 280,000 oz in 2001, a drop of over 26 per cent. As in Japan, a weakened economy that undermined retail sales and inventory reductions, in this case by retailers, were the main negative influences.

The high price of platinum relative to white gold contributed to the decline, with the latter taking market share as the amount spent per sales transaction diminished. This was also true of the bridal sector, which accounts for the majority of platinum sales in the USA, and which is traditionally not very sensitive to price movements.

Sales of platinum jewellery during the Christmas season in 2000 were lower than had been expected, which resulted in large stocks being carried over into 2001. This cut demand for new platinum jewellery from fabricators. To this was added the slide in US equities during the first nine months of 2001 and the stagnation of the economy in the second half of the year, which combined to dampen consumer spending on luxury items. In anticipation of lower sales, retailers streamlined their platinum product lines and reduced inventories. The net result was a further reduction in new metal demand.

Platinum jewellery sales over the 2001 Christmas period in the USA, however, were better than many retailers expected and demand to date in 2002 has been encouraging. US consumer confidence has shown some signs of improvement, increasing the likelihood that spending will rise this year. Much depends on the strength and pace of the US economic recovery from its brief recession, but indicators such as industrial output and employment levels were positive in the first quarter of 2002.

Rest of the World

The Chinese appetite for platinum jewellery remained healthy in 2001; sales of platinum to jewellery manufacturers rose by 200,000 oz (18 per cent) to 1.3 million oz. Higher retail sales were driven by GDP growth of over 7 per cent last year (according to government figures), while the affluence of urban areas continues to increase.

In late 2000 and during the first half of 2001, when the price of platinum was over $600 per oz, Chinese jewellery fabricators found their profit margins on platinum articles reduced. Most were unable to pass on their extra costs in full to retailers, and many increased their production of white gold items as a result. The fall in the platinum price in the second half of 2001 rapidly enabled manufacturers to regain their margins on platinum products and fabricator demand for the metal increased significantly. Despite retail price increases, the Chinese public remained very enthusiastic about platinum jewellery throughout.

Figures from the first quarter of 2002 suggest that platinum jewellery demand this year will show further strong growth. Consumption has been helped by the spread of retail outlets outside of the major cities and the greater choice of products and designs available. Platinum is also gaining a wider consumer base and is not just the preserve of affluent younger buyers.

Platinum consumption in the remainder of the Rest of the World region fell 10 per cent in 2001 to 90,000 oz. Almost all other Asian countries producing platinum jewellery rely heavily on exports to Japan, the USA and Europe and so were affected by the downturn in demand in these areas.

The economic slowdown in the USA cut short growth in the emerging platinum jewellery manufacturing business in India. In recent years, Indian manufacturers have taken advantage of their established position as exporters of gem set gold jewellery to develop sales of platinum products to major wholesalers in the USA. Domestic demand for platinum jewellery in India offers the potential for long-term growth but is currently very modest.

Thai jewellery manufacturers have been hit hard by the fall in the Japanese market, as well as the downturn in the USA. Output in the South East Asian region is generally from fabricators that rely on low production costs to be able to sell into niche markets. Future production will be largely dependent on increased export sales as the key European, US and Japanese economies expand.

Platinum Jewellery Alloys

Platinum jewellery is rarely manufactured from 100 per cent platinum because the pure metal is too soft to withstand the rigours of daily wear. Most is typically produced using platinum of 85 to 95 per cent purity, alloyed with small amounts of other metals to increase its hardness. The platinum purity or "fineness" is nearly always measured in parts per thousand (ppt). A hallmark showing "Pt950" certifies that the metal is composed of 950 ppt (95 per cent) platinum and 50 ppt (5 per cent) other metals.

As well as determining how well a piece of jewellery will resist scratching in use, the hardness of a platinum alloy also affects how easily a piece of jewellery can be shaped and finished by hand. It is also important in the automated manufacture of products such as chains because softer alloys place less wear on the forming machinery. Components such as spring catches, however, have to be made from harder alloys that can withstand the stresses placed upon them in use.

In addition to hardness, the choice of alloy for a particular application depends on several other factors that are influenced by the alloying metal, including purity, melting range and casting behaviour, reactivity, and workability (the ability of the platinum alloy to be shaped, rolled or drawn without becoming brittle and cracking). Cost and appearance are also key considerations but, in general, particular alloy types have tended to dominate in different countries due to manufacturers' long-standing familiarity with their individual characteristics.

Platinum-palladium alloys are widely used in Japan and China. The most common alloys are Pt900/Pd (100 ppt palladium) Pt850/Pd and Pt950/Pd. Pt900/Pd is the general purpose alloy of choice in Japan, offering a good combination of hardness, workability, and suitability for casting, welding and soldering. Chain manufacturers prefer Pt850 because its softness and ductility minimise tool wear and are also very well suited to the chain making process.

The alloy compositions used by Chinese manufacturers tend to vary considerably. Diamond set jewellery is typically produced in Pt900/Pd but other platinum jewellery is produced from alloys containing copper, cobalt or nickel. Pt950/Pd is sometimes used in Europe and Asia for castings requiring fine detail.

Platinum alloys containing up to 5 per cent **cobalt** (particularly Pt950/Co) are extensively used in Europe and Japan, and have gained popularity in the USA. The addition of cobalt produces a fluid alloy that is well suited to the casting process, that can reproduce very fine detail, and which produces hard, durable jewellery.

The alloy Pt900/Ir, containing 10 per cent **iridium**, has very good all round manufacturing characteristics: it can be cast, welded, machined and stamped; it is ductile and malleable; can be hardened through working; and does not readily oxidise. Because of these advantages, Pt900/Ir has traditionally been one of the most important jewellery alloys used in the USA, although there has recently been a swing toward alloys of 950 fineness. Some manufacturers in Germany and Japan also prefer this alloy. Pt800/Ir is very hard and dense, and is used in Germany for the production of fine wirework.

Platinum-copper alloy systems offer several general purpose jewellery alloys for machining and hand-working applications. Casting, however, can be difficult with some copper-containing alloys. The most common compositions contain 30 or 50 ppt copper, sometimes in combination with 50 to 100 ppt palladium.

Ruthenium is used to produce a Pt950/Ru alloy that has good all-round machining properties and is well suited to high volume manufacturing processes. It is widely used for the manufacture of wedding bands, particularly in the USA. Platinum-ruthenium alloys are also commonly used by Swiss watch manufacturers.

Other platinum alloys containing metals such as tungsten, gold and gallium are also produced for the jewellery industry, and can offer advantages for specific applications. Speciality alloys, however, only account for a very small proportion of those used – the great majority of platinum jewellery is manufactured from platinum alloyed with a combination of palladium, iridium, ruthenium, cobalt or copper.

Hallmarking

Jewellery is usually marked to record the platinum content of individual pieces. When backed by consumer protection laws, a hallmark (or assay or standard mark) is a guarantee that the article contains the specified minimum purity of platinum. Some countries permit the composition of the alloy to fall below the standard by a set amount, for example 0.5 per cent, which is known as negative tolerance.

In many countries, platinum is identified by the accepted international abbreviations of "Pt" or "Plat", either preceded or followed by the fineness number. In the USA, alloys of 950 fineness or above may be marked with the word "platinum". In the UK, platinum is identified by a 5-sided shape (a rectangle surmounted by a triangle) within which the fineness number is stamped. In 1975, the European Hallmarking Convention introduced a "Common Control Mark" for platinum that is recognised by each of the signatory countries. This is a diamond shape containing a balance, which in turn surrounds the fineness number.

Europe: for platinum, the finenesses set under the Hallmark Convention are 999, 950, 900, and 850. No negative tolerance is accepted. The countries that have adopted the convention to date are Austria, the Czech Republic, Denmark, Finland, Ireland, the Netherlands, Norway, Portugal, Sweden, Switzerland and the UK.

Most other countries in Europe apply a single platinum 950 standard, with Italy permitting a small negative tolerance. France, Spain and Italy also allow iridium to be counted as platinum. Germany permits use of alloys with 999, 960, 950, 900 and 800 fineness.

Japan: Japanese regulations cover the finenesses 1000, 950, 900, and 850, and permit a negative tolerance of up to 0.5 per cent. This enables manufacturers of 1000 alloy to add small quantities of other elements in order to increase the hardness of the pure platinum.

USA: products manufactured in the USA from platinum with a fineness of 950 or above may be marked "Platinum" or "PLAT". Alloys above 850 fineness can be marked with the abbreviations "Plat" or "Pt" as long as they are preceded by the fineness number. Alloys containing a minimum platinum content of 500 ppt are permitted if the total pgm content is at least 950 ppt. Hallmarks for these alloys have to state the fineness of each metal, for example: "650Plat300Irid".

China: the mainland Chinese jewellery industry has a national hallmarking standard that covers platinum articles, and this is policed by retailers who send incoming goods from manufacturers to approved testing centres. Most alloys used have a platinum fineness of 900 or 950 and are marked accordingly.

Platinum jewellery manufactured in Hong Kong is covered by trade descriptions orders, under which any product described as being "platinum" must have a fineness of at least 850. Similar to Europe and Japan, the hallmarks Pt850, Pt900, Pt950 and Pt990 are used to denote the platinum content of alloys used.

Outline Properties of Common Platinum Jewellery Alloys

Composition % Alloying elements	Pt/pgm Fineness	Melt temp. °C	Hardness Hv	Applications/Notes	Countries of major use
5% Copper	950	1,745	120	General purpose	Europe
5% Cobalt	950	1,765	135	Fluid for hard castings	Europe, USA
3-5% Cobalt/ 5-10% Palladium	850 – 950	1,730 – 1,765	125(C) – 150(C)	Hard castings	Japan
5% Iridium	950	1,790	80	General purpose	Europe, Japan, USA
10% Iridium	900	1,800	110	General purpose	USA
15% Iridium	850	1,820	160	Catches, pins, springs	Japan
20% Iridium	800	1,830	200	Spring applications & fine wirework	Germany
5% Palladium	950	1,765	60, 68(C)	Castings, delicate settings	Japan
10% Palladium	900	1,755	80, 72(C)	General purpose	China, Japan
15% Palladium	850	1,750	90, 64(C)	Chain making	Japan
5% Ruthenium	950	1,795	130	Machining	Europe, USA
5% Tungsten	950	1,845	135	Hard for springs	Europe

NOTES: 1. Melt temperature is the liquidus value – the temperature at which the alloy becomes fully liquid 2. Hardness values are for the annealed state except those marked (C), which are for the as-cast state 3. Pt/pgm finenesses are in ppt.

Platinum Demand: Chemical
'000 oz

	2000	2001
Europe	100	105
Japan	20	20
North America	100	100
Rest of the World	75	65
Total	**295**	**290**

Chemical

Global demand for platinum in the chemical industry was largely stable during 2001, demand declining marginally compared with the previous year to 290,000 oz. Silicone output was broadly similar to the year before and there were no significant additions to paraxylene capacity – the manufacture of both products uses platinum.

Predictions of strong growth for the speciality silicones sector did not materialise during 2001, as demand was hit by slower economic growth in Europe and the recession in the USA.

Speciality silicones are primarily used in the manufacture of adhesives, synthetic rubbers, sealants for construction applications, and a range of consumer goods such as personal care products. As most of the catalyst used is lost during the production process, platinum demand is closely related to silicone output.

Paraxylene is a chemical precursor to purified terephthalic acid (PTA). This in turn is the feedstock for the production of polyester fibres and the plastic polyethylene terephthalate (PET). The manufacture of paraxylene is catalysed using platinum but metal losses during the process are small, so demand is mostly linked to construction of new manufacturing capacity. Several new paraxylene units came on stream in 1999 and 2000, reducing the need for investment in additional capacity last year. This led to a decline in demand for platinum catalysts.

Demand for platinum based process catalysts in other sectors of the chemicals industry is small in comparison to silicones and paraxylene. Demand was broadly similar to 2000 in 2001, although the pharmaceutical industry remains a growth sector.

The nitric acid industry suffered from lower demand and prices for nitrogen fertilisers in 2001 due to weak crop prices, reduced economic growth, and a wet spring planting season in Europe and North America. The deterioration in the fertiliser market meant that there was little significant investment in nitric acid capacity in 2001 and demand for platinum catalysts was broadly similar to the year before.

Platinum Demand: Electrical
'000 oz

	2000	2001
Europe	80	65
Japan	90	80
North America	145	120
Rest of the World	140	120
Total	**455**	**385**

Electrical

Use of platinum in electrical and electronic applications fell 15 per cent to 385,000 oz in 2001, primarily due to a sharp downturn in the global electronics industry, and in sales of personal computers in particular. Demand for platinum in thermocouples also declined, reflecting lower industrial output in Japan, North America and Europe.

Computer hard disks are the largest single electrical application for platinum and demand almost doubled between 1998 and 2000. The rapid growth was due to soaring sales of personal computers and the increase in disk storage capacity through the use of a layer of a platinum-cobalt alloy. In 2001, however, sales of personal computers faltered – worldwide sales dropped by 4 to 5 per cent and shipments in the large US market dropped by 11 to 12 per cent compared to the previous year.

In addition, by the start of 2001, over 90 per cent of all hard disks produced incorporated a platinum alloy layer, reducing the opportunities for further market share gains. Whilst the greater use of platinum in hard disks has increased their data storage density, this has also enabled manufacturers to reduce the number of disks in each hard drive – the average fell from 1.8 disks per

PEM fuel cells power advanced prototype vehicles such as DaimlerChrysler's NECAR 5 and Jeep Commander 2

drive in 2000 to 1.6 in 2001. The net result of lower PC sales and fewer disks per hard drive was a fall in platinum demand of around 15 per cent last year.

There is optimism amongst PC manufacturers that last year's fall in total PC sales will be short-lived, and order levels will recover this year.

Demand for platinum in thermocouples weakened in 2001 as a result of lower levels of production in the key industrial sectors of steel and semiconductor manufacturing. Crude steel output fell by over 11 per cent in the USA and by around 3 per cent in the European Union and Japan in 2001. Sharp declines in semiconductor production reduced the number of semiconductor fabrication units that came on-line last year.

Use of platinum in fuel cells amounted to less than 2 per cent of overall total electrical demand in 2001 but the technology is moving towards commercialisation in several applications. Important developments in 2001 are highlighted in the accompanying panel.

Glass

Demand for platinum in glass manufacturing applications increased by 30,000 oz to 285,000 oz in 2001. Substantial growth in China was driven by construction of new television glass and fibreglass furnaces, and investment in high quality LCD glass capacity continued in Japan and South Korea. These increases heavily outweighed decreased demand in North America and Europe.

FUEL CELLS

The era of commercialisation begins

Fuel cells generate electricity and heat from a simple electrochemical reaction in which oxygen and hydrogen combine to form water. A solid or liquid electrolyte carries electrically charged particles between an anode and a cathode. A catalyst, usually platinum, is used to speed up the reactions at the electrodes. This process produces much less pollution than burning the fuel in a combustion engine or generator and is also more efficient, making it economically and environmentally attractive.

There are several types of fuel cell, utilising different electrolytes and fuels. The proton exchange membrane (PEM) type of fuel cell always employs platinum as a catalyst on the electrodes. Alkaline and phosphoric acid fuel cells also commonly use platinum-containing electrodes. Other types of fuel cell may use pgm to catalyse the conversion of the fuel (such as natural gas, methanol or gasoline) to hydrogen to feed the cell itself. Most current development work is focused on PEM fuel cells.

Present demand for platinum in fuel cells is low; a few thousand ounces annually. Commercial production to date has been mainly of large, typically 200kW, phosphoric acid fuel cells for stationary power generation applications. Smaller PEM units, however, are now under development. For example, Plug Power has already started field trials of PEM fuel cell systems designed to supply electricity and heat to individual homes.

Other organisations in Europe, Japan and North America are expected to follow this lead and units for domestic use should be commercially available within five years. On a shorter timescale, Coleman Powermate expects to launch a small, portable PEM fuel cell generator during 2002.

The automotive sector, however, remains the most exciting area for this technology due to its huge size. Almost every car manufacturer has a fuel cell programme and most have built and exhibited prototypes, with many already entering into pre-commercial partnerships.

Ballard Power Systems, for example, has been developing PEM fuel cell components and systems for automobiles via joint ventures with DaimlerChrysler and Ford. In November 2001 Ballard took full control of the joint venture companies, Xcellsis and Ecostar; in return, DaimlerChrysler and Ford increased their direct ownership of Ballard.

Meanwhile, UTC Fuel Cells (previously known as International Fuel Cells) has forged alliances with companies including Hyundai, Nissan and Renault, to advance development of PEM fuel cell powered automobiles.

A third major grouping is composed of General Motors (GM) together with Toyota. In 1999 the two companies signed a 5 year agreement to work together to develop alternative vehicle propulsion technologies. In early 2002, GM exhibited a new concept car, AUTOnomy, which is specifically designed to be fuel cell powered. Although GM does not intend to manufacture a product based on AUTOnomy for some years, Toyota has announced that it will sell fuel cell cars from 2003.

Honda, meanwhile, has been developing fuel cell technology since 1989 and, like Toyota, intends to introduce a production fuel cell vehicle next year. These are perhaps the most significant developments of the last twelve months as they may mark the beginning of the commercial era for fuel cells.

Up-to-date news and information about the global fuel cell industry can be found on the web site **www.fuelcelltoday.com**.

The Chinese market for fibreglass is expanding strongly, and several major manufacturers in China have scheduled or undertaken expansions in capacity. In contrast, the European and North American fibreglass markets are mature and demand was weakened by the economic slowdown. Nevertheless, there is growth in several applications, including construction and lightweight fibreglass reinforced products in the automotive industry.

The LCD glass market suffered from falling prices due to oversupply in 2001, as demand for consumer electronics such as laptop computers, personal organisers and mobile phones fell. This caused some manufacturers to scale back their expansion plans but construction of several new furnaces did proceed. Renewed investment in this sector should materialise from the second half of 2002, if economic growth in the USA and Europe regains momentum, stimulating demand for equipment manufactured from platinum.

Demand for traditional CRT (cathode ray tube) screens for televisions and desktop computers remained healthy in emerging Asian markets in 2001. Demand for platinum-rhodium alloys used in the manufacturing process was boosted by capacity additions in China and India. In contrast, the CRT glass industry in the USA is battling tough competition from Asian imports, and is not expected to invest in new furnaces in the foreseeable future.

Platinum Demand: Glass
'000 oz

	2000	2001
Europe	20	15
Japan	65	85
North America	50	30
Rest of the World	120	155
Total	**255**	**285**

JM

Petroleum Refining

Platinum based catalysts are used in several stages of petroleum refining, particularly during the reforming of naphtha into downstream petrochemical products. Demand for platinum from the petroleum refining industry increased by 15,000 oz to 125,000 oz in 2001 as incremental additions were made to existing capacity.

The petroleum markets in North America and Western Europe are mature, and large-scale refinery construction is unlikely for both environmental and economic reasons. Demand for platinum catalysts was stable in Europe, China and Japan in 2001 and increased moderately in North America.

Platinum consumption in Latin America and South East Asia is forecast to grow over the next 2 years, with the installation of several new reforming, hydrocracking and isomerisation units.

Other

Demand for platinum in other applications increased by 16 per cent in 2001 to 435,000 oz. The use of platinum in dental alloys grew significantly as the high price of palladium at the beginning of the year caused a strong move towards alternative materials. Gains were also made in applications such as oxygen sensors for cars and platinum electrode spark plugs.

European Stage III auto emissions legislation brought about a significant increase in demand for oxygen sensors in 2000 and 2001. These are an essential part of engine management systems for vehicles fitted with catalytic converters. The new European regulations resulted in manufacturers installing additional sensors to ensure emissions limits are met. The number of sensors per vehicle is expected to stabilise in 2002, and so demand will more closely follow changes in vehicle production.

Platinum Demand: Petroleum Refining
'000 oz

	2000	2001
Europe	15	15
Japan	5	5
North America	35	40
Rest of the World	55	65
Total	**110**	**125**

JM

In North America, the 10 per cent fall in light duty vehicle production in 2001 offset any gains made from the use of greater numbers of sensors per vehicle, and platinum demand was unchanged from the previous year.

The key component of a spark plug is the central electrode that carries the electric charge to the tip. Platinum electrodes have a higher durability than traditional copper electrodes. This enables manufacturers to reduce electrode diameter, which in turn decreases the voltage required. The high durability of platinum can also improve combustion performance over the life of the spark plug, reducing emissions. These advantages have led to a growing proportion of new cars in Europe being fitted with platinum based spark plugs and demand in 2001 increased as a result.

In North America, where platinum spark plugs are already specified as original equipment by all the major auto makers, the decline in automobile production reduced platinum demand. Japanese demand for platinum spark plugs is being eroded by iridium tipped products. The use of electrodes manufactured from iridium or iridium-rhodium alloy facilitates further reductions in electrode diameter and gains in durability.

Platinum Demand: Other
'000 oz

	2000	2001
Europe	105	120
Japan	35	40
North America	210	250
Rest of the World	25	25
Total	**375**	**435**

The dental industry made a substantial switch away from palladium based alloys in 2001, accelerating the trend of the year before. The main beneficiaries were high-gold alloys containing an average of 10 per cent platinum but demand for base metal formulations also increased. This resulted in platinum consumption rising by more than 20 per cent compared to 2000. The change was most noticeable in the North American market, which is sensitive to metal price movements because most dental treatment is not subsidised.

Biomedical applications for platinum components continued to increase in 2001, particularly for catheters and stents used in arterial surgery, and for pacemakers. The trend towards miniaturisation of medical devices, however, is moderating growth in platinum demand.

Use of the platinum based drug, Carboplatin, to combat cancer continues to increase, but in many cases at the expense of Cisplatin (also based on platinum). Production of a new drug, Oxaliplatin, used to fight prostate cancer, is increasing rapidly but total output – and therefore demand for platinum – is still very small.

Investment

The sharp fall in the platinum price between June and August stimulated strong interest in platinum investment products in both the USA and Japan. Sales of platinum coins from the US Mint increased rapidly in the second half of 2001 and lifted the net demand for small bars and platinum coins by 10,000 oz to 50,000 oz. Similarly, Japanese purchases of investment bars increased from July onwards and for the year as a whole outweighed disposals by a net 30,000 oz.

Demand for the US Mint's platinum Eagle series of proof and bullion coins fell year-on-year during the first six months of 2001 as the platinum price averaged almost $600 per oz. However, sales climbed steeply as the price began to fall, and increased by 70 per cent during the second half of 2001 compared to the year before. The investment attraction of platinum bullion coins was further enhanced by the fall in US equity prices during the first 9 months of the year. Sales of US Eagle coins continued at strong levels during the first quarter of 2002, increasing by 14 per cent compared to the first quarter of 2001.

A loan of 196,000 oz of platinum to the US Mint by the DLA has now been repaid, although the Mint is believed to have purchased a proportion of the metal borrowed. The Mint is expected to maintain its working stock of platinum by making annual purchases of metal on the spot market in future, as demand dictates.

The first few months of 2001 saw Japanese sales of large bars back to the market far outweigh new purchases as the price exceeded ¥2,300 per gram. The Japanese market for 500g and 1kg bars is highly price sensitive, therefore as the platinum price began to fall, buying accelerated. From late July onwards, purchases of investment bars jumped dramatically as the price dropped under ¥2,000 per gram, resulting in net demand of 30,000 oz during 2001.

Platinum Demand: Investment
'000 oz

	2000	2001
Coins and small bars		
Europe	0	0
Japan	5	5
North America	35	45
Rest of the World	0	0
	40	**50**
Large bars in Japan	**(100)**	**30**
Total	**(60)**	**80**

Platinum Price in Japanese Yen in 2001


Pd 2
Pd 3

Palladium

Autocatalyst

Global demand for palladium from auto makers fell by over 9 per cent in 2001 to 5.11 million oz. Sales to car companies in Europe and North America dropped substantially, as several thrifted palladium and increased the use of platinum in their catalytic converters. Lower gasoline vehicle production in both regions also affected demand. On the positive side, the reduction in palladium inventories by the North American car industry was not as pronounced as we had predicted. In Japan, tighter auto emissions legislation offset a decline in vehicle production and palladium demand was similar to 2000.

Europe

The use of palladium by the European auto industry slid by 170,000 oz to 1.73 million oz in 2001. The primary cause of the fall was the shift away from palladium to platinum-rich catalysts on gasoline vehicles that was undertaken by several auto manufacturers.

Palladium was used at progressively higher loadings on gasoline autocatalysts between 1995 and 2000, and helped car companies meet the Euro Stage III emissions regulations (it is very effective at reducing hydrocarbon emissions from gasoline engines). The rise in the price of palladium from mid 1999 onwards, however, and concerns about security of supplies led many auto makers to seek to reduce palladium use, both by minimising total pgm loadings and by increasing the use of platinum based autocatalysts on new car models. The effect of this strategy on palladium demand became increasingly apparent throughout 2001.

The growth in the diesel car sector in Europe also affected palladium demand in 2001. Although European production of passenger cars increased by 1 per cent last year, output of gasoline vehicles fell as the market share accounted for by diesels climbed to 36 per cent. Because diesel cars utilise platinum based catalysts, the rise in sales of diesels at the expense of gasoline vehicles reduced autocatalyst demand for palladium.

Japan

Total Japanese auto industry demand for palladium was broadly unchanged in 2001 from the previous year, slipping just 1 per cent to 505,000 oz. New emissions regulations meant that higher loadings of pgm were utilised in autocatalysts fitted to Japanese cars for the domestic market, but this mainly affected platinum rather than palladium demand.

Cars manufactured in Japan for the US export market continued to use palladium based technology to meet the stringent US hydrocarbon emissions limits for gasoline vehicles. The US car market, however, was subdued in 2001 and although Japanese manufacturers gained market share, this had little effect on palladium demand within Japan as car production has been increasingly transferred to facilities abroad.

North America

North American demand for palladium in autocatalysts fell by 415,000 oz to 2.39 million oz last year as thrifting of the metal had a major impact. US car manufacturers have reduced average palladium loadings both through advances in engine management and catalyst technology, and by substituting a proportion of the palladium used with platinum and rhodium.

North American autocatalyst demand for palladium was also hit by the pronounced fall in production of light duty vehicles. US output dropped 10 per cent as manufacturers cut back new car assembly rates, with the auto trade reducing vehicle inventories in the face of the slowing economy.

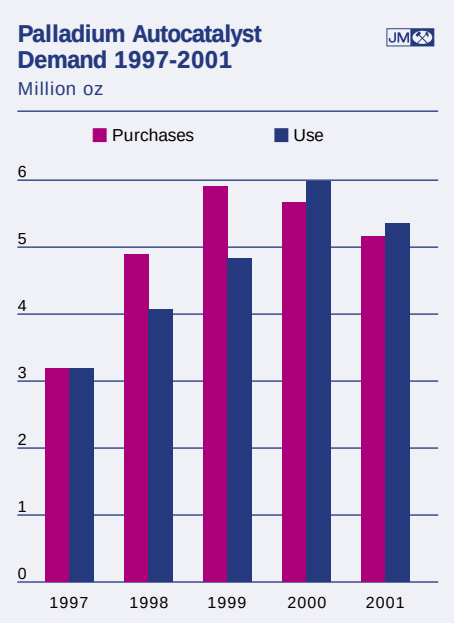
The fall in palladium demand, however, was not as great as we had predicted in our Platinum 2001 Interim Review. The US auto industry was expected to draw heavily on inventories of palladium in 2001 due to the high price in the early part of the year and the increasingly difficult business conditions. This was forecast to reduce greatly purchases of fresh metal.

In the event, however, we believe that stock reductions across the industry as a whole were not very substantial last year. This can be attributed to several factors: the uncertainty that persisted about the future availability of Russian metal, auto makers' continued need for palladium in the longer term, given its effectiveness as

Palladium Demand: Autocatalyst
'000 oz

	2000	2001
Europe	1,900	1,730
Japan	510	505
North America	2,805	2,390
Rest of the World	425	485
Total	**5,640**	**5,110**
Autocatalyst recovery	**(230)**	**(290)**

Good delivery specification palladium bars



a catalyst for the control of gasoline vehicle hydrocarbon emissions, and the rapid fall in the palladium price during the second half of the year.

It is too early to determine the US auto industry's approach to pgm stocks this year. In January 2002, however, Ford Motor Company announced a pre-tax write-down of $1 billion against the value of its pgm inventories and forward contracts. While no information was released about the volumes of individual pgm concerned, Ford has been one of the larger users of palladium in the past.

The company subsequently said that a technical advance in catalyst design would enable it to reduce its use of palladium markedly, estimating that its consumption in 2002 will be approximately half that used in 2000. As a result, Ford now holds palladium in excess of its stock requirement and may sell a proportion of the surplus back to the market this year.

Rest of the World

In the Rest of the World region, the use of palladium in autocatalysts increased by 60,000 oz to 485,000 oz. The increase would have been greater by several thousand ounces had the introduction of South Korean LEV regulations not been postponed. As with platinum, palladium demand benefited from the introduction of tighter vehicle emission regulations in China and India, and rising light vehicle production in China and Brazil.

Autocatalyst Recovery

There was a strong rise in the amount of palladium recovered from recycled autocatalysts in 2001: the total volume increased from 230,000 oz to 290,000 oz. Three quarters of the 60,000 oz increase was accounted for by greater recovery of palladium in North America.

Between July 2000 and January 2001 the rapid increase in the price of pgm, particularly palladium, stimulated efforts to maximise collection of autocatalysts from scrapped vehicles and recovery of the precious metal content. Return of autocatalysts for pgm recovery also climbed in Europe and Japan, boosting secondary palladium supply, but the volumes remain relatively small.

Cars fitted with catalytic converters that primarily contain palladium, rather than platinum, are beginning to be scrapped in rising numbers, increasing the availability of palladium for recovery. Auto manufacturers started using palladium based autocatalysts in significant numbers from the mid 1990s. As many of these vehicles come to the end of their lives over the next few years, the supply of recovered palladium is expected to grow accordingly.

Chemical

After a strong 2000, chemical industry demand for palladium last year fell by 8 per cent (20,000 oz) to 235,000 oz. Sales of palladium catalysts for vinyl acetate monomer production declined, while demand for palladium catchment gauzes from the nitric acid sector was static.

Palladium catalysts are used in the production of vinyl acetate monomer (VAM), the precursor to a wide range of polymers that find application in products such as paints and adhesives. The slowing global economy in 2001 weakened demand for products derived from VAM. This, in turn, reduced demand for palladium catalysts.

The other leading application for palladium process catalysts is in the manufacture of bulk petrochemicals, particularly purified terephthalic acid

BP Chemicals' plant at Hull, UK has an annual capacity of 250,000 tonnes vinyl acetate monomer

(PTA) and polyethylene terephthalate (PET), which are widely used in packaging materials and artificial fibres such as polyester. As with VAM, reduced economic activity in North America, Europe and Japan acted as a brake on PTA and PET demand in 2001.

In contrast, the pharmaceutical and speciality chemicals sectors continued to provide solid growth in demand for palladium based catalysts. Growth was driven by development of new drug treatments, personal care products and food production technologies.

Demand for palladium catchment gauzes from the nitric acid industry was limited by the same market factors that held back demand for platinum catalysts – poor crop prices and a bad spring planting season led to weak fertiliser demand. However, there are indications that the large fall in the palladium price during 2001 may now be increasing demand for palladium gauzes in the North American market.

Dental

The rise in the palladium price to over $1,000 per oz in early 2001 affected demand for palladium based dental alloys markedly. Demand fell by 18 per cent to 670,000 oz as base metal and gold alloys took market share from palladium. The impact was most severe in Europe, where demand plunged by 60 per cent.

The European dental industry has made considerable investment over the past 2 to 3 years in equipment and staff training to enable greater use of base metal alloys, rather than the more traditional palladium-rich formulations. Consequently, when the price of palladium soared, many European dental practices were able to move quickly towards the use of alternatives. Demand for palladium slumped to 40,000 oz in 2001, down from 100,000 oz in 2000 and 180,000 oz in 1999. Because of the investment made in the development of substitute materials, many of these losses are unlikely to be recovered, even if the palladium price remains relatively low.

Palladium Demand: Chemical
'000 oz

	2000	2001
Europe	95	65
Japan	20	20
North America	65	75
Rest of the World	75	75
Total	**255**	**235**

North American and Japanese use of palladium dental alloys also suffered from the metal's price in early 2001: demand fell by 40,000 oz in each region last year. The Japanese market has become more sensitive to the price of palladium since 1999, when the state health insurance scheme placed an increasing proportion of the costs of treatment on the patient.

Electronics

Palladium demand from the global electronics industry collapsed from 2.16 million oz in 2000 to only 700,000 oz in 2001, a slump of almost 70 per cent. There were two main causes: high product and component inventories compounded by poor sales of electronic goods, and the high and volatile price of palladium, which caused manufacturers to run down their strategic stocks of the metal.

Palladium Demand: Dental
'000 oz

	2000	2001
Europe	100	40
Japan	470	430
North America	230	190
Rest of the World	20	10
Total	**820**	**670**

A sharp downturn in the electronic products market at the end of 2000 left retailers and manufacturers with higher than expected inventories. This, in turn, meant producers of electronic components also had high stock levels at the start of 2001. The impact of this stock build up on demand for electronic raw materials was compounded by falling sales of finished goods during the year as the leading economies of the USA, Japan and Germany all slowed. Both personal computer and mobile phone sales are estimated to have fallen by 5 per cent worldwide last year, while orders for automobile electronics were hit by the decline in vehicle production in North America and Japan.

Attempts by manufacturers to reduce their component stock levels, coupled with weaker retail sales, had a pronounced effect on the production of multi-layer ceramic capacitors (MLCC) – by far the leading electronics application for palladium. MLCC output dropped by 27 per cent to 435 billion units last year.

The impact of the high palladium price on demand for the metal from MLCC manufacturers was even more pronounced than the decline in component production. MLCC producers, who were experiencing an erosion of profitability, increasingly worked from strategic stockpiles of palladium during the year and made strenuous efforts to maximise recycling of production scrap. Many manufacturers, particularly those in Japan, are believed to have had substantial holdings of palladium in January and made few purchases of new metal during the year. The result was that demand for palladium from the MLCC industry fell considerably.

The rapid increase in market share taken by nickel electrode MLCC since the mid 1990s abated last year. Palladium based MLCC, however, are likely to lose

further ground when the profitability of manufacturers improves and investment in base metal MLCC production equipment gathers pace.

The weakness in electronics sales and high component inventories also affected demand for palladium based conductive pastes in hybrid integrated circuits (HIC). However, demand was supported to a certain extent by the automotive aftermarket – a major user of HIC. Repair rates increased last year as consumers deferred new vehicle purchases. The performance advantages of palladium in HIC mean that it faces less competition from base metal products in this sector than for MLCC. The fall in the palladium price in the second half of 2001 has further reduced the threat of substitution.

Demand for palladium in plating applications fell by almost 50 per cent during 2001. In addition to the market and inventory issues that affected demand for electronic components, the high price of palladium meant that gold was increasingly used to plate connectors. Manufacturers also made efforts to thrift palladium coatings on lead frames. The price of palladium will have a large bearing on the level of demand for plating electrical components in 2002.

Deferred replacement of electronic products by businesses and consumers reduced the availability of electronic scrap in 2001. In addition, efforts to thrift the use of precious metals in electronics applications is reducing the concentration of pgm in scrap. The amount of palladium returned to the market from this source fell to 290,000 oz, versus 320,000 oz the year before.

MLCC Production by Electrode Type 1997-2001
Billions

Other

Demand for palladium in jewellery and other applications slipped by 10,000 oz in 2001 to 305,000 oz. In the Japanese jewellery sector, intensive inventory reduction of platinum jewellery and lower retail sales cut fabricator demand for platinum-palladium alloys (typically 5 to 15 per cent palladium). This offset a rise in the production of white gold jewellery, which often contains palladium as a whitening agent. Further substitution of palladium occurred in the North American petroleum refining industry, whilst consumption in most other applications was stable.

Global demand for palladium from jewellery fabricators fell by 15,000 oz to 240,000 oz in 2001. Japan is by far the largest consumer of platinum-palladium jewellery alloys and the Japanese platinum jewellery industry had a relatively poor year. Many manufacturers and retailers reacted to falling retail sales by cutting their inventory levels of jewellery as much as possible and remelting old stock. This greatly reduced demand for platinum, diminishing the need for palladium as an alloying agent.

The Japanese jewellery trade tried to cut costs by increasing output of white gold products. However, although white gold alloys in Japan usually contain a proportion of palladium, the impact was not sufficient to outweigh the drop in the platinum sector. At the same time manufacturers reduced the percentage of palladium used in white gold alloys when the palladium price rose.

In China, platinum jewellery manufacture expanded strongly in 2001 but the impact on palladium was limited. The Chinese jewellery industry uses several different alloying metals in addition to palladium, and also migrated towards alloys containing a higher percentage of platinum.

Demand for palladium in petroleum refining continued to be affected by the replacement of some palladium based hydrocracking catalysts with base metal formulations last year. The scale of substitution, however, was lower than in 2000, resulting in reduced sales of reclaimed metal back to the market. In most other palladium applications, such as brazing alloys and catalysts for stationary pollution control, demand was largely unchanged.

Palladium Demand: Electronics
'000 oz

	2000	2001
Europe	265	135
Japan	990	280
North America	485	90
Rest of the World	420	195
Total	**2,160**	**700**

Palladium Demand: Other
'000 oz

	2000	2001
Europe	65	55
Japan	165	150
North America	15	25
Rest of the World	70	75
Total	**315**	**305**

Other Platinum Group Metals

Rhodium

Supplies of rhodium fell sharply in 2001: Russian exports were less than half the previous year's level, while South African shipments also decreased slightly. However, demand declined even more steeply, as auto makers – who had added significantly to strategic stocks in 2000 – drew upon inventories to meet their rhodium requirements. As a result, the market moved into surplus after two years of deficits. Improved availability was reflected in a retreat in the price, from $2,300 in February to a low of $675 in November.

Autocatalyst

Changes in strategic stocks held by auto makers have led to sharp swings in autocatalyst demand for rhodium over the last two years, at a time when underlying consumption on catalysts has remained virtually unchanged. During 2000, we believe that US and Japanese car companies bought substantial quantities of rhodium for inventory; this was partly reversed last year, with metal being withdrawn from stockpiles for use on catalysts. As a result, sales of rhodium to the auto industry fell by 29 per cent to 566,000 oz in 2001.

In contrast, actual use of rhodium on catalysts was stable last year, as modest increases in loadings were offset by lower production of gasoline vehicles in most markets. In North America, output of light vehicles fell by 10 per cent, reflecting a modest decline in sales combined with a substantial reduction in inventories of finished vehicles. Rhodium consumption also fell, though by a smaller percentage: some auto makers have raised the rhodium content of their catalysts as part of their palladium thrifting programmes. However, it appears that improvements in catalyst design are likely to limit further increases in rhodium loadings. Although not the main incentive behind last year's reductions in strategic stocks, this may have been a factor, since inventory levels are partly related to expectations of future demand.

Despite a slight increase in domestic car sales, auto production in Japan fell by 3 per cent last year, affected by a sharp reduction in exports to North America and Europe. This decline was largely offset by a rise in average rhodium loadings in order to meet tighter emissions legislation. As a result, consumption of rhodium on catalysts was virtually unchanged, but fresh sales of metal to auto makers were much lower than the previous year due to inventory adjustments.

In Europe, vehicle production was virtually unchanged in 2001. However, gasoline cars continued to lose market share to diesel models, which carry platinum-only catalysts. Manufacturing of gasoline vehicles actually contracted last year, largely cancelling out a slight increase in average rhodium loadings. As a result, rhodium demand rose only marginally compared with 2000.

Consumption growth in the Rest of the World region was mainly due to higher sales to auto makers in Latin America: demand in Mexico was lifted by further increases in rhodium loadings on models for export to the USA, while the Brazilian market continued to benefit from growth in car production and sales.

Rhodium Supply and Demand
'000 oz

	2000	2001
Supply		
South Africa	457	452
Russia	290	125
North America	17	23
Others	3	4
Total Supply	**767**	**604**
Demand		
Autocatalyst: gross	793	566
recovery	(79)	(92)
Chemical	39	44
Electrical	7	6
Glass	42	39
Other	10	11
Total Demand	**812**	**574**
Movements in Stocks	(45)	30

These gains were partly offset by a plunge in vehicle output in Argentina, where economic and political crisis has resulted in a sharp decline in consumer spending. In Asia, there was some increase in rhodium usage in smaller markets such as India, Malaysia and Thailand, but demand in the largest market, Korea, was flat. Following a series of difficult years for the Korean auto industry, the introduction of local LEV regulations has been postponed until 2003, although some car companies are already selling vehicles meeting the new limits.

The amount of rhodium recovered from scrapped catalysts rose by 16 per cent to 92,000 oz last year. In North America, higher pgm prices during early

2001 provided an incentive for growth in the collection and processing of spent autocatalysts. Recoveries in this region were also boosted by further increases in the average rhodium content of scrapped catalysts, reflecting stricter legislation which entered force in the early 1990s.

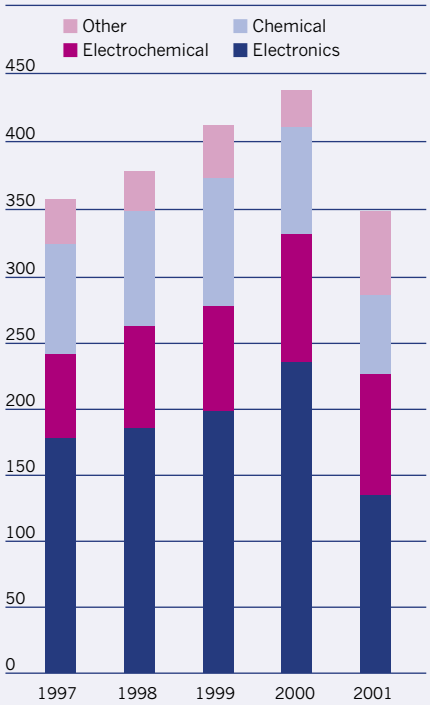
The amount of rhodium recovered in Europe also continued to expand, though from a very low level. This was largely due to a gradual improvement in collection of catalyst scrap. In addition, an increasing proportion of vehicles scrapped last year were manufactured after 1993, when EU emissions legislation first led to the universal use of catalysts on gasoline cars.

Other

Demand for rhodium in other applications rose by 2 per cent to 100,000 oz in 2001. In the chemicals sector, investment in new production capacity for oxo-alcohols and other speciality chemicals resulted in an increase in sales of rhodium process catalysts, especially in the Rest of the World region. However, this was partly offset by a downturn in demand from the glass industry.

Oversupply in the LCD glass market resulted in less additional manufacturing capacity being constructed than in 2000, and hence in a reduction in purchases of rhodium. The impact on demand was moderated by construction of new cathode ray tube glass capacity in China and India.

Demand for Ruthenium 1997-2001
'000 oz



Ruthenium & Iridium

A plunge in demand from the electronics industry was the principal factor behind last year's fall in consumption of both ruthenium and iridium. Use of ruthenium declined by 22 per cent to 349,000 oz in 2001, while demand for iridium was 31 per cent lower than the previous year, at 86,000 oz.

Last year was difficult for the electronics industry. Many device manufacturers, anticipating continued strong growth in retail sales, entered the year with a large overhang of both finished products and components. When consumer demand proved less robust than expected, these companies cut production and began to work off inventories. As a result, there was a collapse in demand for components such as resistors, which are ruthenium's principal application in the electronics sector.

With industry stocks of components much reduced, demand for resistor chips – and hence for ruthenium – is expected to recover in 2002. There will also be a modest addition to electronics demand for ruthenium from a new application: hard disks. It has been reported that the addition of a microscopic layer of ruthenium between two magnetic layers on a hard disk results in a large increase in the density at which data can be stored. This technology should enable disk manufacturers to overcome what were previously believed to be the physical limits of data density, and to develop hard disks with data storage capacities four or more times those of current products. Manufacturing of ruthenium-containing disks started in 2001, and the technology is expected to be applied to the majority of hard disks within a few years.

Iridium is also used in the electronics sector, principally in the form of crucibles for the growth of high-purity crystals. In recent years, there has been a huge expansion in demand for lithium-based crystals used in surface acoustic wave (SAW) filters, which prevent interference between individual mobile phones. Manufacturers made significant additions to crystal-growing capacity during 2000, and this was reflected in strong demand for iridium crucibles. The industry now has sufficient capacity to meet crystal demand for the foreseeable future, and as a result, there has been a

Ruthenium Demand by Application
'000 oz

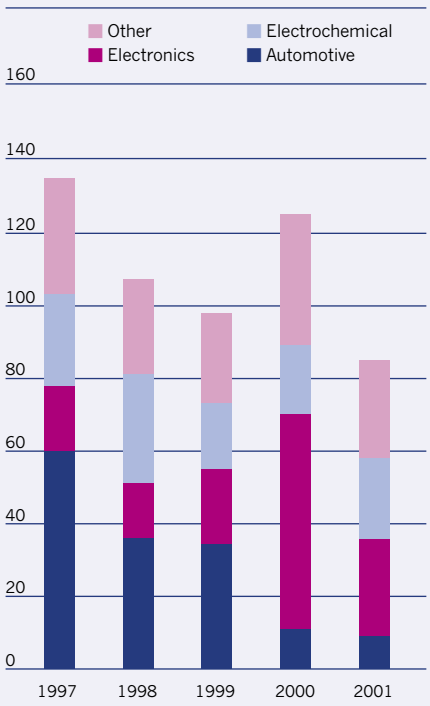
	2000	2001
Chemical	79	61
Electrochemical	97	92
Electronics	233	134
Other	36	62
Total Demand	**445**	**349**

Iridium Demand by Application
'000 oz

	2000	2001
Automotive	11	9
Electrochemical	19	22
Electronics	59	27
Other	36	28
Total Demand	**125**	**86**

Demand for Iridium 1997-2001

'000 oz



sharp downturn in crucible sales. Demand for iridium in this sector halved in 2001 and is expected to fall again this year.

The electrochemical industry is also a significant consumer of both ruthenium and iridium. Both metals are required in coatings for electrodes used in the chloralkali process, which involves the electrolysis of brine to produce chlorine and caustic soda. During 2001, there was a small decline in demand for ruthenium, and a slight increase in consumption of iridium. This was largely due to a continued switch away from older mercury and diaphragm cells, which are associated with environmental problems, towards newer membrane technology. The latter type of plant uses electrodes with a lower ruthenium content but higher iridium loadings.

In recent years, demand for ruthenium and iridium in process catalysts has been enhanced by investment in plants using two new processes: the Kellogg Advanced Ammonia Process (KAAP), which produces ammonia using a ruthenium-based catalyst, and the Cativa process for the production of acetic acid using an iridium-ruthenium catalyst. However, there were no new Cativa or KAAP plants in 2001, although top-up metal was required for existing operations. This contributed to a decline in demand for both iridium and ruthenium from the process catalyst sector.

Both iridium and ruthenium are used in the auto sector. Ruthenium consumption is small, being confined to a limited number of spark plugs where it is used as a component of platinum alloys; this is expected to remain a very minor application. In contrast, demand for iridium in spark plugs is expanding; it has been used for some time by Japanese manufacturers, and iridium-tipped plugs are now also being fitted to some premium European and US models. It is claimed that iridium plugs show improved performance and durability compared with platinum based products, but their higher cost is likely to limit market penetration.

In recent years, substantial quantities of iridium have been used in autocatalysts for some gasoline direct injection models in Japan and Europe. However, the enforcement of stricter emissions limits in both regions is resulting in the phasing-out of this technology in favour of conventional platinum-based catalysts. Demand has fallen sharply and is expected eventually to disappear completely, although in the short term some iridium may continue to be used on models for sale in Asian markets with less stringent emissions legislation.

The jewellery sector consumes small amounts of iridium and ruthenium as components of platinum alloys. The use of such alloys is largely confined to the USA and Europe, with the two largest platinum jewellery markets, Japan and China, traditionally favouring palladium-containing alloys instead (see the special feature on page 28). Demand for iridium and ruthenium declined in 2001, in line with lower fabrication levels of platinum based jewellery in Western Europe and North America.

Among ruthenium's other applications, the most substantial is in ruthenium-titanium piping for offshore drilling and geothermal projects. There was a sharp increase in demand in 2001, and further growth is expected; most new projects of this type are expected to use ruthenium-containing alloys, which are more corrosion resistant and hence have a longer life than conventional steel-clad piping.

Other PGM Supplies

Supplies of rhodium fell by 21 per cent to 604,000 oz in 2001. There was a sharp dip in exports from Russia, which had made unusually heavy shipments in early 2000. Sales by Almaz in 2001 totalled 125,000 oz, less than half the previous year's level, with most of this metal being imported by the USA. Shipments from South Africa were also down slightly, at 452,000 oz. Although production increased, there was no repeat of the sales from producer stocks which added to supplies in 2000.

Supplies of ruthenium and iridium were reduced sharply in 2001, reflecting lower demand and prices. Although there was an increase in the output of both metals in South Africa, we believe that stocks of unsold metal grew.

Production of rhodium, ruthenium and iridium is expected to increase steadily over the next few years, principally due to the expansion of platinum mining in South Africa. Most new projects will exploit the UG2 reef, which contains higher concentrations of these metals than the Merensky Reef.

Prices & Futures Markets

Platinum

The platinum price reached $645 in January 2001, its highest level for almost 14 years. The rise was driven both by strong physical demand and the palladium price, which soared in reaction to actual and potential shortages of Russian metal. However, persistent selling by investors on TOCOM and funds on NYMEX pushed platinum down to $555 by early April.

From mid June the poor economic situation in Japan, the weakening US economy and the falling palladium price stimulated heavy selling of platinum futures. Consequently platinum dropped $160 in just two months, slipping under $430 in mid August and then hitting a low of $406 in October. A recovery began in late November as the US economic outlook started to improve, and market sentiment became more positive. This, coupled with talk in December of delayed Russian export quotas for 2002 plus steady physical demand, carried platinum up to $477 by the end of the year.

Platinum entered 2001 with a fix of $610 on **January** 2nd. A rush of physical buying, followed by speculation that Russian pgm export quotas would be delayed until February, pushed the price to $645 by mid month – its highest level since April 1987. Sentiment was buoyed by the palladium price soaring over $1,000 and by reports that General Motors expected to increase its platinum consumption in autocatalysts. However, funds and investors on NYMEX and TOCOM then moved to take profits and several rounds of selling eroded the price to $604 by the end of the month.

Selling on the New York and Tokyo exchanges continued into early **February** but was mitigated by good physical demand and platinum edged up to $608. Conflicting reports about when Russian pgm export quotas would be signed and a fall in the palladium price then triggered fund selling of platinum, dragging it down to $592 by the 13th. By the 28th, however, the closure of short positions and continued solid physical demand had moved the price up to $610.

Platinum slumped to $576 on the 5th of **March**, US funds selling platinum futures as the palladium price plunged. Consumer buying briefly lifted platinum back above $600 but anecdotal evidence of Russian spot sales pushed it down to $590 on the 15th. Faltering equity prices plus the weakening US economy then set off further fund selling. With palladium still sinking, strong consumer buying could not prevent platinum retreating to $563 on the 30th.

April started with funds going short in New York and platinum ended on the 2nd at $555. That, however, concluded a three week bout of selling. Driven by rising loco Zurich lease rates and physical demand, the price climbed over the next two weeks, peaking at $630 after Easter. It then softened as short-term lease rates (which had reached 35 per cent) began to abate and offers of Russian spot material were reported, platinum ending the month at $594.

As Russian sales dried up at the beginning of **May**, short covering was followed by investors re-establishing long positions on NYMEX and platinum advanced to $622. These gains, however, were quickly relinquished and platinum traded around $605 until the middle of the month. Further speculative purchasing and a rally in gold helped platinum climb to $622 on the 29th. The rise was short-lived as fund selling in the USA plus a strengthening of the yen against the dollar precipitated selling on TOCOM, and the price fell to $607.

Sales by the general public on TOCOM were reflected by a fall in London to $594 on **June** 1st and were followed by stop-loss liquidation of long positions in New York. After settling

Average PGM Prices in $ per oz

Average	Platinum	Palladium	Rhodium	Iridium	Ruthenium
2000	544.92	681.74	1,998.00	415.00	129.83
2001	529.02	603.25	1,603.89	413.01	132.11
Percentage Change	–3%	–12%	–20%	0%	2%

Platinum and palladium prices are averages of London am and pm fixings. Other pgm prices are averages of Johnson Matthey European base prices.

between $585-593 for a week, platinum spot sales grew and traders speculated that investor liquidation of long positions on TOCOM might be imminent. Market sentiment became bearish and the price slid to $574 on the 13th. Selling on the London fixings started to outweigh physical demand, while the slowing US economy and expectations of a further fall in Japanese demand added to the downward momentum. The price slipped to $558 at the close of the month.

The first half of **July** was unremarkable; physical demand counterbalanced moderate selling pressure and the price floated between $550-560. The market came to life on the 18th when Japanese investors, who had become unsettled by the poor short-term prospects for platinum demand, rushed to liquidate long positions. By the time the TOCOM daily price limit had been reached, over 100,000 oz of platinum futures had been sold by the general public. US funds subsequently closed out long positions on NYMEX and the price dropped over $25 to end the day at $520.

Further heavy selling by US funds and Japanese investors had depressed the London fix to $490 by the 30th. On the 31st TOCOM again went limit down, and with little interest from industrial buyers, platinum fixed at $476 having fallen over $80 in 12 days of trading.

Thin trade between $470-480 marked the first days of **August**. Between the 6th and the 8th, however, Japanese investors resumed their liquidation of long positions, selling heavily as pessimism about the outlook for demand grew. This, tied to a dearth of physical buying, pushed platinum down to a 19 month low of $433 on the 9th. The belief that most substantial long positions on TOCOM had been eliminated then helped the price rebound to over $450 but a second bout of selling on TOCOM caused a fall to $422 on the 16th.

A new Russian presidential decree (No.742) covering trade in precious metals and gemstones became effective on the 25th and briefly caused a hiatus in pgm exports. The regulation stipulates that the State Assay Chamber must certify shipments prior to export. However, the necessary administration had not been implemented in time, and exports were subsequently held up in customs. This triggered dealer short covering and lifted platinum over $460.

On the 29th, however, Japanese importers reported that Russian pgm were still being delivered under annual contracts and concern eased. The poor short-term prognosis for the Japanese economy then triggered another round of selling on TOCOM, and the price subsided to $446 on the 31st. During August almost 3 million contracts were traded on the Japanese exchange, equivalent to over 47 million oz of platinum.

The metal traded in a tight $440-446 range until 11th **September,** with just light physical sales. Platinum made small gains in London in the immediate aftermath of the terrorist attacks on the USA, stepping up to $455 on the 12th. A more significant rally started on the 14th when continuing delays to Russian shipments (compounded by the disruption to air traffic) led to a run of borrowing, and short-term lease rates rose to 16 per cent – the London fix climbed almost $20 to $474 as a result.

Platinum Prices in 2001

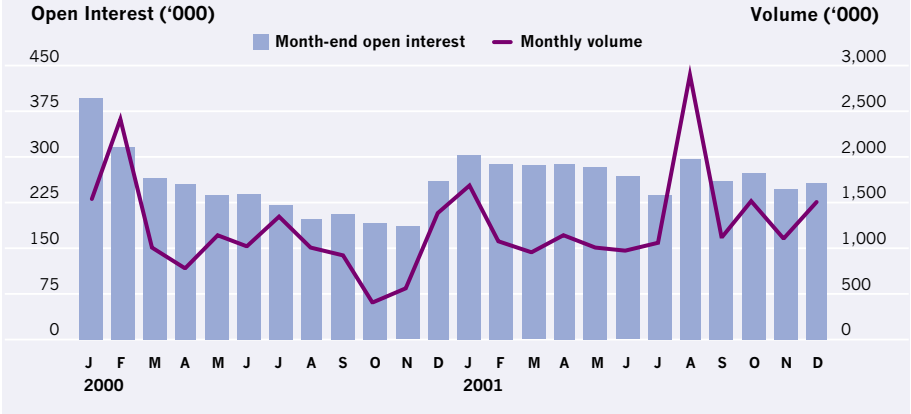
London am and pm fixings

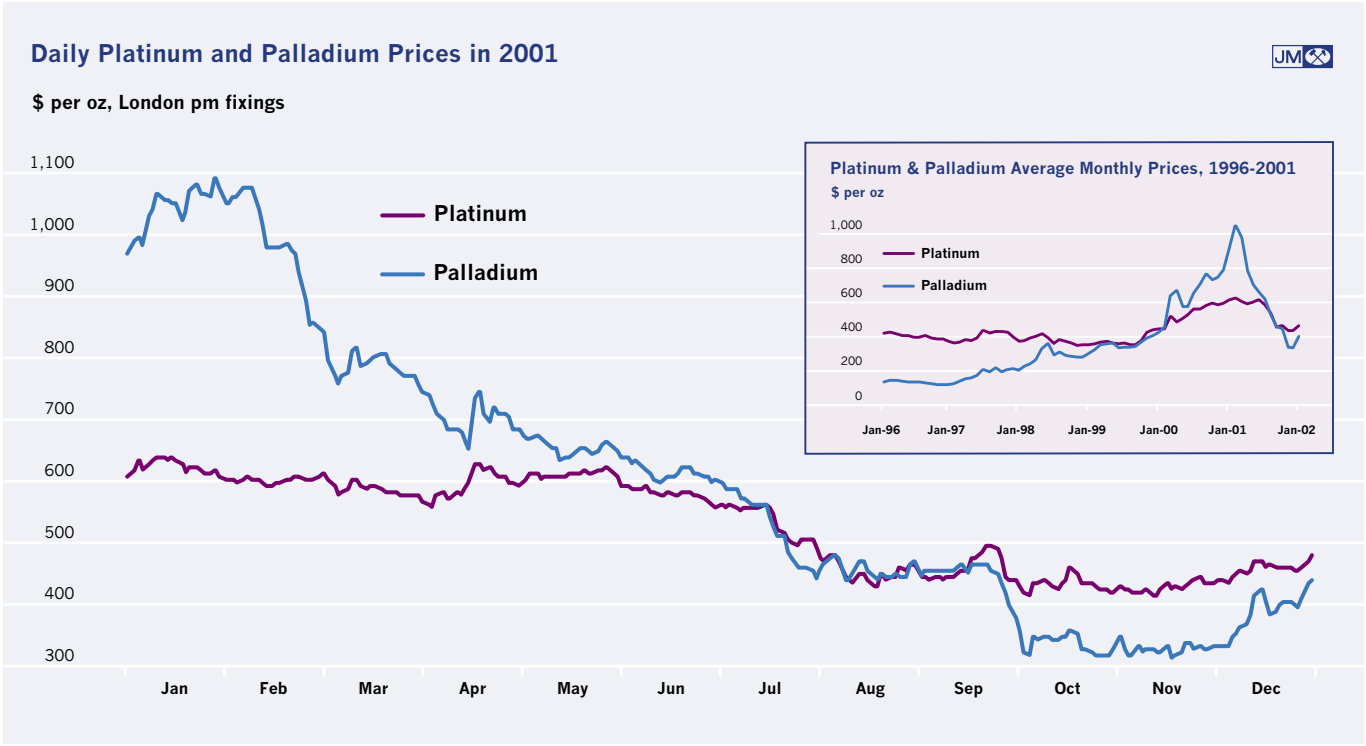
$ per oz	High	Low	Average
Jan	645.00	602.00	621.51
Feb	613.00	592.00	601.20
Mar	609.00	563.00	584.99
Apr	630.00	555.00	594.87
May	622.00	598.00	609.95
Jun	596.00	558.00	579.42
Jul	560.00	473.00	531.38
Aug	482.00	422.00	451.31
Sep	495.00	429.00	458.13
Oct	462.00	406.00	431.67
Nov	443.00	416.00	429.61
Dec	480.00	450.50	461.33

Platinum reached the month's high of $495 on the 20th before growing expectations of a significant slowdown in the US economy and talk of Russian sales in London triggered a plunge to $447 on the 25th. Investor selling on TOCOM, in response to deepening concern about the Japanese economy, then reduced the price to $429 at the month end.

Platinum slid to the year's low of $406 on the 2nd **October** after TOCOM futures fell by the daily price limit. A rise in loco Zurich short-term lease rates to over 25 per cent tugged the price sharply higher to $446 on the 5th, and after

TOCOM Platinum Futures Contracts in 2000 & 2001





easing somewhat, another run of borrowing pushed one-month lease rates back towards 30 per cent. This sparked short covering on TOCOM, boosting platinum to $462 on the 15th. Profit taking, falling lease rates and heavy selling in London then weakened the market. The price fell smartly to $436 on the 17th and drifted downwards to end October at $423.

The market was balanced in the first week of **November**, trading around $420. Firm physical demand pushed platinum up to $434 in London on the 12th, before a plane crash in New York caused the NYMEX January contract to spike to $450 that afternoon. The crash, however, was not attributed to an act of terrorism and platinum shuffled back to $424 on the 13th. After several quiet days, a strengthening of the dollar against the yen caused short covering on TOCOM and London fixed at $443 on the 21st. The market edged under $440 before improving sentiment about the economic prospects for 2002 carried platinum back to $443 on the 30th.

The positive sentiment flowed into **December**. Rising equities, better than expected US car sales, and rallies in silver and palladium lifted platinum to $470 by the 10th. Russian sales and a downturn in palladium then undermined the market somewhat but solid industrial and jewellery demand kept the metal above $450. From $454 on the 20th, platinum climbed towards the end of the year. Rumours about delays to Russian export quotas for 2002 elevated the price to $470 on the 27th and platinum ended 2001 with a fix of $477.

Palladium

The delayed approval of Russian pgm export quotas and an illiquid market propelled palladium to a record London fix of $1,094 in January 2001. However, a combination of weakening industrial demand, particularly from the automobile and electronics sectors, and persistent offers of physical metal then produced a collapse, the price slumping to $315 by early October.

The market began a cautious rally in November as the lack of Russian spot sales, which had been suspended since August, began to have an effect. With sentiment about 2002 becoming more positive, palladium climbed to end the year at $440. Activity on NYMEX and TOCOM was very limited during the year; only 117,000 contracts were traded on the Japanese exchange.

With little physical metal available in **January**, the palladium price jumped from the year's opening fix of $965 to breach $1,000 on the 8th in thin trading. Rising lease rates and rumours of delays to the approval of Russian pgm export quotas boosted the price to a new high of $1,085 on the 11th. Following a dip for profit taking, industrial buying helped the metal to a record peak of $1,094 on the 26th, a premium of almost $480 to platinum. Light selling followed and palladium faded to $1,050 on the 31st.

On the 8th of **February** the price dropped to $1,040 as rumours circulated that Russian export quotas would be signed shortly. Offers of spot material lowered the price to $975 over the next three days, with most traders identifying Russia as the source of the sales (Norilsk

Nickel, the world's dominant producer, holds a 10 year export licence for palladium and so is not dependent on the annual quota negotiations). Consumer interest supported the metal around $975 between the 12th and the 19th but then further spot sales in London on the 21st started a slide that would last virtually uninterrupted until October. The price fell to $935 at the afternoon fix, dropped under $900 the following day, and then ended the month at $839 after heavy fund selling.

Spot sales continued to act as a dead weight in **March**. The price sank under $800 on the 1st and tumbled to a four month low of $750 on the 5th. Again, the consensus amongst traders was that the palladium entering the market was being sold on behalf of Russian interests. There was a short rebound as selling evaporated, palladium briefly touching $860 on NYMEX, but physical metal returned to the market from the 20th onwards. The volumes offered, although small, were not easily absorbed and the price retreated to end March at $738.

In early **April** the volume of physical sales increased, precipitating a further fall in price. The London fix dropped below $700 on the 4th and sank to $650 on the 12th. On the 17th, a dealer that had been a leading seller of physical metal started buying instead, causing a rebound on the London fixings. Traders interpreted this as an attempt to support the palladium price above $650. The sudden lack of physical metal in the market started a rapid rally, which was fuelled by some frantic short covering. The spot price jumped above $700 and the afternoon fix reached $735. The spike peaked at $765 on the morning of the 18th but then quickly subsided. A different seller began offering material on the fixings, buying fell away, and the price slid back under $700 by the 20th. With evident physical availability and weakening demand, palladium drifted down to $682 on the 30th.

The first eight days of **May** were very quiet – light selling was balanced by physical demand and the price settled between $670-675. It softened to $652 on the 11th before an influx of metal on to the London fixings caused a sudden drop to $630 on the 14th. The remainder of the month was uneventful: with only small volumes offered in London, palladium traded in a $640-660 range.

Moderate physical sales and a lack of buying meant a lacklustre **June**; by the 13th the price had dropped below $600. Industrial buyers were attracted back at this level and palladium rose to $620 on the 20th. The downward momentum resumed on the 22nd with further small physical volumes offered persistently on the London fixings; the price slipped under $600 again on the 28th.

Palladium Prices in 2001

London am and pm fixings

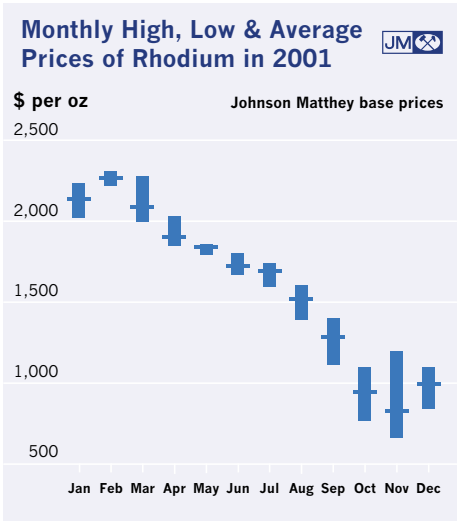
$ per oz	High	Low	Average
Jan	1,094.00	965.00	1,040.75
Feb	1,081.00	839.00	973.43
Mar	828.00	735.00	780.86
Apr	765.00	650.00	697.21
May	675.00	630.00	654.98
Jun	645.00	594.00	613.92
Jul	598.00	438.00	525.30
Aug	485.00	438.00	455.18
Sep	466.00	360.00	444.15
Oct	360.00	315.00	335.24
Nov	347.00	315.00	328.65
Dec	440.00	355.00	399.25

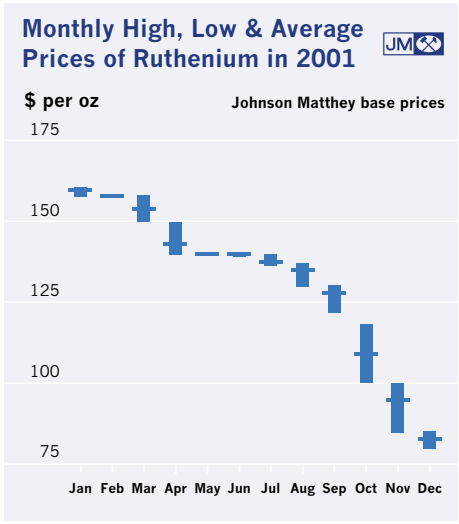
JM

TOCOM Palladium Futures Contracts in 2000 & 2001

By the 13th **July** palladium had subsided to $559 in subdued trading. Thereafter, the descent accelerated as physical metal from a variety of sources fed a market from which consumers were almost completely absent. Russian sales were joined by offers from Japanese traders as they sought to dispose of excess stocks, which had accumulated due to the weakness of domestic demand. Palladium slid to $543 on the 16th – a discount to platinum for the first time since May 2000 – and dropped below $500 by the 20th. With minimal buying and continued offers of physical metal, palladium hit an 18 month low of $438 on the morning of the 31st, a drop of $160 in a month. Short covering then provided a fillip, the price moving up to $457 that afternoon.

Palladium recovered to $485 on the 3rd of **August** as the persistent selling waned and buying interest returned. However, it dropped sharply to $438 on the 7th as the platinum price plunged. On the 9th, news emerged that Norilsk Nickel intended to limit spot sales to help boost the price and the company subsequently withdrew from the spot market. The announcement fuelled a rebound to $475 but the price soon





retreated to trade between $440-460 for much of the remainder of the month.

For the first three weeks of **September** the market was almost comatose, fixing in the narrow range $450-466 between the 1st and the 21st. The price started to fall again from the 24th, following platinum down, and forceful selling on the afternoon London fix on the 26th caused a slump to $400. Even at this level industrial demand remained weak and offers of small volumes were sufficient to weigh the price down to $360 on the 28th.

Palladium hit $315 on the 2nd **October**, its lowest price for over two years, as sales of physical metal continued. Russian officials attributed the sales to US consumers reducing stocks, but some traders claimed that Russian material was also entering the market. Industrial buyers returned at this level and the price rebounded to $349 as dealers covered short positions.

After fluctuating between $340-360 until the 17th, palladium slipped backwards, in tandem with platinum, to end on the 22nd at $317. Almaz, Russia's pgm marketing agency, caused the fix to jump to $346.50 on the 29th by saying that it would not return to the spot market until prices recovered. But the rally evaporated rapidly and the price slid to $320 on the 31st.

The market touched $315 again at the first fix of **November**, then firmed to $331 on the 2nd as reports suggested that Russian palladium spot sales might not resume until mid 2002. For much of the rest of the month trading was very quiet around $330. The final two days of the month saw palladium progress to $347 following a platinum rally, albeit on small trading volumes.

Palladium advanced by over $80 in **December** on the back of modest industrial buying and the absence of Russian spot sales. From an opening fix of $355 on the 3rd, the price climbed to $423 on the 10th. Sentiment was helped by rising base metal prices and an improvement in some equity markets. Profit taking knocked palladium back to $383 on the 12th and it traded close to $400 until just before Christmas. Reports that delays in issuing 2002 Russian pgm export quotas were likely surfaced on the 24th and this speculation lifted palladium to $440 at the year's final fix.

Other PGM

A lack of Russian sales boosted rhodium to a six month high of $2,300 in February 2001. Russian metal reappeared on the market from March onwards, and with industrial demand weak the price fell to $675 by mid November. Consumer buying returned at this level and helped rhodium recover to $950 at year end. With demand faltering and supply ample, the ruthenium price fell to $80 during 2001. Process catalyst and electronic demand for iridium weakened during the year, and the price softened slightly in response.

A shortage of Russian metal pushed the Johnson Matthey rhodium base price from $2,025 at the beginning of January to a high of $2,300 in late February. Russian sales resumed in March, however, and by the end of April the price had retreated below $2,000. With continued offers of metal from Almaz during the traditionally quiet summer months and reduced purchases by auto companies, rhodium was trading at a 20 month low of $1,125 by the end of September.

In October and early November the market struggled to absorb more rhodium from Russia and the price sank to $675, its lowest level since the end of 1998. Russian sales then abated and consumer interest returned, causing a rebound to $1,250 on the 27th November. Further selling saw the price to slip back to $850 by the 20th December, before the possibility of delays to Russian exports during early 2002 resulted in a moderate rally to $950.

Over the course of 2001 ruthenium lost almost all of the gains made the previous year. Trading was quiet during the first six months of the year, the Johnson Matthey base price easing from $160 in January to $140 in June. Long liquidation by speculators and weak demand for ruthenium-based electronic components such as resistors resulted in the decline accelerating in the second half, the price touching $100 by the end of October and ending the year at $80.

The downturn in the electronics industry in 2001 (particularly the mobile phone sector) also reduced demand for iridium crucibles. The fall in demand was reflected in the JM base price, which faded from $415 to $395 in November.

Supply and Demand Tables

Notes to tables

Supply figures are estimates of sales by the mines of primary pgm.

With the exception of the autocatalyst sector, **demand** estimates are net figures, demand in each sector being total purchases by consumers less any sales back to the market. Thus, annual totals represent the amount of primary metal that is acquired by consumers in a particular year.

From 1993, demand numbers for **Europe** include an estimate of net consumption in the former COMECON countries of eastern Europe. From 1996, consumption in China is incorporated into our figures for the **Rest of the World** region. We continue to exclude the CIS from our demand estimates.

Movements in stocks in a given year reflect changes in stocks held by fabricators, dealers, banks and depositories but excluding stocks held by primary refiners and final consumers. A positive figure indicates an increase in stocks; a negative figure indicates a rundown in stocks.

Gross autocatalyst demand is purchases of pgm by the auto industry for manufacture of catalytic converters. **Autocatalyst recovery** is pgm recovered from scrapped catalytic converters and is allocated to the region in which the converter was scrapped.

Investment: small refers to the long-term holding of metal in the form of coins, and bars weighing 10 oz or less. **Investment: large** is in the form of 500 g and 1 kg bars in Japan and includes platinum held on account for subscribers to accumulation plans.

Platinum Supply and Demand

'000 oz	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Supply										
South Africa	2,750	3,360	3,160	3,370	3,390	3,700	3,680	3,900	3,800	**4,100**
Russia	750	680	1,010	1,280	1,220	900	1,300	540	1,100	**1,300**
North America	200	220	220	240	240	240	285	270	285	**350**
Others	120	130	140	100	130	120	135	160	105	**110**
Total Supply	**3,820**	**4,390**	**4,530**	**4,990**	**4,980**	**4,960**	**5,400**	**4,870**	**5,290**	**5,860**
Demand By Application										
Autocatalyst: gross	1,550	1,685	1,870	1,850	1,880	1,830	1,800	1,610	1,890	**2,520**
recovery	(230)	(255)	(290)	(320)	(350)	(370)	(405)	(420)	(470)	**(520)**
Chemical	215	180	190	215	230	235	280	320	295	**290**
Electrical	165	165	185	240	275	305	300	370	455	**385**
Glass	80	80	160	225	255	265	220	200	255	**285**
Investment: small	145	125	155	75	110	180	210	90	40	**50**
large	110	180	240	270	130	60	105	90	(100)	**30**
Jewellery	1,510	1,615	1,740	1,810	1,990	2,160	2,430	2,880	2,830	**2,550**
Petroleum	120	105	90	120	185	170	125	115	110	**125**
Other	150	165	190	225	255	295	305	335	375	**435**
	3,815	**4,045**	**4,530**	**4,710**	**4,960**	**5,130**	**5,370**	**5,590**	**5,680**	**6,150**
Western Sales to China	0	20	50	130	-	-	-	-	-	-
Total Demand	**3,815**	**4,065**	**4,580**	**4,840**	**4,960**	**5,130**	**5,370**	**5,590**	**5,680**	**6,150**
Movements in Stocks	5	325	(50)	150	20	(170)	30	(720)	(390)	**(290)**
	3,820	**4,390**	**4,530**	**4,990**	**4,980**	**4,960**	**5,400**	**4,870**	**5,290**	**5,860**
Demand By Region										
Europe	860	895	935	880	840	875	910	995	1,150	**1,490**
Japan	1,870	1,975	2,145	2,215	2,005	1,885	1,795	1,820	1,410	**1,250**
North America	705	760	940	1,015	1,180	1,250	1,325	1,080	1,225	**1,285**
Rest of the World	380	415	510	600	935	1,120	1,340	1,695	1,895	**2,125**
	3,815	**4,045**	**4,530**	**4,710**	**4,960**	**5,130**	**5,370**	**5,590**	**5,680**	**6,150**
Western Sales to China	0	20	50	130	-	-	-	-	-	-
Total Demand	**3,815**	**4,065**	**4,580**	**4,840**	**4,960**	**5,130**	**5,370**	**5,590**	**5,680**	**6,150**

Platinum Demand by Application: Regions

'000 oz	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Europe										
Autocatalyst: gross	575	610	605	560	515	510	545	560	680	**1,055**
recovery	(5)	(5)	(10)	(15)	(20)	(25)	(30)	(30)	(40)	**(55)**
Chemical	50	40	50	55	60	70	60	80	100	**105**
Electrical	30	20	25	25	25	45	45	70	80	**65**
Glass	15	15	30	35	40	20	25	20	20	**15**
Investment: small	35	25	45	10	5	5	5	5	0	**0**
Jewellery	85	105	100	120	125	150	160	185	190	**170**
Petroleum	20	25	25	15	15	15	15	15	15	**15**
Other	55	60	65	75	75	85	85	90	105	**120**
Totals	**860**	**895**	**935**	**880**	**840**	**875**	**910**	**995**	**1,150**	**1,490**
Japan										
Autocatalyst: gross	350	320	290	270	245	255	240	250	290	**345**
recovery	(45)	(50)	(45)	(40)	(50)	(50)	(55)	(60)	(60)	**(70)**
Chemical	20	15	15	20	20	20	20	20	20	**20**
Electrical	50	45	45	45	45	65	55	75	90	**80**
Glass	20	30	80	105	80	85	80	65	65	**85**
Investment: small	40	55	40	35	25	25	25	20	5	**5**
large	110	180	240	270	130	60	105	90	(100)	**30**
Jewellery	1,290	1,350	1,450	1,480	1,480	1,390	1,290	1,320	1,060	**710**
Petroleum	10	10	5	5	5	5	5	5	5	**5**
Other	25	20	25	25	25	30	30	35	35	**40**
Totals	**1,870**	**1,975**	**2,145**	**2,215**	**2,005**	**1,885**	**1,795**	**1,820**	**1,410**	**1,250**
North America										
Autocatalyst: gross	525	600	790	820	850	800	775	535	620	**790**
recovery	(180)	(200)	(230)	(260)	(275)	(290)	(310)	(315)	(350)	**(370)**
Chemical	90	75	65	70	80	80	80	95	100	**100**
Electrical	55	65	75	115	130	100	105	120	145	**120**
Glass	15	15	20	25	30	45	20	25	50	**30**
Investment: small	65	40	65	25	75	145	175	60	35	**45**
Jewellery	35	45	55	65	90	160	270	330	380	**280**
Petroleum	35	40	5	40	60	50	40	40	35	**40**
Other	65	80	95	115	140	160	170	190	210	**250**
Totals	**705**	**760**	**940**	**1,015**	**1,180**	**1,250**	**1,325**	**1,080**	**1,225**	**1,285**
Rest of the World										
Autocatalyst: gross	100	155	185	200	270	265	240	265	300	**330**
recovery	0	0	(5)	(5)	(5)	(5)	(10)	(15)	(20)	**(25)**
Chemical	55	50	60	70	70	65	120	125	75	**65**
Electrical	30	35	40	55	75	95	95	105	140	**120**
Glass	30	20	30	60	105	115	95	90	120	**155**
Investment: small	5	5	5	5	5	5	5	5	0	**0**
Jewellery	100	115	135	145	295	460	710	1,045	1,200	**1,390**
Petroleum	55	30	55	60	105	100	65	55	55	**65**
Other	5	5	5	10	15	20	20	20	25	**25**
Totals	**380**	**415**	**510**	**600**	**935**	**1,120**	**1,340**	**1,695**	**1,895**	**2,125**

Palladium Supply and Demand

'000 oz	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Supply										
South Africa	1,260	1,395	1,500	1,600	1,690	1,810	1,820	1,870	1,860	**2,010**
Russia	2,100	2,400	3,300	4,200	5,600	4,800	5,800	5,400	5,200	**4,340**
North America	450	415	410	470	455	545	660	630	635	**850**
Others	70	70	70	70	95	95	120	160	105	**120**
Total Supply	**3,880**	**4,280**	**5,280**	**6,340**	**7,840**	**7,250**	**8,400**	**8,060**	**7,800**	**7,320**
Demand By Application										
Autocatalyst: gross	490	705	975	1,800	2,360	3,200	4,890	5,880	5,640	**5,110**
recovery	(95)	(100)	(105)	(110)	(145)	(160)	(175)	(195)	(230)	**(290)**
Chemical	205	190	185	210	240	240	230	240	255	**235**
Dental	1,195	1,210	1,265	1,290	1,320	1,350	1,230	1,110	820	**670**
Electronics	1,830	2,015	2,230	2,620	2,020	2,550	2,075	1,990	2,160	**700**
Jewellery	205	210	205	200	215	260	235	235	255	**240**
Other	60	35	115	110	140	140	115	110	60	**65**
Total Demand	**3,890**	**4,265**	**4,870**	**6,120**	**6,150**	**7,580**	**8,600**	**9,370**	**8,960**	**6,730**
Movements in Stocks	(10)	15	410	220	1,690	(330)	(200)	(1,310)	(1,160)	**590**
	3,880	**4,280**	**5,280**	**6,340**	**7,840**	**7,250**	**8,400**	**8,060**	**7,800**	**7,320**
Demand By Region										
Europe	675	680	885	1,340	1,525	1,840	1,985	2,095	2,410	**2,000**
Japan	1,780	1,990	2,200	2,445	1,885	2,350	2,215	2,205	2,105	**1,330**
North America	1,155	1,295	1,430	1,960	2,185	2,675	3,690	4,255	3,445	**2,570**
Rest of the World	280	300	355	375	555	715	710	815	1,000	**830**
Total Demand	**3,890**	**4,265**	**4,870**	**6,120**	**6,150**	**7,580**	**8,600**	**9,370**	**8,960**	**6,730**

Palladium Demand by Application: Regions

'000 oz	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Europe										
Autocatalyst: gross	40	115	260	650	860	1,100	1,370	1,530	1,900	**1,730**
recovery	0	0	0	0	(5)	(5)	(5)	(10)	(15)	**(25)**
Chemical	75	65	60	65	65	70	65	65	95	**65**
Dental	300	265	255	250	255	260	210	180	100	**40**
Electronics	210	210	255	325	300	340	270	255	265	**135**
Jewellery	35	35	30	30	30	50	50	50	45	**35**
Other	15	(10)	25	20	20	25	25	25	20	**20**
Totals	**675**	**680**	**885**	**1,340**	**1,525**	**1,840**	**1,985**	**2,095**	**2,410**	**2,000**
Japan										
Autocatalyst: gross	85	90	125	145	180	245	480	600	510	**505**
recovery	(35)	(30)	(30)	(25)	(30)	(45)	(50)	(55)	(50)	**(55)**
Chemical	20	20	20	20	20	20	20	20	20	**20**
Dental	450	500	550	580	600	620	590	545	470	**430**
Electronics	1,130	1,280	1,400	1,600	990	1,390	1,060	980	990	**280**
Jewellery	120	120	120	115	115	110	105	105	150	**140**
Other	10	10	15	10	10	10	10	10	15	**10**
Totals	**1,780**	**1,990**	**2,200**	**2,445**	**1,885**	**2,350**	**2,215**	**2,205**	**2,105**	**1,330**
North America										
Autocatalyst: gross	320	450	525	950	1,230	1,680	2,820	3,490	2,805	**2,390**
recovery	(60)	(70)	(75)	(85)	(110)	(105)	(115)	(125)	(155)	**(200)**
Chemical	65	65	60	70	70	70	70	75	65	**75**
Dental	400	400	410	410	410	415	390	350	230	**190**
Electronics	405	420	450	545	490	550	460	405	485	**90**
Jewellery	0	5	5	5	5	10	10	10	10	**10**
Other	25	25	55	65	90	55	55	50	5	**15**
Totals	**1,155**	**1,295**	**1,430**	**1,960**	**2,185**	**2,675**	**3,690**	**4,255**	**3,445**	**2,570**
Rest of the World										
Autocatalyst: gross	45	50	65	55	90	175	220	260	425	**485**
recovery	0	0	0	0	0	(5)	(5)	(5)	(10)	**(10)**
Chemical	45	40	45	55	85	80	75	80	75	**75**
Dental	45	45	50	50	55	55	40	35	20	**10**
Electronics	85	105	125	150	240	270	285	350	420	**195**
Jewellery	50	50	50	50	65	90	70	70	50	**55**
Other	10	10	20	15	20	50	25	25	20	**20**
Totals	**280**	**300**	**355**	**375**	**555**	**715**	**710**	**815**	**1,000**	**830**

Rhodium Supply and Demand

'000 oz	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Supply										
South Africa	278	278	330	342	359	377	400	410	457	**452**
Russia	80	80	80	80	110	240	110	65	290	**125**
North America	19	17	15	13	5	16	16	18	17	**23**
Others	1	1	1	1	2	3	4	8	3	**4**
Total Supply	**378**	**376**	**426**	**436**	**476**	**636**	**530**	**501**	**767**	**604**
Demand By Application										
Autocatalyst: gross	305	356	379	464	424	418	483	509	793	**566**
recovery	(22)	(25)	(34)	(37)	(45)	(49)	(57)	(65)	(79)	**(92)**
Chemical	18	11	10	13	21	36	31	34	39	**44**
Electrical	7	9	8	8	9	9	6	6	7	**6**
Glass	7	3	14	17	53	43	34	35	42	**39**
Other	13	12	11	9	9	10	10	9	10	**11**
Total Demand	**328**	**366**	**388**	**474**	**471**	**467**	**507**	**528**	**812**	**574**
Movements in Stocks	50	10	38	(38)	5	169	23	(27)	(45)	**30**
	378	**376**	**426**	**436**	**476**	**636**	**530**	**501**	**767**	**604**
Demand By Region										
Europe	119	127	129	139	154	165	175	178	199	**202**
Japan	63	68	68	59	64	70	75	84	153	**104**
North America	110	127	139	224	170	137	177	167	332	**133**
Rest of the World	36	44	52	52	83	95	80	99	128	**135**
Total Demand	**328**	**366**	**388**	**474**	**471**	**467**	**507**	**528**	**812**	**574**

Glossary

g	grams
kg	kilograms
tonne	1,000 kg
tons	short tons (2,000 pounds or 907 kg)
oz	ounces troy
pgm	platinum group metals
ppt	parts per thousand
prices	all prices quoted are per oz unless otherwise stated
R	South African rand
$	US dollars
¥	Japanese yen
Almaz	Almazjuvelirexport, the pgm marketing agency of the Russian Federation
CO	carbon monoxide
DLA	US Defense Logistics Agency
GDP	gross domestic product
HC	hydrocarbons
HIC	hybrid integrated circuit
JEA	Japanese Environment Agency
LCD	liquid crystal display
LEV	Low Emissions Vehicle
Merensky, UG2, Platreef	platiniferous orebodies in South Africa
MLCC	multi-layer ceramic capacitor
NOx	oxides of nitrogen
NYMEX	New York Mercantile Exchange
PEM	proton exchange membrane
PET	polyethylene terephthalate
PM	particulate matter
PTA	purified terephthalic acid
TOCOM	Tokyo Commodity Exchange
ULEV	Ultra Low Emissions Vehicle
VAM	vinyl acetate monomer
ZEV	Zero Emissions Vehicle

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