The outlook for PGM supplies:

New mines and expansions in North America and Zimbabwe

While there is no question that South Africa and, to a lesser extent, Russia will continue to dominate world pgm production for the foreseeable future, high prices are encouraging the development of pgm mining in other countries. Expansions are currently underway at North America's two primary pgm producers, North American Palladium and Stillwater, while the possibility of significant pgm production in Zimbabwe has been revived with the recent announcement of funding for Zimplats' Ngezi project. New mines and expansions in Canada, the USA and Zimbabwe could add over 800,000 oz of palladium and 350,000 oz of platinum to annual pgm production by the middle of this decade.

Canada

In Canada, pgm have traditionally been produced as by-products of nickel and copper mining by Inco and Falconbridge. As recently as the 1940s, the nickel deposits of the Sudbury Basin were the world's largest single source of pgm, and these deposits still produce substantial amounts of metal – around 350,000 oz of platinum, palladium and rhodium in 2000. Palladium typically accounts for 55-60 per cent of the pgm content of the Sudbury ores, with the remainder mainly platinum; the rhodium content is small.

Since the mid 1990s, fluctuations in nickel and copper prices have encouraged some rationalisation of mining at Sudbury, leading to the closure of several of Inco's lower-grade, higher-cost mines. However, this has had little impact on pgm output because the focus has shifted to mining areas of higher grade ore.

High pgm prices are likely to result in some increases in pgm output in future. In January 2001, Inco announced that it had discovered several zones of pgm-rich ore in the Sudbury region that could be mined from existing mining infrastructure. It has already started mining a small deposit at the Copper Cliff North Mine, which is reported to contain 300,000 tonnes of ore with an exceptionally high grade of over 16 grams of pgm per tonne. Other discoveries include those at Totten and Kelly Lake, where pgm grades are estimated to be 4.8 and 3.6 grams per tonne respectively.

Another significant source of by-product pgm is Falconbridge's Raglan mine on the Ungava peninsula in the far north of Quebec. An expansion was completed last year, and should lead to higher output from Raglan in 2001. The processing pipeline for Raglan's ores is particularly long, because concentrate from the mine has to be transported by ship from the remote mine site to the company's smelter at Sudbury; the pgm are then sent for refining in Norway. The palladium:platinum ratio in Raglan's ore is thought to be about 3:1.

It was not until 1993 that primary pgm production began in Canada on a significant scale, at the Lac des Iles operation now owned by North American Palladium. This is essentially a palladium mine: the ore contains only around one ounce of platinum for every ten ounces of palladium, while the rhodium content is negligible. The Lac des Iles deposit is one of several pgm occurrences in the area, and further exploration is being carried out by North American Palladium and other companies.

Although the average grade at Lac des Iles is relatively low, at less than 2 grams per tonne, the pgm are not confined to a narrow reef but occur throughout extensive areas of mineralisation. For example, the Roby Zone (the source of current production) is about one kilometre long, 815 metres wide and at least 650 metres deep. This makes it possible to mine the deposit using low-cost, open-cast, bulk mining techniques.

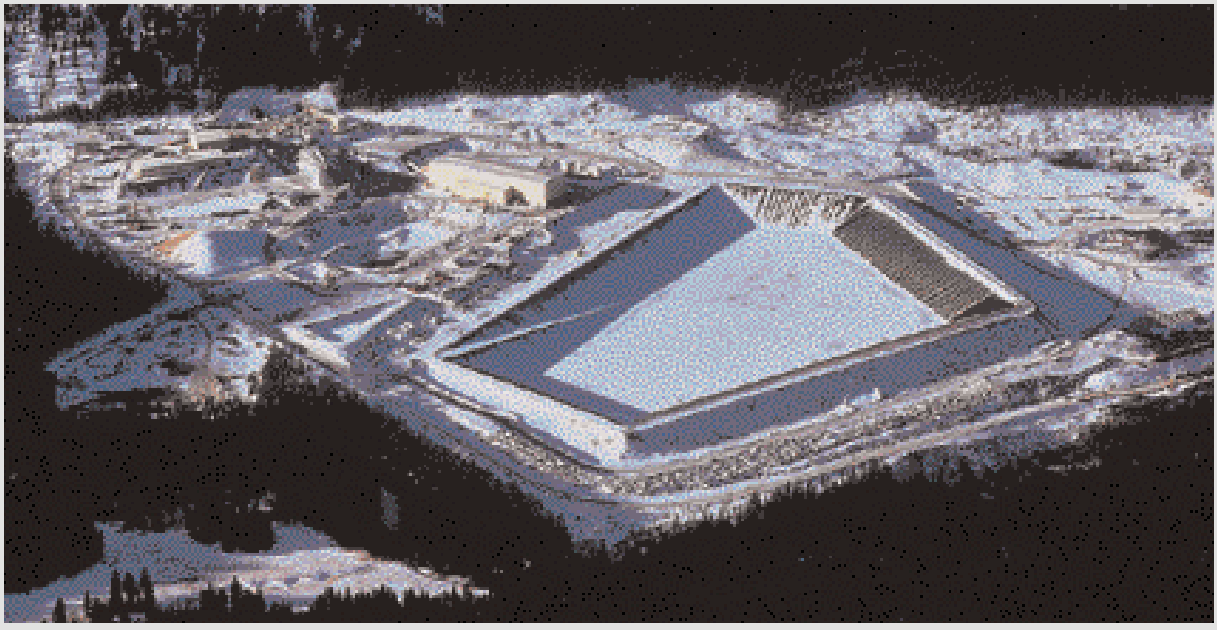
North American Palladium produced 95,000 oz of palladium last year, and is currently undertaking an expansion that is planned to take output to an average of 250,000 oz per annum. Initially, in 2002 and 2003, output is planned to be even higher as the mine will exploit a relatively rich zone of ore. Development of a new open pit commenced in mid 2000; ore has been stockpiled ahead of the commissioning of a 15,000 tonne per day mill, which is expected to start operations during the second quarter of 2001.

USA

The USA has only one primary pgm producer, the Stillwater Mining Company, which operates a mine at Nye in Montana. Stillwater exploits a pgm-bearing layer known as the J-M (Johns-Manville) reef, which is probably the richest deposit currently being exploited anywhere in the world. The mill head grade is typically between 0.65 and 0.7 oz per ton (equivalent to 22-24 grams per tonne), with a palladium:platinum ratio of just over 3:1.

Mining the J-M reef is challenging, because it dips steeply and has been partly eroded so that areas of high-grade ore are not continuous. This has made it difficult to mine large quantities of ore and, despite an ambitious expansion programme, mill throughput at Nye remains relatively modest – just under 700,000 tons in 2000, yielding 430,000 oz of pgm. Although last year saw an acceleration of underground development and the commissioning of additional ore conveying capacity, it is expected to take several years for the operation to reach its design rate of 3,000 tons per day. In September 2000, Stillwater announced a three year operating plan under which mill throughput at Nye will gradually increase to 2,800 tons per day by 2003. Refined pgm output is planned to rise from around 500,000 oz in 2001 to 665,000 oz in 2003.

Stillwater is also constructing a second pgm mine at East Boulder, about 18 miles from Nye. Last year, two tunnel-boring machines intersected the pgm-bearing J-M reef, and during the fourth quarter an initial drilling programme was undertaken in order to provide further information about the orebody. Construction of underground infrastructure is underway, and during 2001 the company plans to begin developing mineable ore reserves. At full production of 2,000 tons of ore per day, East Boulder should produce more than 400,000 oz of pgm annually.



Surface infrastructure at Stillwater's East Boulder project

Zimbabwe

Zimbabwe's Great Dyke has long been seen as a significant potential source of pgm but over the years a series of trial mines and one large project have all closed, leaving the small Mimosa mine as Zimbabwe's only primary pgm producer. The Hartley Platinum mine, which closed in June 1999, was the victim of unexpected geological problems and low mining productivity.

The Great Dyke is a geological feature running through the heart of Zimbabwe for about 550 kilometres in a roughly north-south direction. The pgm occur in a layer known as the Main Sulphide Zone, which is typically about 3 metres thick. However, the economic mining width may be as little as one metre, depending on grade, metal prices and the chosen mining method. The pgm content is lower than that of South African ores, with head grades generally below 4 grams per tonne, of which about 55 per cent is platinum. The reef can be difficult to mine, because it is not visible to the naked eye; this can lead to off-reef mining, which reduces head grades because of the dilution of ore with waste rock.

Although the political situation in Zimbabwe is delicate, the government has proposed a new, more favourable tax regime for platinum mines, intended to provide the stimulus for fresh investment. Zimplats recently announced that it had raised the necessary funds for the development of its Ngezi open-pit mine, with Impala Platinum injecting $30 million and taking a 30 per cent stake in the project. The remainder of the estimated $50 million capital requirement has been raised through debt financing. Production at Ngezi is planned to start during 2002, with ore being trucked for processing at the Hartley concentrator and smelter (now known as the Selous Metallurgical Complex), which Zimplats acquired following the mine's closure in 1999. The resulting matte will be refined by Impala Refining Services. Annual production is planned to be around 98,000 oz of platinum, 85,000 oz of palladium and 8,000 oz of rhodium.

There is also the possibility of a modest expansion at Mimosa which is owned by the local chrome mining company, Zimasco. An expansion that would treble platinum output has been under consideration for several years, but is unlikely to proceed until Mimosa gains access to outside investment. Although a proposed acquisition of Zimasco by Anglo American collapsed in 2000, it is possible that one of South Africa's platinum producers will purchase Mimosa and fund an increase in output.

A third potential site of pgm production is Anglo American's Unki project, at Shurugwi in central Zimbabwe. The development of a new mine, producing around 120,000 oz of pgm per annum, was announced in February 1998. Progress has since been stalled by political and economic problems, but the prospect of a new fiscal regime may lead to the reactivation of this project.