

PAPUA NEW GUINEA

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Papua New Guinea generated a total GDP of US\$3.8 billion in 2000, yielding a *per capita* GDP of US\$782. This is lower than in the mid-1990s mostly due to a decline in the value of the local currency (kina) against the US dollar. Mining and quarrying accounted for 17.1% of the GDP.

Strong performances from the four main mines resulted in gold and copper production exceeding forecasts for the year 2000.

OK Tedi

The Ok Tedi mine is a large porphyry copper-gold deposit mined by open-pit methods employing a riverine tailings disposal system. It is located in the remote Star Mountains of the Western Province some 18 km east of the border with Indonesia. The mine lies at an altitude of 2000 m in a very high rainfall area receiving between 8.5 and 10.5 m/y of rain.

The operator, Ok Tedi Mining Ltd (OTML) is owned 52% by BHP, 30% by the PNG Government and 18% by Inmet Mining Corp. of Canada. Following BHP's 1999 announcement of its decision to withdraw from the project, negotiations were initiated to determine the details of majority shareholder BHP's exit. These talks continued throughout 2000.

Total mine production for 2000 averaged 235,000 t/d of which 84,500 t/d is ore treated through the mill. Estimated recoverable proved and probable reserves at June 30, 2000 were 304 Mt at an average grade of 0.87% Cu and 0.93 g/t Au. The contained product is estimated to be 2.18 Mt Cu and 6.1 Moz Au. OTML's primary markets are located in Japan, Asia and Europe. The Ok Tedi mine contributes around 10% of PNG's gross domestic product, accounting for nearly 20% of its annual foreign exchange earnings.

Despite a World Bank (WB) report suggesting that, based solely on environmental grounds, the mine should close at the earliest possible time, all stakeholders acknowledge that there are significant social and economic issues that need to be resolved before any mine closure can be satisfactorily achieved.

Dredging continued as an environmental mitigation measure to reduce overbank flooding by removing mine-derived sand and gravel from the lower Ok Tedi River.

Extensive consultation with local communities throughout 2000 has centred on securing informed consent on the terms within which the mine might continue operating for its remaining life. As an early step in each

Mineral Production						
Mine	Au (kg)		Ag (kg)		Cu (t)	
	1999	2000	1999	2000	1999	2000
Ok Tedi	12,490	16,608	33,143	45,034	187,921	203,061
Porgera	23,468	28,318	3,133	3,707	Na	Na
Misima	6,162	6,880	19,664	24,199	Na	Na
Lihir	19,456	18,850	389	Na	Na	Na
Tolukuma	2,325	2,025	9,479	5,470	Na	Na
Small Scale Miners	1,846	1,859	734	787	Na	Na
Totals	65,747	74,540	66,542	79,197	187,921	203,061

Na – Not available

Mineral production for 2001 is expected to total 65,000 kg of gold and 190,000 t of copper.

community discussion, "Heads of Agreement" are negotiated to provide a framework within which detailed discussions can proceed.

Porgera

The Porgera gold mine lies in Enga Province in the Highlands of Papua New Guinea. Mining commenced in 1990 as an underground operation with a transition to total open-pit operation in the mid to late 1990s.

Placer Dome has a 50% shareholding in the operation held through its wholly-owned subsidiaries Highlands Gold Ltd and Placer Niugini Ltd. Goldfields (RGC) Ltd holds 25%, Orogen Minerals holds 15%, Mineral Resources Enga 5% and Yuwai Ltd 5%.

Open-pit mining operations are scheduled to be completed around 2007. Gold production will continue until at least 2011 from stockpile reclamation. The open-pit mining rate is currently 225,000 t/d of ore and waste.

At the end of 2000, the mine had produced a total of 9.9 Moz of gold since commissioning in 1990 with a peak annual production in 1992 of 1.48 Moz. Production rates for the remainder of the mine life are expected to be in the range 650,000 to 700,000 oz/y. Gold production is from a refractory gold ore body where sub-microscopic gold is bound within pyrite grains. The gold recovery circuit includes flotation of the sulphide minerals followed by pressure oxidation, leaching and conventional CIP gold recovery. Mill feed for 2000 amounted to 6.02 Mt. Total cash costs per ounce were US\$236.

Placer Dome, the mine's operator and major shareholder, carried out a major review of future development options including a new dumping strategy. No problems were anticipated in obtaining government approvals for the

new dump by the end of the March quarter of 2001. A drainage adit to dewater the open pit, which ceased to be free draining, neared completion at the end of 2000.

Proven and probable ore reserves as at December 31, 2000, were 78.5 Mt at 3.3 g/t Au containing 8.2 Moz of gold. In addition to this, there is a mineral resource estimate of 53.7 Mt at 2.2 g/t gold.

Lihir

The Lihir mine lies on Lihir island in New Ireland Province 590 km northeast of mainland Papua New Guinea. Lihir Gold Ltd is a publicly listed company with the principal shareholders being; Rio Tinto plc (17.15%), Niugini Mining Ltd/Battle Mountain, (14.91%), 7.12% held by Mineral Resources Lihir on behalf of the people of Lihir, Vengold Inc. (4.97%), with the balance of 55.85% held by private and institutional investors. The mine is managed and operated by Lihir Management Co., a wholly-owned subsidiary of Rio Tinto.

Present ore production is coming from two overlapping pits, the Minifie and Lienetz. The gold resource is associated with a residual geothermal system and is located adjacent to the sea with the present Minifie pit base approximately 90 m below sea level. The pit is dewatered using twelve dewatering wells.

Historical Mineral Production 1989-2000				
Year	Comment	Au (kg)	Ag (kg)	Cu (t)
1989		25,380	92,507	203,825
1990	Porgera start-up	32,323	112,327	170,221
1991		59,810	123,630	204,459
1992		69,241	93,108	193,359
1993		60,096	96,017	203,184
1994		58,654	77,758	206,368
1995		51,701	65,153	212,737
1996		51,573	59,036	186,665
1997	Lihir start-up & El Nino	48,482	49,165	111,515
1998	El Nino drought	61,641	59,294	152,200
1999		65,747	66,542	187,921
2000		74,540	79,197	203,060

The residual geothermal system is made safe, by shallow geothermal wells drilled to assist with depressurisation and cooling in the vicinity of the pit. Based on present information, power generation using geothermal steam is feasible. Well-testing to determine steam production capacity from the Minifie, Lienetz and Kapit areas is planned for early 2001, allowing for economic evaluation of power generation options to proceed. Rock temperatures in a significant proportion of the ore exceed 100° and special explosives and detonating cord are required for blasting at these high temperatures.

Open-pit mining shifted from contract to owner managed in 2000 resulting in cost savings and higher mining rates. The present mining rate is 37 Mt/y of which 3.13 Mt was sulphide ore and 0.1 Mt oxide ore to the mill. It is planned to increase the mining rate in 2001 to 46 Mt/y. The current 31-year mine life plans for mining in the pit to take place over a 14-year period with high-grade ore being fed direct to the mill. Low-grade ore is being stockpiled for later reclamation and processing over the 17-year period following the cessation of open-pit mining operations.

Apart from a small tonnage of surficial oxide material, the Lihir ore body is refractory with a high sulphide content. Metallurgical treatment is by whole-ore pressure oxidation using three autoclaves followed by CIL for gold recovery. The feasibility of installing a fourth autoclave is being undertaken. The plant is presently capable of handling 3.6 Mt/y yielding 91% Au recovery.

Lihir produced 606,310 oz (18,859 kg) of gold in 2000 compared with 625,520 oz (19,456 kg) in 1999 with production for 2001 estimated at 600,000 oz. Total cash cost for 2000 was US\$228/oz.

Ore reserves at December 31, 2000 were 108.8 Mt, grading 3.65 g/t Au for a total of 11.5 Moz recoverable gold. This lies within a total resource envelope of 428.9 Mt grading 2.69 g/t Au for a total of 37.1 Moz.

Misima

Ownership of Misima Mines Pty Ltd is Placer Dome 80% and Orogen Minerals Ltd 20%. The Misima mine is located on Misima Island in the Milne Bay Province in eastern Papua New Guinea. The mine is an open-pit gold mine, which has on average produced over 300,000 oz/y of gold. The mine commenced operations in 1989 and has to date produced some 99.92 t of gold and 516 t of silver. The mine works a low-grade ore body but is able to maintain low operating costs due to its strategic location in an island setting, adjacent to the coast. Gold and silver are produced from a conventional CIP gold processing plant.

The mine is very near the end of its life and present indications are that open-pit operations will cease in May 2001, with processing of low-grade stockpiles continuing until 2004. Annual gold production declined from an average of 330,000 oz (10,300 kg) over the years 1990 to 1995 to 221,177 oz (6,879.5 kg) in 2000. Silver also declined from an annual average of 1.9 Moz (60,000 kg) from 1990 to 1995 to 777,997 oz (24,199 kg) in 2000. These declines were forecast and occurred primarily as a result of a combination of harder ore and lower head grades as the mine approaches the end of its life.

Ore reserves as at December 31, 2000 were 18.1 Mt at 0.9 g/t Au containing approximately 420,000 oz of gold.

Tolukuma

The Tolukuma resource was discovered in 1986 by Newmont Exploration and was ultimately developed by Dome Resources NL, with first gold production in December 1995. Towards the end of 1999 ownership changes occurred, with Durban Roodeport Deeps Ltd (DRD) of South Africa initially taking up a 20% interest in the project. In July 2000, it completed the acquisition of 98.5% of Dome Resources.

The mine lies in the Central Province, 100 km north of Port Moresby in the rugged Owen Stanley Mountains. Access is only by helicopter and all mine activities are helicopter supported.

Gold production commenced in December 1995 at an annual rate of 100,000 t of ore and 50,000 oz of gold. Production in 2000 totalled 65,104 oz (2,025 kg) of gold and 175,857 oz (5,469 kg) of silver, slightly down on 1999 production. The ore is free milling and treated with a conventional CIL plant followed by Inco process tailings detoxification.

The mine initially operated as a small open pit and in 1997 commenced underground mining operations. By mid-1997 all ore production was being derived from underground. A small open pit was operated in 1999-2000 to supplement underground feed. Overall head grades for 1999 averaged 17.8 g/t Au.

The mine life was initially estimated to be five years. However exploration activities surrounding the known mineable reserves continue to be positive, and potential exists to extend the mine life by several years. Reserves and resources as at the end of 1998 were 909,000 t at an average grade of 21.9 g/t Au and 93.0 g/t Ag.

Papua New Guinea has several advanced prospects, some of which are at an advanced stage of economic evaluation.

Simberi

The Simberi gold project lies in the Tabar Islands some 40 km north west of Lihir. It was granted a Mining Lease in December 1996 for the development of a medium-scale gold mine treating oxide ore overlying a sulphide resource of unknown size. The project is owned by Nord Pacific Ltd and proposes to produce 40,000 oz/y of gold for five years. Oxide ore reserves as at August 1996 were 4.4 Mt at 1.54 g/t Au. This ore reserve is based on a zero stripping ratio. The project

remains on hold as a result of depressed gold prices.

Bougainville

The Bougainville Copper Project commenced operations in 1972 and was producing at an annual rate of 166,000 t of copper and 450,000 oz of gold at the time of its forced closure in 1989. Over its operating life it produced 3 Mt of copper and 305 t (9.7 Moz) of gold in concentrate.

The mine, at Panguna, was forced to close in May 1989 following an armed rebellion by disgruntled mine area landowners. Although there are significant moves towards a peaceful resolution of the conflict on the island there is no time frame for recommissioning of mining operations on the island.

The suspension of operations at Panguna in 1989 was a major blow to the economy of Papua New Guinea. At the time of its closure the mine accounted for nearly 10% of GDP, 36% of export earnings and 18% of government revenue.

Access to the mine site on Bougainville to enable a detailed review of the mine and its infrastructure is still not possible.

Bougainville Copper Ltd is owned 53.6% by Rio Tinto, public shareholders 27.3% and the PNG Government 19.1%. Access to the mine site on Bougainville to enable a detailed review of the mine and its infrastructure is still not possible. Irrespective of the access matter, Bougainville Copper is also mindful of the increased cost of replacing infrastructure and the present depressed metal prices, to the extent that it is investigating the disposal of assets on Bougainville and looking at alternative investments.

Remaining ore reserves are 691 Mt at 0.4% Cu and 0.47 g/t Au, sufficient for a mine life of 15 to 16 years at the production rate prevailing prior to closure.

Ramu Nickel

The Ramu Project is a pre-development nickel and cobalt project located in Madang Province on the north coast of Papua New Guinea. The project is based on the mining of lateritic ores at the Kurumbukari mine site and the processing of those ores at a refinery site located at Basamuk Bay some 130 km from the mine site. It is proposed to produce value added London Metal Exchange grade nickel cathode, a first for Papua New Guinea.

The project is designed to produce 33,000 t of nickel cathode and 3,200 t of cobalt cathode annually although the potential to expand the output by up to 50% from an operational base is well recognised. It is anticipated that the nickel will be produced for a cash cost of US\$0.41/lb. net of cobalt credits (at US\$10/lb Co) or US\$1.38/lb Ni before cobalt credits. The capital cost of development is estimated at US\$838 million. Ramu is proposing a submarine tailings placement as opposed to placement of tailings in land-based tailings dams.

The completed feasibility is based on an ore reserve of 75.7 Mt at a grade of 0.91% Ni and 0.10% Co which will support the operation for at least 20 years. Potential has been recognised to extend the life through exploration success in the surrounding area.

The project has all the necessary government permits to proceed and agreements with the local indigenous communities have been reached. Currently an additional equity participant is being sought to advance the project.

Morobe

The Morobe gold project lies in the Wau area of Morobe Province. Wau is the site where the first large-scale discovery of gold took place in Papua New Guinea in 1923. The project comprises three principal prospects: Hidden Valley, Kaveroi Creek, and Hamata. The measured, indicated and inferred resource estimated to September 30, 2000 is 79.1 Mt at 2.0 g/t Au and 28 g/t Ag.

The project is owned by Aurora Gold Ltd (50%), CDC Financial Services (Mauritius) Ltd (CDCFS) (45%) and Kula Fund Ltd (5%).

As a result of a favourable prefeasibility assessment of the project, the company announced on December 23, 1999 that the Morobe Project will proceed with a bankable feasibility study in the year 2000. This study, with a budget of approximately A\$10 million, is aimed at enhancing resources and confirming the viability of the project.

Technical activities undertaken as part of the first phase of the bankable feasibility study have been completed. These activities focussed on completing resource delineation drilling, geotechnical drilling for pit slope design and optimisation metallurgical testwork. The metallurgical testwork results to date confirm that the Hidden Valley ore types are free milling with good recoveries of gold and silver anticipated using conventional gold processing techniques.

Aurora and CDCFS reviewed the Phase One report for the bankable feasibility study, and approval was given to proceed with completion of the study scheduled for mid-2001.

Frieda Project

A large porphyry copper deposit was first discovered at Frieda River in the 1960s. Highlands Gold Ltd (now Highlands Pacific Ltd) took over the Exploration Licence in 1987 and embarked on an aggressive exploration and metallurgical testing programme to develop a mining project based on the Nena and Frieda deposits. In 1997, Cyprus-Amax Inc. entered the joint venture and became the manager of the Frieda exploration project. However, 1999 saw Cyprus-Amax exit the project following the company's takeover by Phelps Dodge.

The total porphyry copper resource is estimated to be in excess of 1,000 Mt at 0.5% Cu and 0.3 g/t Au. The high sulphidation Nena resource, which lies adjacent to the porphyry system, has reserves of 52.8 Mt at

2.0% Cu and 0.7 g/t Au with an additional oxide gold cap of 12.8 Mt averaging 1.4 g/t Au using 0.25% Cu and 0.6 g/t Au cut offs.

A mining pre-feasibility study was completed by Highlands Pacific in early 1996 resulting in a proposed development strategy including a leach, solvent extraction and electro-winning circuit to produce LME grade A copper. Estimated capital cost of the project was US\$1.6 billion, whilst operating costs were projected to be in the lowest quartile of the global cost curve. Highlands Pacific is seeking joint-venture participation.

Wafi

Rio Tinto holds the exploration licences over an advanced exploration prospect at Wafi situated in Morobe Province near Lae. The prospect has two distinct mineral occurrences. A porphyry copper prospect has been drilled out giving an indicated resource of 75.5 Mt at 1.22% Cu and 0.53 g/t Au, and an indicated resource of 24.7 Mt at 1.43% Cu and 0.96 g/t Au. An epithermal gold prospect adjacent to the porphyry contains in the order of 62 Mt at 2.4 g/t Au. Aurora Gold has an option over Wafi contingent on the receipt of positive results from its Morobe Gold project feasibility study.

Mount Kare

Located in the Enga Province of PNG, the Mount Kare gold mining project has had a short but colourful history. It was the location of a significant gold rush in 1988 which is reputed to have produced nearly 1 Moz of gold.

Exploration of the hard-rock potential of the Mount Kare area was continued through 2000 by Madison Enterprises of Vancouver. The resource for Mount. Kare, estimated by the independent engineering firm Watts Griffis & McOuat, stood at 25.5 Mt at 2.2 g/t Au and 29.0 g/t Ag (using a 1.0 g/t Au equivalent cut-off, with the cutting of high-grade gold assays to 30 g/t). This equates to 2.24 Moz of contained gold equivalent.

The geology of the area has significant similarities to the Porgera mine which lies some 11 km to the northeast on what appears to be a structural trend.

Kainantu

The Kainantu gold project has taken some dramatic steps forward since the entry in 1999 of Nippon Mining and Metals Co. Ltd into a joint venture with Highlands Pacific on the property. Based on drilling to mid-2000, Highlands Pacific estimated an inferred resource at the Irumafimpa prospect of 1.84 Mt at 30.1 g/t Au, or 1.78 Moz of contained gold. Assays reported from the completed drill holes included bonanza grade intersections of 5 m at 92.3 g/t Au, including 2 m at 227.7 g/t Au and 5 m at 12.7 g/t Au, including 2 m at 25.3 g/t Au.

However, a re-calculation of the resources based on results to the end of December 2000 gave an estimated resource of 886,700 t at 28.3 g/t Au containing 805,600 oz of gold. Large fluctuations in resource estimates of narrow high-grade veins based on drilling are not unusual.

Sea-Floor Exploration

Exploration Licences covering two offshore areas in the Manus Basin continue to be held by Nautilus Minerals Corp. The licences cover known areas of sea-floor massive sulphide mineralisation (VMS black smoker deposits). The mineralisation in the Manus Basin is associated with andesitic and dacitic source rocks with high gold, silver, copper and zinc grades and low lead grades. Average copper and gold grades for 59 samples collected to date from the Pacmanus deposit are 9.9% Cu and 15 g/t Au. Grades from 24 samples from the Suzette deposit average 15.3% Cu and 21 g/t Au.

These areas lie in water depths of around 1,600 m and raise interesting possibilities for the future of sea-floor mining within Papua New Guinea's territorial waters. Offshore mining technology has to date been focused on either shallow water diamonds or very

deep water (>5,000 m) manganese nodules. New technologies for the exploration and mining of these black smoker deposits will be required and perhaps provide the greatest challenge for the project.

Small Scale Alluvial Gold Mining

Small-scale alluvial gold miners produced almost 60,000 oz of gold in 2000. This is primarily from hand method operations although there are a small number of mechanised operations now in production. An expanded extension service for small-scale miners commenced in 1998 and it is hoped that production from this sector will continue to increase over the next few years.

Exploration Activity

Mineral exploration expenditure in 2000 tended to be focused on advanced exploration projects with minimal exploration expenditures on grass roots exploration. Total mineral exploration expenditure was US\$15 million with most being spent on the Morobe Gold project, Ramu Nickel Project and the Mount Kare and Kainantu Gold projects. Papua New Guinea's share of the global exploration dollar has declined from 2.3% in the heady days of the late 1980s to 1.5% in 1995 and to 0.75% in 2000.