



Supplies

Supplies, Mining and Exploration

South Africa

South African platinum production increased to 4.45 million oz in 2002, an increase of 8.5 per cent (350,000 oz) compared with the previous year. All the major producers increased output, both through improvements at existing mines and the development of new operations. Shipments of palladium from South Africa rose by 7.5 per cent to 2.16 million oz, while sales of rhodium grew 7.3 per cent to 485,000 oz.

Anglo Platinum

Anglo Platinum's production of refined platinum increased by 6.7 per cent in 2002 to 2.25 million oz, 100,000 oz less than the group originally intended. Much of the increase came in the second half of the year as new projects began delivering increased volumes of concentrate. Output of refined palladium for the year rose 6 per cent to 1.11 million oz, and rhodium production increased to 211,700 oz.

At the group's Rustenburg section platinum output declined by 9 per cent to 655,500 oz but this was mainly a result of the incorporation of the Brakspruit, Bleskop and Paardekraal shafts into the Rustenburg UG2 Phase 1 project. At Amandelbult, head grades and concentrator recoveries improved and platinum output rose by 5 per cent to 711,000 oz.

In the first half of the year, a drop in mill head grade resulting from a low-grade intrusion in the south pit at Potgietersrust led to a 22 per cent fall in refined platinum output to 165,000 oz. An accelerated stripping programme, additional production from a new mini-pit, and completion of the Ga-Pila village relocation resulted in an increase in available ore reserves by year-end. Union Section maintained production levels and work focussed on upgrading infrastructure and increasing available ore reserves, while production, head grade and concentrator recovery all increased at Lebowa.

Refined platinum output at the Bafokeng Rasimone Platinum Mine climbed to 162,000 oz as stope development increased and mining efficiencies improved. Production commenced at the Rustenburg UG2 Phase 1 project and concentrator throughput built up rapidly through the year, yielding 145,000 oz of platinum. The concentrator at the Modikwa joint venture was also commissioned and the mine produced a total of 25,000 oz of platinum (*further details of this and other developing projects are given in*

the special feature on page 14). Downstream, Anglo Platinum completed construction of a new smelter at Polokwane. This will process concentrate from the group's new mines on the eastern limb of the Bushveld Igneous Complex, as well as taking concentrate from Lebowa and PPRust.

Impala Platinum

In 2002, the volume of ore milled at the Impala lease area increased by 5 per cent to 15.2 million tonnes, and refined platinum production rose 7 per cent to 1.063 million oz. In the longer term, to maintain output from the area at 1 million oz of platinum per annum, Impala is planning to construct a new R5 billion shaft. This will be capable of delivering over 0.5 million tonnes of ore per year from 2008 onwards to replace declining output from other areas of the Impala lease.

Impala Platinum intends to increase refined platinum output (including metal from bought-in concentrate and toll refining) to 2 million oz per annum by 2006. An expansion of refining capacity to 1.65 million oz platinum per annum has been completed and a study has been initiated to evaluate a further increase to 2.5 million oz per annum.

At the Crocodile River mine, in which Impala owns an 83 per cent interest, the volume of ore milled in 2002 fell by 23 per cent to 613,000 tonnes. Production of platinum in concentrate totalled a little over 33,600 oz. Extensive geological problems slowed development underground and had an adverse impact on face availability and output. In February 2003 Impala announced that an evaluation of the long-term viability of the mine had begun, and a decision on its future is expected by the end of June 2003.

At Impala's Marula project on the Eastern Bushveld, plant construction and mine development started in August and September 2002 respectively. Stockpiles of development ore from the UG2 reef are being built up in anticipation of the start of plant commissioning in September 2003.

During 2002, Impala increased its equity interests in Zimbabwean platinum producers. Impala now holds 50 per cent of ZCE Platinum (Aquarius Platinum holds the other 50 per cent) and has a 36 per cent direct interest in Zimplats. Impala already owned a 30 per cent direct interest in Makwiro Platinum, the Zimplats subsidiary that operates the Ngezi mine and Selous Metallurgical complex. Impala refines concentrate from both the ZCE and Zimplats operations.

| PGM Supplies: South Africa '000 oz | | |
|---------------------------------------|-------|-------|
| | 2001 | 2002 |
| Platinum | 4,100 | 4,450 |
| Palladium | 2,010 | 2,160 |
| Rhodium | 452 | 485 |
| | | |



Supplies

The expansion of platinum mining in South Africa

A period of unprecedented growth

The South African platinum industry is currently expanding at an unprecedented rate in order to meet projected increases in demand. With the exception of Northam, all existing producers have ambitious expansion plans. They will be joined by several new entrants as the South African government's policy of black economic empowerment leads to the greater involvement of black-led companies in the platinum mining sector, mainly in the form of joint ventures with existing producers. Additional investment is also expected from non-South African companies, such as the UK's Cluff Mining and Canada's SouthernEra.

As a result of this expansion activity, platinum output is set to rise substantially over the next four years. If all new projects reach their targets, refined production from South African platinum mines could be as high as 6.3 million oz in 2006, with Anglo Platinum alone reaching an annual production rate of 3.5 million oz.

The changing focus of platinum mining

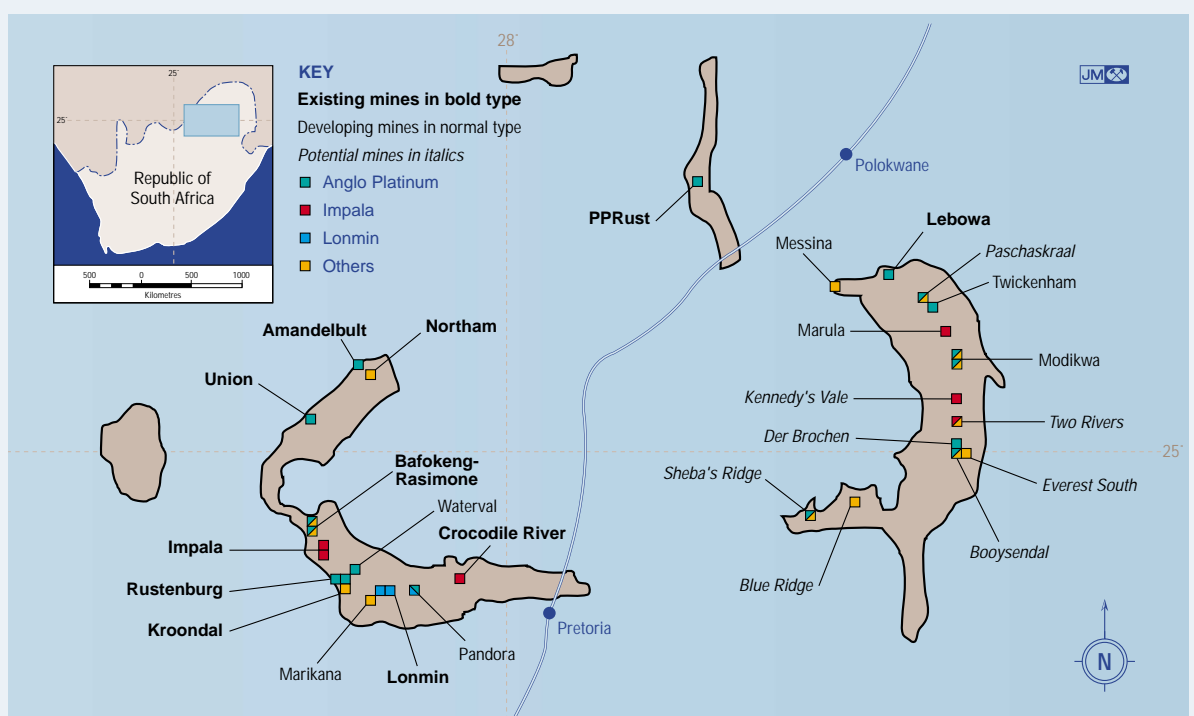
Traditionally, platinum mining in South Africa has been concentrated on Merensky Reef reserves hosted by the western limb of the Bushveld Igneous Complex. The Merensky Reef has been the main source of ore because it generally has a higher pgm content than the UG2 and, because of its lower chromite content, is also easier to process. However, as much of the shallow Merensky ore on the western Bushveld has now been extracted, most of the proposed new projects will mine UG2 reserves.

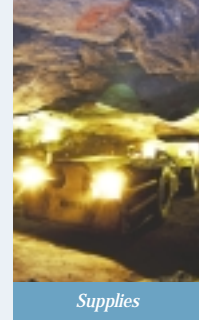
In 1998 – before the most recent phase of expansions – the UG2 reef accounted for around 38 per cent of the ore processed by South African platinum mines. By 2002, that proportion had risen above 50 per cent and in 2006 we expect UG2 to account for over 60 per cent of the total ore processed.

The Merensky Reef reserves on the western Bushveld were exploited in preference to those on the more remote eastern limb because grades in the west tend to be higher and access and infrastructure was easier to develop. However, higher platinum prices, the prospect of rising demand, and above all the depletion of the most attractive ore reserves on the western Bushveld have begun to offset these disadvantages. The eastern limb accounted for a mere 6 per cent of platinum production in 2002; by 2006, that proportion will be around 18 per cent and by the end of this decade, could be as high as 30 per cent.

These developments have important implications for the production of other pgm, especially palladium and rhodium. Assuming all the proposed expansions are successful, platinum output will rise by over 40 per cent between 2002 and 2006, but palladium and rhodium output will each increase by over 60 per cent. Ruthenium and iridium output will also increase significantly. Compared with the Merensky Reef, the UG2 contains a higher proportion of minor pgm, particularly rhodium and ruthenium, while the UG2 in some parts of the eastern Bushveld contains unusually high concentrations of palladium (in some places, exceeding the platinum grade) – see charts opposite.

Schematic map indicating the Bushveld Complex and showing the approximate locations of actual and potential platinum mines





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The western Bushveld: near-term additions to production

Despite increased investment on the eastern limb, development is also continuing on the western Bushveld; in fact, in the short term, most additions to platinum production will come from projects in this area. The existing infrastructure means that expansions can often be brought on stream very quickly. For example, Phase 1 of Anglo Platinum's Rustenburg UG2 project was able to source ore through the redevelopment of existing Merensky Reef shafts. This enabled the project to reach production just 17 months after the decision to develop the mine had been announced. On the eastern limb, the construction of new mines and the build-up of production will generally be much slower.

Anglo Platinum is engaged in a number of other expansion projects on the western Bushveld, including a doubling of capacity at its Bafokeng Rasimone Platinum Mine. This project, which involves the Royal Bafokeng Nation as a 50 per cent joint venture partner, should add 230,000 oz of platinum to the mine's annual capacity.

In November 2002, Anglo Platinum announced a tailings retreatment project at Rustenburg, which will produce an average of 120,000 oz of platinum annually over its 15 year life, and a month later the group confirmed that it would proceed with Phase 2 of its Rustenburg UG2 project. This will involve a doubling of concentrator capacity to 800,000 tonnes of ore per month, and will generate an additional 306,000 oz of platinum annually (although this will be offset by declining output from the Merensky Reef at the Rustenburg Section).

Lonmin is also expanding its existing mines on the western limb, with the aim of lifting platinum production to over 1 million oz per annum (this will include the company's share of output from the Pandora joint venture with Anglo Platinum). In October 2002 Lonmin commissioned two new 120,000 tonne per month concentrators; these will initially be used to process ore from newly developed open pits, and later to concentrate material from underground operations at the Karee mine and the Pandora joint venture. The latter is planned to mine some 320,000 tonnes of UG2 ore per month, yielding 230,000 oz of platinum per annum, when it reaches full production in 2007.

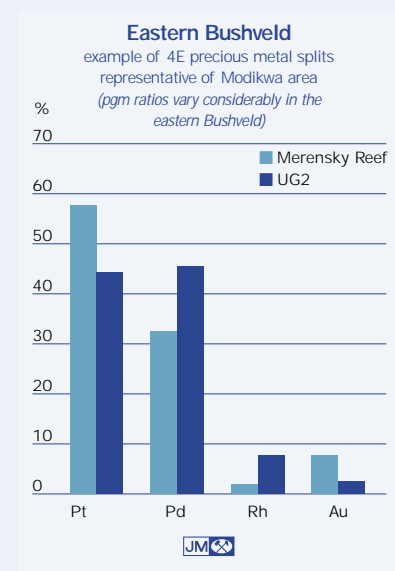
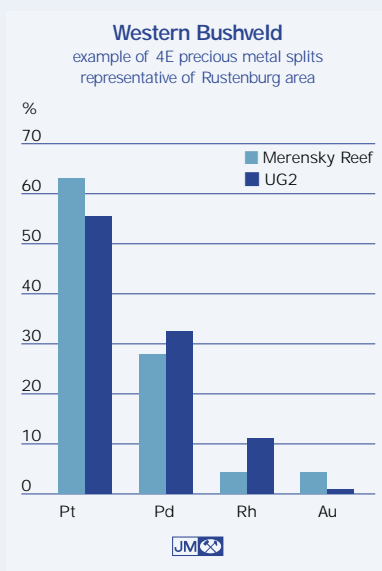
Impala's ability to grow output from its existing lease area is relatively limited. However, the company is considering investing in a new concentrator circuit to increase UG2 milling capacity and is also evaluating a tailings reprocessing project. These projects could help to lift annual platinum output from the Impala lease area to over 1.1 million oz per annum.

Towards the end of 2002, Aquarius Platinum brought the Marikana platinum mine into production following a very rapid construction and commissioning schedule. This is the company's second operation on the western limb, joining the Kroondal mine



The Marikana mine is one of several projects contributing to rising pgm production on the western Bushveld.

An aerial view of the Modikwa mine in the middle of the eastern Bushveld.





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Decline development at Impala's Marula mine, which is scheduled to produce 103,000 oz of platinum per year.



10 km to the west. The Marikana UG2 concentrator has a milling capacity of 128,000 tonnes per month, which will yield 95,000 oz of platinum in concentrate annually. The project will make its first significant contribution to platinum supplies this year.

New horizons: projects on the eastern Bushveld

Until 2001, Anglo Platinum's small Lebowa operation was the only active platinum mine on the eastern limb of the Bushveld (not counting PPRust on the northern extension). It was joined in 2001 by SouthernEra's redevelopment of the mothballed Messina mine, and in 2002 by the start of Anglo Platinum's Modikwa project, a joint venture with a black empowerment consortium led by African Rainbow Minerals.

The Messina project was partly developed in the early 1990s, but low pgm prices led to the operation being placed on care and maintenance in 1992. The Canadian company SouthernEra acquired the mine in March 2000 and limited pgm production began in 2001 from the Voorspoed section. Last year the company announced a decision to expand Phase 1 of the project by 50 per cent to 120,000 tonnes of ore per month; this is expected to yield around 95,000 oz of platinum per annum when full production is reached in 2005.

A second phase of development is currently in the advanced stages of planning; this will involve a further increase in production

via the exploitation of resources on the farm Doornvlei, about 12 km east of the Voorspoed shaft. A third stage of expansion is also proposed that could encompass reserves on the Dwaalkop properties, which lie between Voorspoed and Doornvlei. Prospecting rights for this section were granted to a joint venture between SouthernEra and Mvelaphanda Resources in August 2002.

Modikwa is the most advanced of Anglo Platinum's suite of projects on the eastern Bushveld. The mine made its first contribution to platinum supplies last year, and output should increase rapidly in 2003. The concentrator reached its design throughput rate of 200,000 tonnes per month in September 2002, initially milling relatively low-grade ore from underground development and early stoping operations. The head grade should improve substantially this year and full production of 162,000 oz of platinum per annum is expected during 2004.

Anglo Platinum also began construction of the first decline at the new Twickenham mine in mid-2002. Sinking of a second shaft commenced in February 2003, and a 250,000 tonne per month concentrator plant is scheduled for commissioning in 2005. Full production of 160,000 oz of platinum and 176,000 oz of palladium should be achieved two years later.

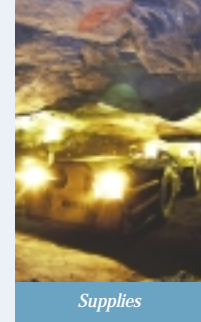
The Der Brochen project is likely to be the next of the group's eastern limb projects to proceed. A feasibility study is due to be completed in 2003 and the mine is scheduled for commissioning in 2006. Anglo Platinum also has two proposed joint ventures adjacent to the Twickenham and Der Brochen project areas. These will be stand-alone operations, with ownership split 50:50 between Anglo Platinum and black empowerment groupings. The latter will contribute some mineral rights to the joint ventures, which were granted by the government in August 2002. The Booyensdal project is located immediately south of Der Brochen, while Paschaskraal fills the gap between Lebowa and Twickenham (*see map*). No formal announcement of the scope of these projects has been made, but they are all likely to be substantial operations, similar in size to the Modikwa mine.

Impala is also undertaking a major project on the eastern Bushveld – the Marula platinum mine – in which it holds an 80 per cent interest. The remainder is split evenly between Mmakau Mining and a community-based empowerment consortium. Mine development began in September 2002 and stockpiles of development ore are being accumulated in anticipation of the start of concentrator commissioning in October 2003. Full mill throughput is planned for March 2004, with steady state production of 103,000 oz of platinum per annum from August of that year.

A second possible phase of development at Marula would involve an increase in the volume of UG2 ore mined and would lift platinum production to about 190,000 oz per annum. This could be undertaken about two years after Phase 1 is completed. A third phase would see Impala develop the Merensky Reef, which is

Sinking of the second shaft at Anglo Platinum's Twickenham project began with this blast in February 2003.





Legislation leads the changes

Two pieces of South African legislation enacted over the past year have been instrumental in opening up opportunities for new companies to enter the South African pgm industry.

The Mineral and Petroleum Resources Development Bill (the Minerals Bill) was enacted in October 2002 and resulted in the control of mineral rights being transferred from the private sector to the state. A key aim of the bill was to broaden ownership of mineral rights and to expand opportunities for 'historically disadvantaged South Africans' (HDSAs) to participate in the mining industry. To this end, the legislation introduced the principle of 'use it or lose it' to prospecting and mining rights that had previously been granted. This resulted in significant packages of prospecting rights that had no record of recent or current

exploration being relinquished by their previous owners to the government, many of them in advance of the legislation. Some of these were subsequently then put up for tender.

October 2002 also saw the publication of the Broad Based Socio-Economic Empowerment Charter for the Mining and Minerals Industry (the 'Mining Charter'). One of the key elements of this legislation is that mining companies have to provide for HDSA participation in the industry. Targets of 15 per cent HDSA ownership of equity or attributable production within 5 years and 26 per cent within 10 years have been set. This has encouraged the formation of joint ventures between established platinum producers and black economic empowerment groups to develop new pgm mines on the Bushveld Igneous Complex.

vertically separated from the UG2 by about 400 metres. This has the potential to more than double platinum output at Marula to around 400,000 oz per annum but is unlikely to go ahead before the end of this decade.

Another project that is likely to contribute to platinum production within the next two years is Aquarius Platinum's Everest South. This is immediately east of the Booyensdal project area, in a location where a "bulge" in the UG2 has produced a small stand-alone deposit east of the normal path of the reef. During 2002, Aquarius undertook a feasibility study, including trial mining operations. The project is expected to be given the formal go-ahead during 2003 and to enter production about 12 months from the start of development. It will have a milling rate of 250,000 tonnes per month, generating around 135,000 oz of platinum annually.

Other projects on the eastern Bushveld are less advanced and are unlikely to add to platinum supplies before the second half of this decade. The Two Rivers project, immediately north of Anglo Platinum's Der Brochen project, is a joint venture between Anglovaal Mining, Impala, and a black empowerment consortium. It is currently at the feasibility study stage, and a formal decision to proceed is expected this year. At a milling rate of 175,000 tonnes of UG2 ore per month, annual output of platinum would be around 113,000 oz.

Other potential future producers include the mothballed Kennedy's Vale mine, in which Impala owns an 83 per cent stake via its holding in Barplats. The operation has an existing partly developed vertical shaft to a depth of 900 metres. Impala is currently evaluating the feasibility of redeveloping the mine to extract the UG2 reef using mechanised methods.

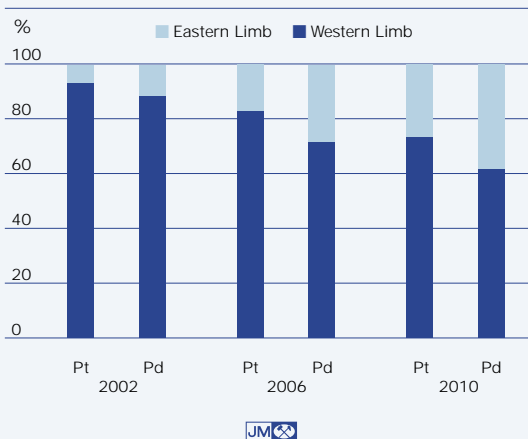
The UK company Cluff Mining has two active projects on the southern section of the eastern limb (in addition to other projects at a less advanced stage of exploration elsewhere on the Bushveld).

Drilling at Blue Ridge West has enabled the company to outline a resource of 39 million tonnes of UG2 ore at a grade of 3.1 grams per tonne. A feasibility study is due to be completed in the second quarter of 2003, and this envisages a mine producing around 105,000 oz of platinum per annum.

Cluff is also currently undertaking a second phase of exploration at the Sheba's Ridge project, to the west of Blue Ridge, in a joint venture with Anglo Platinum. The area has a complex geology: previous drilling discovered five pgm-bearing reefs, including layers similar to the Merensky Reef, UG2 and Platreef.

A number of other companies are also exploring the pgm potential of properties on the Bushveld Complex, some through joint venture agreements with Anglo Platinum and Impala. Most of these projects, however, are at a very early stage of exploration.

The Changing Profile of PGM Production Across the Bushveld Complex





Supplies

Lonmin

Lonmin produced a total of 757,450 oz of refined platinum in the year to the end of September 2002, the increase of 6 per cent over the previous 12 months reflecting a rise in the tonnage of ore milled. The company intends to be producing 1 million oz per year of refined platinum by 2008. As part of this long-term development programme, two new 120,000 tonne per month concentrators were brought on stream in October 2002 (see page 15 for details).

In March 2002, Lonmin commissioned a large new smelter at its Western Platinum operations to replace the existing furnaces. However, in December the smelter's furnace suffered an explosion, resulting in significant damage. Subsequently, the older Merensky furnace and three Pyromet furnaces (which process UG2 ore) were re-commissioned and a proportion of concentrate is being sent to Impala for toll refining. The accident caused Lonmin to restate its planned platinum output for the 2003 financial year as being not less than 840,000 oz, compared to the previous target of 870,000 oz. Nevertheless, this would represent an 11 per cent increase on 2002. The smelter is due be brought back on line towards the end of 2003.

During 2002 the South African competition authorities gave permission for the Pandora joint venture between Anglo Platinum and Lonmin to proceed. Northam Platinum and the Bapo Ba Mogale Tribe will acquire minority interests in the venture to satisfy the Black Economic Empowerment requirements of the South African Mining Charter.

In December 2002, Viking Platinum LLC signed a deal to supply Lonmin's Western Platinum operations with spent catalytic converter material. The deal allows for a build up in deliveries from March 2003 onwards, starting at a rate of 3,500 oz per month of contained pgm, rising to 8,500 oz per month.

In Western Australia, Lonmin decided not to advance its option to acquire a 50 per cent interest in the Munni Munni platinum project but continued to help fund development work on the Panton Sill project, owned by Platinum Australia Ltd. Testing of a cyanide leach process began in January 2003.

Northam

The volume of ore milled by Northam increased by 11 per cent to 2.2 million tonnes in 2002, yielding almost 315,000 oz of pgm in concentrate. The year-on-year increase was due in part to a 32-day strike in 2001. The proportion of UG2 milled (which generally has a lower grade than the Merensky Reef) increased to around 31 per cent, up from 26 per cent, but despite this there was an overall improvement in head grade.

Northam initiated a programme of accelerated development of Merensky Reef reserves to improve face availability during 2002, which increased mining flexibility. This programme will continue throughout 2003 and should lead to a further small increase in pgm production this year. In March 2003, the company successfully re-commissioned its on-mine smelter after a planned furnace re-build.

Aquarius Platinum

Production of platinum in concentrate at Aquarius Platinum's Kroondal mine increased by 18 per cent to 134,000 oz and palladium output rose 13 per cent to 60,000 oz in 2002. The higher pgm output resulted from a plant expansion commissioned the previous year.

Production of pgm would have been higher still had Aquarius not encountered an area of increased potholing and faulting in the Kroondal mine during the second half of the year. This had a deleterious impact on mining performance, grade and recoveries. The company expects the problems to have been largely overcome by the end of the second quarter of 2003 through increased mine development.

At the Marikana mine, plant commissioning took place six weeks ahead of schedule in November 2002, and 2,243 oz of pgm in concentrate were produced by the end of the year. The full production rate of

Flotation cells at the processing plant that serves Aquarius Platinum's Marikana mine. The plant was commissioned in November 2002.





155,000 oz of pgm per annum from the current open pit operations is expected during the third quarter of 2003.

A feasibility study into the Everest South project, including trial mining and bulk sample testing was completed in January this year. Subject to the results of the study, underground mining is expected to start in 2004 and at full production the project should yield around 220,000 oz of pgm per annum.

SouthernEra

At SouthernEra's majority owned Messina mine, 2002 saw completion of the main shaft to the 425 metre level, and construction and commissioning of the Voorspoed concentrator. This, together with a smaller existing concentrator, gives the operation a capacity of 120,000 tonnes per month. Ore production, which started to build during the final quarter of the year, is expected to reach 80,000 tonnes per month during the third quarter of 2003, and should achieve capacity during the second quarter of 2004. A programme to deepen the shaft to 730 metres has been initiated.

SouthernEra also concluded a 50:50 joint venture agreement with Mvelaphanda Resources covering the Dwaalkop properties, mineral rights to which were awarded to the partners in August 2002. These rights lie between the current Messina Phase 1 (Voorspoed) leases and the planned Phase 2 of development on ground held by SouthernEra to the east (Doornvlei section). A feasibility study on developing the Doornvlei resource was completed during 2002 and envisages a second 120,000 tonne per month mine reaching full production in 2005. The company is now considering how best to incorporate the Dwaalkop resource into its development plans.

Other Projects in South Africa

Details on other pgm development projects are given in the special feature that starts on page 14. The other existing source of pgm in South Africa is the Nkomati nickel mine in Mpumalanga province operated by Anglovaal Mining (Avmin). This produces in the region of 35,000 oz of pgm per annum. A feasibility study on an expansion programme that would result in nickel output increasing by three to four times the current rate of production was completed in 2002. This would also have the effect of substantially raising by-product pgm output. Mining authorisation and environmental applications have been submitted but Avmin is also examining alternative production scenarios.

Russia

Sales of palladium by Russia in 2002 are estimated to have fallen by 56 per cent to 1.93 million oz as Norilsk Nickel remained out of the spot market. Shipments of platinum and rhodium also fell, by around a quarter, to 980,000 oz and 90,000 oz respectively.

Norilsk Nickel suspended spot sales of palladium in August 2001 and therefore entered 2002 with a significant stockpile of unsold metal. The company maintained its absence from the spot market throughout most of 2002, although it continued to ship some metal under existing supply contracts. In May, Norimmet, its marketing arm in London, gained the right to sell palladium independently of state pgm export agency Almaz (although Almaz remains the only organisation legally entitled to export pgm from Russia), and began to pursue long-term contracts for the supply of metal to various consumers. Norilsk has stated that it intends to market the majority of its palladium in future through long-term contracts, although it will continue to make spot sales of platinum and rhodium.

A significant portion of Norilsk's annual output of palladium, perhaps equivalent to about six months of production, was used last year to repay a long-standing loan from the Ministry of Finance. The loan, which dated from 1994, was repaid by a transfer of palladium to the state treasury Gokhran. This must have accounted for a large part of the stockpile of unsold metal dating from August 2001. In addition, Norilsk's proposed acquisition of a majority stake in Stillwater Mining involved the deposition of 877,000 oz of palladium in a London vault by early March 2003, against part payment of the share purchase. This, together with the repayment of the government loan, must have drawn Norilsk's residual stock of palladium down to a low level.

Gokhran itself has stated that it did not sell any palladium from state inventories in 2002, citing an agreement with Norilsk to restrict supplies to the market in the face of declining prices. The position of the other significant Russian holder of palladium, the Central Bank, is less clear. The Bank is believed to hold metal in Switzerland and may well have sold some of this stock in 2002.

During the year Norilsk continued to invest in its mining and processing facilities in northern Siberia and the Kola Peninsula. The largest expenditures were on

| PGM Supplies: Russia '000 oz | | |
|---------------------------------|-------|-------|
| | 2001 | 2002 |
| Platinum | 1,300 | 980 |
| Palladium | 4,340 | 1,930 |
| Rhodium | 125 | 90 |





Supplies



Part of the primary milling circuit at the Norilsk-Talnakh operations.

the Taimyrskiy and Skalistiy mines at Talnakh, and the development of the Pelyatka gas field which supplies the Norilsk-Talnakh operations.

In March 2003 the Board of Directors of Norilsk Nickel approved a 'Production Plan to 2015'. Although details of the plan have not been released, especially of the pgm aspects, it was made clear that the emphasis was on increasing production efficiencies and reducing costs, and not on expansion of mine output. In contrast with statements made in 2000 and 2001, when the palladium price was rising sharply, it was noted that pgm production would remain approximately constant. However, pgm output could be increased by processing stored pyrrhotite and other concentrates if justified by market fundamentals.

For the first time, the two major alluvial platinum producers in the Far East of Russia, Kondyor and Koryak, were allocated export quotas for their metal in 2002. Production at these operations has, however, declined in recent years as their deposits have become progressively depleted and both appear to be putting more emphasis on the exploitation of gold deposits in Khabarovsk and Kamchatka respectively.

North America

Supplies of platinum from North American mines climbed by 10 per cent in 2002 to 395,000 oz, and palladium shipments jumped by 16 per cent to 990,000 oz. Production of pgm at North American Palladium and Stillwater Mining increased as a result of recent expansion programmes, whilst Inco boosted its by-product platinum and palladium output by mining small but pgm-rich nickel ore bodies.

Canada

In 2002, North American Palladium's Lac des Iles mine processed 4.85 million tonnes of ore with a palladium head grade of 1.91 grams per tonne, yielding 219,325 oz of palladium in concentrate. This was an increase of 72 per cent compared to the previous year – a result of the major expansion of the mill and concentrator circuits completed in June 2001 and of improvements in head grade and recoveries. Platinum production in 2002 totalled 19,180 oz.

In September 2002 the operation's primary crusher had to be taken out of service for unexpected repairs. This affected both mill throughput and feed grade. The crusher was brought back into service in December

but proved to be unreliable and a new primary crusher has been purchased. This is due to be operational by the middle of 2003; the company will continue to use contract crushing equipment until that time.

The nickel operations of Inco Limited produced a record 431,000 oz of by-product pgm in 2002, a rise of 6.4 per cent over the previous year (405,000 oz). Refined platinum output reached 189,000 oz, while palladium production climbed to 224,000 oz.

Inco's pgm output of more than 400,000 oz in both 2001 and 2002 was largely a result of the company's decision in the late 1990s to aggressively explore for and develop pgm-rich ore bodies around its existing mines, and to bring these rapidly into production to benefit from strong pgm prices. A small high-pgm grade ore body – the 138 zone – at its Copper Cliff North mine in Ontario was the source of substantial volumes of pgm-rich concentrate during the past two years.

In 2003, the company forecasts that overall pgm production will decline to 355,000 oz as the 138 zone nears depletion. Inco, however intends to bring pgm production back up to an annualised rate of 400,000 oz per annum by the end of the year. Exploration and definition drilling of other pgm-rich ore bodies have been accelerated, and nickel and copper separation in its matte processing plant will be improved, which will further reduce in-process inventories of pgm.

Output of by-product pgm from Falconbridge's Canadian nickel mines and from purchased feed eased back in 2002. Scheduled shutdowns and a shortage of mine and custom feed meant that its Nikkelverk refinery in Norway operated below capacity, and deliveries of pgm for the year as a whole declined. However, by the fourth quarter the supply of concentrates to the refinery had increased and it established a new quarterly pgm production record.

In common with Inco, Falconbridge has stepped up its exploration for new nickel deposits with a significant pgm content in the Sudbury Basin. During 2002 the total inferred resource at its Nickel Rim South prospect was increased to 6.3 million tonnes of ore averaging 1.7 per cent nickel, 3.4 per cent copper, 2.2 grams per tonne platinum and 2.5 grams per tonne palladium. A decision on whether to proceed with an underground exploration programme will be made in 2003.

During 2002, FNX Mining Company embarked on an extensive exploration programme of five Sudbury Basin properties, located around sites of former mines, which have been optioned from Inco. FNX has been



successful in delineating significant nickel-copper and copper-nickel-pgm resources at all of the sites, and plans to develop several ore bodies at the McCreedy West property during 2003. This is subject to approvals from Inco (which holds a 20 per cent interest in FNX and will process all concentrate from the company) and to receipt of government production permits.

First production is planned from a small, high-grade ore body, the 700 zone, which comprises a resource of 139,000 tonnes averaging 6.1 per cent copper, 0.81 per cent nickel and around 5.6 grams per tonne platinum, palladium plus gold. This will be mined at an initial rate of 200 tonnes per day.

USA

Stillwater Mining Company produced 476,000 oz of palladium and 141,000 oz of platinum in 2002, a 22 per cent increase from 2001. The Stillwater mine produced approximately 491,700 oz of pgm – less than the 504,000 oz produced the previous year due to a decline in head grades. The East Boulder mine produced approximately 125,600 oz of pgm in what was its first full year of production.

Stillwater's total pgm output of 617,000 oz was 3.5 per cent lower than forecast by the company in September 2002. In addition to the poorer ore grades in the upper west part of the Stillwater mine, industrial relations difficulties and disruptions caused by increased health and safety enforcement activity contributed to the shortfall. The company has forecast total pgm production of 615,000 oz in 2003, of which 450,000 oz will be produced by the Stillwater mine and 165,000 oz by East Boulder. Ore output at the Stillwater mine will be reduced but mining will focus on a higher grade ore zone during the year.

In November 2002, Stillwater Mining and Norilsk Nickel jointly announced that a deal had been agreed whereby Stillwater will issue 45.5 million new shares to Norilsk, giving the Russian company a 51 per cent equity stake. Norilsk will pay for the shareholding with \$100 million in cash and 877,000 oz of palladium. Stillwater plans to sell the palladium under new long-term contracts; the metal is not intended to be sold in lieu of production from the company's mines.

Should the deal be concluded, Norilsk Nickel will also offer to acquire up to 10 per cent of the remaining outstanding shares of Stillwater, which could increase its ownership to 56 per cent. The two companies will also negotiate an agreement under which Stillwater

will purchase large volumes of palladium per year from Norilsk and market the metal to its customers.

The two companies received a request for further information from the US Federal Trade Commission in January 2003. Regulatory assessment was continuing at the time of writing and the deal was also still subject to approval by Stillwater's existing shareholders.

Zimbabwe

The expansion of the Zimbabwean pgm mining sector accelerated sharply in 2002. As development programmes at both the Mimosa and Ngezi mines progressed, platinum and palladium output increased almost five-fold to around 130,000 oz.

Expansion of the Mimosa joint venture between Impala and Aquarius Platinum accelerated during the second half of 2002. An expanded crushing circuit was brought on stream in the third quarter, followed by commissioning of a new concentrator. Production of pgm in the final quarter of the year reached 10,410 oz, an increase of 30 per cent on the same period in 2001. Expansion of the underground mine continued into 2003, with the full production rate of 4,760 tonnes per day expected in May. Once recoveries have been optimised, pgm output will total 135,000 oz per annum, of which around 65,000 oz will be platinum.

Opencast mining at Zimplats' 70 per cent owned Ngezi operation began in late 2001 and the ramp up of production continued in 2002. By the first quarter of 2003 the mill had achieved a processing rate of 6,000 tonnes per day of ore. The Selous metallurgical plant produced just less than 119,000 oz of pgm plus gold during 2002, containing around 55,000 oz platinum.

Trial underground mining at Ngezi started in September 2002 with the aim of proving the suitability of mechanised mining and assessing the geological conditions in detail. The increased level of geological knowledge has allowed Zimplats to upgrade an additional 34 million oz of pgm resources to reserves. Underground mining is expected to have a significantly lower cost per tonne compared to mining deeper portions of the planned open pit.

Output of pgm plus gold at Ngezi is expected to total 168,000 oz in the financial year ending June 2003, rising to 195,000 oz the following financial year. A feasibility study on the potential expansion of the mine to 400,000 oz pgm plus gold per annum is due to be completed by December 2003.

| PGM Supplies: North America '000 oz | | |
|--|------|------|
| | 2001 | 2002 |
| Platinum | 360 | 395 |
| Palladium | 850 | 990 |
| Rhodium | 23 | 28 |
| | | |

| PGM Supplies: Zimbabwe & Others '000 oz | | |
|--|------|------|
| | 2001 | 2002 |
| Platinum | 100 | 145 |
| Palladium | 120 | 170 |
| Rhodium | 4 | 9 |
| | | |