

THE MINERAL INDUSTRY OF PAPUA NEW GUINEA

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The mineral industry in the Independent State of Papua New Guinea remains the cornerstone of the country's economy, as it has since 1972 when the large Panguna porphyry copper-gold-silver mine on Bougainville Island in North Solomons Province concluded its first full year of production. The country's mining operations range from primitive gold panning and sluicing by individuals and small gold-mining companies to large, modern, mechanized copper and gold open pit and underground operations.

At yearend, four major metal mines (Lihir, New Ireland Province; Misima, Milne Bay Province; Ok Tedi, Western Province; and Porgera, Enga Province) and one minor gold mine (Tolukuma, Central Province) were operating. The petroleum sector included the Hides Natural Gas Project in Southern Province and the Gobe, Kutubu, and Moran oil- and gasfields in the southern highlands region. These facilities produced virtually all the country's mineral production, excluding minor amounts of alluvial gold by individual panners, clays, sand and gravel, and stone used for construction purposes.

The mining and petroleum sectors contributed an estimated 25% to the country's gross domestic product, approximately 70% of export revenue, and 75% of taxation and mining royalty revenue (PNG Resources, 1998b). In addition to this direct contribution to the economy of Papua New Guinea, the mining and petroleum sectors also contributed intangibly to the economy through interdependence with the construction and service sectors, providing people with employment and training in technical skills, and contributing to the funding of health, education, and community infrastructure and development programs.

Mining and petroleum exploration and development in Papua New Guinea are regulated by the Mining and Petroleum Acts of 1992. The Mining Act details the types of mining tenements available; the making of mining development contracts; payments of rents, fees, and royalties; registration of interests and dealings in tenements; and compensating the occupiers of affected lands. The principal mining tenements for large-scale operations under the Mining Act are exploration licenses and special mining leases. There also are mining leases and alluvial mining leases for smaller scale development, as well as ancillary tenements, such as leases for mining easements. An exploration license confers the exclusive right to explore for certain minerals within a defined area. The special mining lease gives tenure to carry out construction and operations for the mining of a large mineral deposit. These leases are dependent on the negotiation and signing of a mining development contract with the Government, the approval by the

Minister for Mining and Petroleum of a proposal for development, and reaching agreement for appropriate compensation with the indigenous people who occupy the land. The holder of a mining lease or special mining lease is entitled to conduct mining operations and owns all minerals lawfully extracted.

The Petroleum Act deals with the types of petroleum licenses available, registration of interests and dealings in tenements, compensation for owners and occupiers of affected lands, and payments of rents, fees, and royalties. Three types of tenements may be issued under the Petroleum Act, namely licenses for petroleum prospecting, petroleum development, and pipelines. Petroleum-prospecting licenses confer the exclusive right to explore for petroleum, but the holder is required to enter into a further agreement with the Government regarding exploration and development within the license area. Petroleum-development licenses give tenure to recover and own the petroleum and to construct and operate all necessary facilities. Pipeline licenses confer the authority to construct and operate a pipeline system and related facilities.

The Department of Environment and Conservation is the Government agency responsible for environmental protection and conservation of Papua New Guinea's diverse natural environment and serves as the regulatory and monitoring agency for the extraction of all mineral resources in the country.

Since the closure of Bougainville Copper Ltd.'s (BCL) Panguna Mine on Bougainville Island in North Solomons Province a decade ago, all the country's copper production has come from the Ok Tedi Mine on Mount Fubilan in the Star Mountains of Western Province, 18 kilometers (km) east of the border with the Indonesian Province of Irian Jaya. Copper production at the Ok Tedi Mine commenced early in 1987. Ore processing averages approximately 30 million metric tons per year. Estimated recoverable proved and probable reserves on May 31, 1998, were 344 million metric tons (Mt) at an average grade of 0.88% copper and 0.92 grams per metric ton (g/t) gold. The contained product is estimated to be 2.1 Mt of copper and 192,800 kilograms (kg) of gold. The mining lease was granted in 1981 for 21 years with right of renewal for an additional 21-year period. In 1998, capacity was approximately 190,000 metric tons per year (t/yr) of copper (Broken Hill Pty. Co. Ltd., 1998, p. 26-27), down from the normal 210,000 t/yr owing to adverse El Niño-related weather conditions that caused a severe drought during 1997 and the early months of 1998. The drought caused low water levels in the Fly River, disrupting barge movement between the loading port at Kiunga in the upper Fly River and the silo ship *Karabi*. The *Karabi*

functioned as a storage and transshipment facility moored off Umuda Island, 850 km downstream at the river's mouth in the Gulf of Papua. The force majeure declared on deliveries of copper in September 1997 was not lifted until April 14, 1998 (Mining Journal, 1998a). In midyear, BHP Copper laid off almost 10% of its staff, or 172 of its employees, citing the drought as well as low world copper prices as the causes (Engineering and Mining Journal, 1998). Copper prices remained at their lowest levels in 10 years (Mining Engineering, 1998).

In early December, BHP Ltd. closed its exploration office in Port Moresby and ceased all its exploration activities in Papua New Guinea. The decision to close was a result of corporate restructuring and reduction of exploration budgets (Mining Magazine, 1998).

BCL produced copper concentrate containing gold and silver from its mine at Panguna from 1972 until operations were suspended on May 15, 1989, owing to militant activity necessitating BCL to withdraw its personnel early in 1990. In January 1998, after several failed early efforts at peace and several successful meetings in 1997, a truce was brokered in Christchurch, New Zealand, between Papua New Guinea's central authorities, local authorities, and the rebellious militants. On April 30, 1998, an agreement was signed by all sides calling for a "permanent and irrevocable" cease-fire starting at midnight (Far Eastern Economic Review, 1998).

Although the peace process continued positively and was further encouraged by the United Nations agreeing to deploy a small observer mission to Bougainville, BCL remained pessimistic about the condition of its abandoned Panguna Mine site and equipment. Although BCL believes it may not regain access to the mine site for some time, where it already has gained access, such as the power station at Loholo and facilities in the Arawa area, considerable deterioration has been confirmed. BCL also believes if that situation is repeated at the mine site, little, if any, of its assets would be suited to renewal of operations, especially if the low world prices for copper and gold continued (Bougainville Copper Ltd., 1998, p. 3).

In February, Cyprus Climax Metals Co. of the United States entered into an agreement with Australia's Highlands Pacific Ltd. whereby Cyprus Climax will acquire a 75% interest in Highlands Pacific's 86% share in the Frieda River copper-gold project and take over as manager of the project. The Japanese consortium OMRD Frieda Co. Ltd. holds the remaining 14% in the project. The Frieda River prospect straddles the border of Papua New Guinea's East Sepik and West Sepik Provinces in the northeast corner of the country. If the feasibility study scheduled to be completed by December 2000 confirms expectations, the resulting mine would be larger than the giant Ok Tedi Mine. The prefeasibility study done for the site in 1996 estimated potential annual production of 220,000 metric tons (t) copper and 10,000 kg gold (U.S. Embassy, Port Moresby, Papua New Guinea, 1998).

In September, the Republic of Korea's Young Poon Mining and Construction Co. began development of the Kuta gold mine near Mount Hagen in Central Highlands Province. Initial production was scheduled for yearend 1998, and full production

was to be attained by yearend 1999. The mineralization is estimated to contain approximately 195 t of recoverable gold (Mining Journal, 1998c).

The Lihir gold deposit on Lihir Island is about 700 km northeast of the capital city of Port Moresby. It is one of the largest gold deposits in the world with reserves of more than 373 t of gold. With present reserves and processing capacity, mining will be conducted for another 13 years, during which the higher grade ore will be fed directly to the processing plant and the lower grade ore will be stockpiled. The stockpiled ore will be processed during the following 17 years, or a total projected mine life of 30 years (Vengold Inc., 1998, p. 4-7).

After bringing the Lihir gold mine into production smoothly and well ahead of schedule in 1997, Lihir Gold Ltd.'s first full year of production turned out to be a difficult one. A low gold price was a backdrop for operational problems that significantly affected output and financial performance. In the first semester of 1998, the chief operational problem concerned interruptions to the 1,450-metric-ton-per-day (t/d) Linde oxygen plant that caused abnormal downtime. Later in the year, modifications were required to the brick linings of the three autoclaves that caused their being off-line for most of the second semester. Lihir Gold processed a total of 2.064 Mt of sulfide ore and 288,000 t of oxide ore during 1998, producing 16,168 kg of gold in bullion, 20% lower than planned. Production of gold for 1999 was forecast to be 21,775 kg (Lihir Gold Ltd., 1998, p. 7).

The Misima open pit gold and silver mine is located on Misima Island in the D'Entrecasteaux Islands group, Milne Bay Province, approximately 240 km southeast of the Papua New Guinea mainland. Production of gold in 1998 was 5,780 kg, 13% below that of 1997 and 4% below the production forecast. In contrast, silver production for the year, 18,120 kg, exceeded the projected production of 12,130 kg by 49%. The shortfall in gold production was attributed to lower ore grades from the East Umuna pit and lower throughput owing to maintenance downtime of the semiautogenous grinding mill (Orogen Minerals Ltd., 1998, p. 28).

In the third quarter, the U.K. Government's Commonwealth Development Corp. and Aurora Gold Ltd. of Australia jointly bought the Morobe gold project in Morobe Province from the administrator of the assets of Australian Gold Fields NL (AGF). AGF appointed a voluntary administrator in March (Mining Journal, 1998b). The Morobe project consists of the former gold mines Hidden Valley and Wau, along with several adjacent prospects, containing inferred resources of 155 t gold and 1.9 Mt silver. The purchase price was \$14.4 million (South Sea Digest, 1998a).

Based on data generated to September 30, 1998, a resource estimate was calculated at yearend for the Mount Kare gold prospect. Indicated and inferred resources were 20.4 Mt at a grade of 5.6 g/t gold and 28.7 g/t silver, at a 1 g/t cutoff and no grade cutting (Mining Magazine, 1999). The prospect is owned by Canada's Madison Enterprises Corp., 65%, in joint venture with Matu Mining Pty. Ltd., 25%. The remaining 10% interest is owned by the traditional landowners, held by the landowner company Kare-Puga Development Corp., the company that holds the special mining lease for hard-rock gold

at Mount Kare (Mining Journal, 1997). The prospect is 18 km southwest of the huge Porgera Mine.

Production at the large Porgera open pit gold mine, 250 km west of Mount Hagen, returned to near normal operating levels early in 1998 after recovering from the El Niño-caused drought that significantly reduced production in 1997. Throughput in the processing plant increased from an average 12,000 t/d in 1997 to 15,750 t/d in 1998 (Metal Bulletin, 1999). Production for the year was 22,606 kg of gold, aided by a 6% rise in production during the December quarter (South Sea Digest, 1999). Gold production exceeded the projection for 1998, the first full year of production solely from the open pit, by 64%, but exceeded that of 1997 by only 2%. Mining occurred at the increased rate of 210,000 t/d. By yearend, an average gold recovery rate of 75% was achieved, versus the average rate in 1997 of 73%, owing to modifications within the processing plant. These included an upgrade of the 310-t/d oxygen plant, installation of a gravity gold cleanup circuit and expansion of the flotation circuit. Commissioning of the Waile Creek Rubber Dam was completed, which increased Porgera's process water reservoir capacity by approximately 100% in contained volume. The additional storage capacity should greatly reduce interruptions to operations caused by prolonged drought conditions such as occurred in 1997 (Orogen Minerals Ltd., 1998, p. 24).

Toward yearend, Dome Resources NL was close to commissioning underground development at its Tolukuma gold mine, 100 km north of Port Moresby. Dome Resources had been concentrating on drive development to the outer limits of its ore reserve blocks. Electrification of the underground workings and connection to the mine's power grid were scheduled to be carried out in the first quarter, 1999 (South Sea Digest, 1998b).

Highlands Pacific expected to proceed with its \$1.33 billion Ramu nickel-cobalt joint-venture project by the second semester of 1999 following completion of the feasibility study that confirmed the low cost of the huge project. The bankable feasibility study, prepared by Fluor Daniel and H.A. Simmons, estimated cash operating costs for the project will average \$3.00 per kilogram nickel and just \$0.90 per kilogram after cobalt credits, assuming a cobalt price of \$22.00 per kilogram. The manager of the project, Highlands Pacific, holds a 65% share with Australian copper producer Nord Pacific Ltd., which holds the remaining 35% interest. Following the granting of the special mining lease, the Government will have the right to acquire a 30% participating interest in the project for reimbursement of sunk costs. The project, located in Ramu River Province near the port city of Madang, will have an estimated capital cost of \$788 million, which will cover all mine, processing, and infrastructure up to mechanical completion of the project. The mine will produce 33,000 t/yr of nickel cathode and 3,200 t/yr of cobalt as pure cobalt sulfate from reserves estimated to be sufficient to support a 20-year mine life. First metal production was expected by the end of 2001 (Pacific Islands Monthly, 1998). Highlands Pacific was intending to use high pressure leaching to recover the nickel, a proposed process similar to, but not the same as, those being commissioned at the laterite nickel mines in Western

Australia—Bulong, Cawse, and Murrin Murrin (Metal Bulletin, 1998).

The Kutubu Oilfield in Southern Highlands Province, 480 km northwest of Port Moresby, was Papua New Guinea's first successful oilfield. The Kutubu Oilfield, consisting of a number of producing wells, is comprised of the Agogo and the Iagifu-Hedinia fields. Production in 1998 was 18.9 million barrels (Mbbbl) of oil, about 32% lower than that of 1997 owing to natural field decline and increasing gas production. All production is transported to a marine loading terminal in the Gulf of Papua by pipeline for export, mainly to the Asian and Australian markets. Oil was first produced from the Kutubu Oilfield in June 1992 (Orogen Minerals Ltd., 1998, p. 12).

Construction of the infrastructure and production facilities for the Gobe Oilfield, Papua New Guinea's second petroleum field, was completed ahead of schedule and under budget early in 1998. The Gobe Oilfield is about 500 km northwest of Port Moresby, straddles the Gulf Province-Southern Highlands Province border, and comprises two fields, the Gobe Main and the SE Gobe, that are about 5 km apart. The first crude oil flowed from Gobe Main on March 9 and from SE Gobe on April 17. Production for the year from Gobe Main was 7.11 Mbbbl of oil and SE Gobe produced 3.57 Mbbbl of oil (Orogen Minerals Ltd., 1998, p. 14.)

The Moran Oilfield in Southern Highlands Province was discovered in 1996. In 1998, the field continued to be evaluated to assess its viability for full development. A conceptual study to identify an appropriate development strategy was completed in November and initial engineering work was begun (Orogen Minerals Ltd., 1998, p. 16).

The Chevron Asiatic Ltd.-led group working on the \$2.5 billion (Orogen Minerals Ltd., 1998, p. 5), 2,600-km proposal to pipe natural gas from the Papua New Guinea highlands to the central east coast of Queensland, Australia, continued to be assessed as to its feasibility during the year (Petroleum Gazette, 1999). When completed, the project would transport natural gas from Papua New Guinean gasfields into Northern Queensland via the Torres Strait, down the Cape York Peninsula to the port city of Townsville and then on to the industrial city of Gladstone. Planning of the project at yearend included gas wells and associated infrastructure at the Gobe, Kutubu, and, possibly, Hides oil and gasfields; a wet gas pipeline following the route of the existing oil pipeline from the oil and gasfields to a processing facility off the southern coast in the Gulf of Papua that will separate the wet gas into its component product streams; and a dry gas pipeline extending to the Queensland markets. In the third quarter, the consortium of Australian Gas Light Co. and Malaysia's Petronas was contracted to develop the Australian part of the project. Construction was to start in April 1999 (Petroleum Economist, 1998).

Enron Papua New Guinea Ltd., a subsidiary of Enron Corp. of the United States, announced in the final quarter of the year that it was terminating its joint-venture agreement in the oil refinery proposed to be constructed near Port Moresby (PNG Resources, 1998a). If constructed, the new refinery would be Papua New Guinea's first oil refinery.

All the country's petroleum production was exported from

the marine export terminal in the Gulf of Papua and sold to refineries in Australia, Japan, and Southeast Asia. Very little of the natural gas produced in the process of recovering oil in Papua New Guinea has been used commercially or flared. The vast majority of the gas has been recompressed and reinjected into the oil wells for recovery at a later date (Orogen Minerals Ltd., 1998, p. 18). A small amount of gas from the Hides Gasfield is used at the Porgera Mine. Papua New Guinea has a small topping refinery, the Iagifu Ridge Refinery, 200 meters above Lake Kutubu in Southern Highlands Province that produces a small quantity of aviation and diesel fuels from condensate for sale within the country and in conjunction with the Kutubu project itself.

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Major Sources of Information

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TABLE 1
PAPUA NEW GUINEA: PRODUCTION OF MINERAL COMMODITIES 1/

Commodity 2/		1994	1995	1996	1997 e/	1998 e/
Copper, mine output, Cu content	metric tons	209,329	212,737	168,024	111,200	190,000
Gold, mine output, Au content	kilograms	59,286	53,405	51,119	49,900	58,500
Gas, natural	million cubic meters	1,757	1,832	1,990	2,100	2,300
Natural gas liquids	42-gallon barrels	73,100	77,000	110,800	116,000	120,000
Petroleum, crude	thousand 42-gallon barrels	44,008	33,624	38,641	27,850 r/ 3/	29,600
Silver, mine output, Ag content	kilograms	77,758	68,306	58,131	49,500	51,600

e/ Estimated. r/ Revised.

1/ Table includes data available through May 26, 1999.

2/ In addition to the commodities listed, cement and crude construction materials (common clays, sand and gravel, and stone) are produced, but output is not reported quantitatively, and available general information is inadequate to make reliable estimates.

3/ Reported figure.

TABLE 2
PAPUA NEW GUINEA: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity e/
Cement	thousand tons	PNG-Halla Cement Pty. Ltd. (Halla Cement Corp. of the Republic of South Korea, 50%; State of Papua New Guinea, 50%)	Lae, Morobe Province	500
Copper	do.	Ok Tedi Mining Ltd., operator [BHP Copper, managing shareholder, 52.6%; Mineral Resources Development Co. (State of Papua New Guinea), 30%; and Inmet Mining Corp. of Canada, 17.4%]	Ok Tedi Mine, Mount Fubilan, Western Province	190
Do.	do.	Bougainville Copper Ltd., operator and manager. [Rio Tinto Ltd., 53.6%; public shareholders, 27.3%; and Mineral Resources Development Co. (State of Papua New Guinea), 19.1%]	Panguna Mine, Bougainville Island, North Solomons Province 1/	180
Gold		Lihir Gold Ltd. [Southern Gold (Bahamas) Ltd., a 75-25 joint venture between Rio Tinto Ltd. and Vengold Inc., 22.87%; Niugini Mining Ltd., 17.15%; Mineral Resources Lihir Pty. Ltd. (State of Papua New Guinea trust for the people of Lihir Island), 10.34%; Orogen Minerals Ltd. (state-controlled corporation), 6.81%; Vengold Inc., 3.7%; and other public shares, 39.13%	Lihir project, Lihir Island, New Ireland Province	18
Do.		Misima Mines Pty. Ltd., operator and manager [Placer Niugini Ltd., 80%; Orogen Minerals Ltd. (state-controlled corporation), 20%]	Misima Mine, Misima Island, Milne Bay Province	6
Do.		Oakland Pty. Ltd., operator and manager, 90%, and Kare-Puga Development Corp. (local landowner group), 10%	Mount Kare alluvial deposit, 18 kilometers southwest of the Porgera Mine, Enga Province	5
Do.		Madison Enterprises Corp. (Canada), manager, 65%; Matu Mining Pty. Ltd., 25%; and Kare-Puga Development Corp. (local landowner group), 10%	Mount Kare hardrock deposit, 18 kilometers southwest of the Porgera Mine, Enga Province	
Do.		Ok Tedi Mining Ltd., operator [BHP Copper, managing shareholder, 52.6%; Mineral Resources Development Co. (State of Papua New Guinea), 30%; and Inmet Mining Corp. of Canada, 17.4%]	Ok Tedi Mine, Mount Fubilan, Western Province	20
Do.		Bougainville Copper Ltd., operator and manager [Rio Tinto Ltd., 53.6%; public shareholders, 27.3%; and Mineral Resources Development Co. (State of Papua New Guinea), 19.1%]	Panguna Mine, Bougainville Island, North Solomons Province 1/	10
Do.		Placer Niugini Ltd., operator [Highlands Gold Ltd., 25%; Placer Pacific Ltd., 25%; Goldfields Ltd., 25%; Orogen Minerals (state-controlled corporation), 15%, and (Minerals Resources Porgera Pty. Ltd. (State of Papua New Guinea), 51%; Mineral Resources Porgera Pty. Ltd. (Porgera landowner group and Enga Provincial Government), 49%), 10%	Porgera Mine, 130 kilometers west of Mount Hagen, Enga Province	30
Do.		Clayfield Pty. Ltd., operator and manager (Dome Resources NL, 100%)	Tolukuma Mine, 100 kilometers north of Port Moresby, Central Province	2
Silver		Misima Mines Pty. Ltd., operator and manager [Placer Niugini Ltd., 80%; Orogen Minerals Ltd. (state-controlled corporation), 20%]	Misima Mine, Misima Island, Milne Bay Province	30
Natural gas	thousand cubic meters per day	BP Petroleum Development Ltd., operator and manager, 92.5%, and Oil Search Ltd., 7.5%	Hides Gasfield, Southern Highlands Province	425
Petroleum	thousand 42-gallon barrels per day	Chevron Niugini Pty. Ltd., operator and manager, 19.38%; BP Petroleum Development, 19.38%; Mobile Exploration and Producing Australia Pty. Ltd., 16.46%; BHP Petroleum (PNG) Inc., 9.69%; Oil Search Ltd., 7.75%; Mineral Resources Development Co. (State of Papua New Guinea), 6.75%; Merlin Pacific Petroleum Co., 4.84%; Orogen Minerals Ltd. (state-controlled corporation), 15.75%	Kutubu Oilfield (Agogo, Iagifu-Hedinia, and Usano Fields), in Southern Highlands Province	50
Do.	do.	Chevron Niugini Pty. Ltd., operator and manager, 19.375%; BP Australia Ltd., 19.375%; Orogen Minerals Ltd. (state-controlled corporation), 15.75%; Mobile Exploration and Producing Australia Pty. Ltd., 11.612%; BHP Petroleum (PNG) Inc., 9.688%; Oil Search Ltd., 7.762%; Petroleum Resources (Kutubu) Pty. Ltd., 6.75%; Merlin (JPP) Petroleum Co., 4.844%; and Merlin Pacific Oil Co. NL, 4.844%	Moran Oilfield, Southern Highlands Province 2/	15

See footnotes at end of table.

TABLE 2--Continued
 PAPUA NEW GUINEA: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity e/
Petroleum--Continued: thousand 42-gallon barrels per day	Chevron Niugini Pty. Ltd., operator and manager, 19.37%; Oil Search Ltd., 27.14%; Orogen Minerals Ltd. (state-controlled corporation), 20.5%; Mobile Exploration and Producing Australia Pty. Ltd., 16.46%; BHP Petroleum (PNG) Inc., 9.69%; Merlin Pacific Petroleum Co., 4.84%; and Mineral Resources Development Co. (State of Papua New Guinea), 2.00%	South East Gobe Oilfield, Gulf and Southern Highlands Provinces	10
Do.	do. Chevron Niugini Pty. Ltd., operator and manager, 10.66%; Oil Search Ltd., 21.90%; Orogen Minerals Ltd. (state-controlled corporation), 20.5%; Southern Highlands Petroleum Ltd., 17.61%; Mobile Exploration and Producing Pty. Ltd., 9.05%; Mount Isa Mines Ltd., 6.98%; BHP Petroleum (PNG) Inc., 5.33%; Merlin Pacific Petroleum Co., 2.66%; Cue Energy, 2.44%; Mineral Resources Development Co. (State of Papua New Guinea), 2.00%; and Mountains West Exploration Inc., 0.87%	Gobe Main Oilfield, Southern Highlands Province	10

e/ Estimated.

1/ Closed since May 1989 because of civil unrest.

2/ Under development for probable 1999 commissioning.