

PAPUA NEW GUINEA

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The economy of Papua New Guinea has undergone significant changes since the country gained its independence from the Australian-administered United Nations' trusteeship in 1975. The country has moved from a primarily subsistence-based agricultural economy to one having somewhat more diversification through the discovery and development of significant metal mining and petroleum deposits. Since the country's independence, the mineral industry has been an integral part of the economy. In 1999, the mining and petroleum sectors contributed an estimated 25% to the country's gross domestic product and 70% of its exports, although only employing about 2.5% of the workforce (Australian Journal of Mining, 1999, p. 50). The sector also has become an increasingly important source of taxes to the national Government; in 1999, the sector was responsible for generating an estimated 75% of Government revenue through taxation and mining royalties (PNG Resources, 1998).

The country's producing mines centered on four very large operations, one medium-sized enterprise, and a large small-scale sector that included several thousand mechanized alluvial gold mines and primitive manual gold panning-sluicing workings by numerous individuals. The major operations were the Ok Tedi copper-gold mine in Western Province, the Lihir gold mine in New Ireland Province, the Misima gold-silver mine in Milne Bay Province, and the Porgera gold mine in Enga Province. The Tolukuma gold-silver mine in Central Province also was a significant although smaller producer. Projects in the petroleum sector included Gobe Main, Kutubu, Moran Central, and SE Gobe oilfields in the Gulf and the Southern Highlands Provinces. These facilities produced virtually all the country's minerals-petroleum production; minor amounts of clays, sand and gravel, and stone used for construction purposes were excluded.

Government Activities

Mining and petroleum exploration and development in Papua New Guinea were regulated by the Mining and the Petroleum Acts of 1992. The Mining Act deals with the types of mining tenements available; making mining development contracts; payments of rents, fees, and royalties; registration of interests and dealings in tenements; and compensation for 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, approval by the Minister for Mining and Petroleum of a proposal for development, and reaching an 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 licenses may be issued under the Petroleum Act—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 tenement 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.

Commodity Review

Copper.—In 1999, all the country's copper production was mined from the Ok Tedi Mine at the headwaters of the Ok Tedi River on Mount Fubilan in the Star Mountains, which is about 18 kilometers (km) east of the border with the Indonesian Province of Irian Jaya. Copper production at Ok Tedi began in 1987 following 3 years of gold-only production. The open-cut operation used conventional truck-and-shovel technology to mine approximately 30 million metric tons per year (Mt/yr) of ore and 55 Mt/yr of waste rock; about 200,000 metric tons per year (t/yr) of copper-in-concentrate and 12,500 kilograms per year (kg/yr) of gold-in-concentrate are produced (BHP Ltd., 1999, p. 7). The final concentrate, which contains about 34% copper and 20 grams per metric ton (g/t) gold, was then thickened and piped 137 km to handling facilities at Kiunga for filtering and drying before shipment down the Fly River in 2,500-metric-ton (t) barges (Resource Information Unit, 2000, p. 37).

Waste rock and tailings from the Ok Tedi Mine have been discharged into the Ok Tedi River ever since successive major landslides forced the abandonment of construction at the tailings dam site shortly after mining startup in 1984. The resulting buildup of mine sediment in the lower Ok Tedi and Fly Rivers

produced flooding and sediment deposition on the floodplain leading to about a 100-square-kilometer vegetation die-back. An environmental study released in August 1999 showed the environmental effects of the mine would be far greater and more damaging than predicted and that none of the four options studied earlier showed a clear remedy (OTML [Ok Tedi Mining Ltd.] Board Report, [August 11, 1999], Discussion of results— Mine waste management project risk assessment, accessed September 19, 2000, at URL <http://www.oktedi.com/environment/MWMP%20Risk%20Assessment.pdf>). The options were to continue the dredging trial in the lower Ok Tedi; to dredge and pipe the tailings to a formed storage area; to do neither but continue mining; or to close the mine early. The study showed that the early closure option would severely affect national and provincial economies and have significant impacts on the social stability and well being of the affected communities. The storage of piped tailings would also create social and environmental problems because of the amount of land involved and the potential for acid generation. The dredge option could only deliver limited environmental benefits. The Government subsequently indicated that an early closure of the Ok Tedi Mine was not acceptable (Resource Information Unit, 2000, p. 37).

Gold and Silver.—The Lihir gold deposit, which is on Lihir Island, is about 700 km northeast of the capital city of Port Moresby, was one of the world's largest gold deposits. Mining was based on two adjacent overlapping pits, Lienetz and Minifie, that supplied high-grade ore for immediate processing and lower grade ore for stockpiling for future gold production. Virtually all the ore was refractory sulfides, which required oxidation in autoclaves prior to leaching by cyanidation (Resource Information Unit, 2000, p. 55).

Although gold production during the first half of the year was lower owing to the relining of two of the three autoclaves, the mine still produced more than 19,400 kilograms (kg) of gold for the year, which was a 20% increase compared with that of 1998. In June, the processing plant was upgraded with the addition of a second oxygen plant, enabling a 30% increase in gold production during the second half of the year. Gold production in 2000 and 2001 was forecast to remain about the same at 19,300 kg/yr (Lihir Gold Ltd., 1999).

The Misima open pit gold and silver mine was 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 and silver in 1999 was 6,162 and 19,664 kg, respectively (Orogen Minerals Ltd., 2000, p. 28-29). Mining in 1999 continued in the East Umuna Stage 2 and the Tonowak pits. Mining per se was scheduled to end in July 2000, although sufficient stockpiled ore remained for processing to continue on-site for an additional 5 years (Resource Information Unit, 2000, p. 56).

The huge Porgera open pit gold mine is in Enga Province 620 km northwest of Port Moresby. In 1999, 23,475 kg of gold was produced; this was about 4% more than that of 1998. The year began with the transition from Stage 2 to Stage 3 of the open pit, and although it impacted heavily on gold production in the first months of the year, it enabled production to increase so that a new quarterly production record of 7,649 kg of gold was set in the third quarter of the year (Orogen Minerals Ltd., 1999, p. 24). Stripping of the Stage 4 pit was underway and development of a

2-km-long pit-water drainage adit was approved and started during the third quarter. Construction of the adit avoided expensive pumping for pit dewatering in future pit stages, as well as providing access to small high-grade ore pockets outside the pit shell that could be used for the small-scale underground mining scheduled to start in 2001 (Resource Information Unit, 2000, p. 59).

The gold present in Porgera's high-sulfide ore was refractory, and treatment consisted of conventional crushing and grinding, followed by bulk flotation of the sulfides. The resulting concentrate was then roasted and recovered by cyanide leaching in a conventional carbon-in-pulp plant.

Dome Resources NL's medium-sized high-grade Tolukuma Mine, which was located in mountainous terrain 100 km north of Port Moresby, was atypical in that it was the only mining operation in the world that had been built, serviced, and operated with all materials and personnel transported to its site entirely by helicopters. In early 1999, electrification of the underground workings was completed with the connection of the underground electrical grid to the mine surface grid by means of an aerial power line. Resources for fiscal year ending June 30, 1999, were 660,000 t at 28 g/t gold and 100 g/t silver, which would give a mine life of about 5 years processing ore at a rate of 120,000 t/yr (Resource Information Unit, 2000, p. 60-61).

Nickel.—The Ramu Nickel Project in northern Papua New Guinea was a large-scale nickel laterite undertaking being planned for development in Madang Province 75 km southwest of the provincial capital and port city of Madang. A \$22 million feasibility study completed in November 1998 estimated Ramu's resources to be 143 million metric tons (Mt) at 1.01% nickel and 0.1% cobalt, which included minable reserves of 75.5 Mt at 0.91% nickel and 0.1% cobalt (Resource Information Unit, 2000, p. 83). Upgraded ore was to be transported by a 134-km slurry pipeline to feed a refinery at Basumuk on the Bismark Sea coast where it was to be processed by pressure acid leach technology to produce approximately 33,000 t/yr of London Metal Exchange-grade cathode nickel by solvent extraction and electrowinning and 3,200 t/yr of cobalt metal. The Project was owned by Ramu Nickel Ltd. (68.5%) and Orogen Minerals, which agreed to acquire a 31.5% share in the project for \$6.75 million on November 26, 1999 (Orogen Minerals Ltd., 1999, p. 31).

Natural Gas and Oil.—The Kutubu Oilfield in Southern Highlands Province 480 km northwest of Port Moresby was Papua New Guinea's first successful oilfield. The Kutubu Oilfield consisted of a number of producing wells in the Agogo and the Iagifu-Hedinia fields. Production in 1999 was 15.2 million barrels (Mbbbl) of oil, which was about 20% lower than that of 1998 owing to natural field decline and increasing gas production (Orogen Minerals Ltd., 1999, p. 12-13). Cumulative production since commercial production began in 1992 was 246 Mbbbl of oil (Oil Search Ltd., 1999, p. 16). Production from the Kutubu Oilfield was expected to continue to decline at a rate of about 30% per year as the field is depleted and increasing gas production from wells continue to constrain production. All production was 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 discovered at Kutubu in 1986,

and commercial production began in 1992 (Orogen Minerals Ltd., 1999, p. 12- 13).

The Gobe Oilfield consists of two separate fields—the Gobe Main and the SE Gobe. They are about 5 km apart, straddle two petroleum development licenses (PDL), and are operated by separate joint-venture partners (Resource Information Unit, 1999, p. 109). The field is located in Gulf and Southern Highlands Provinces about 85 km southeast of the Kutubu Oilfield and was Papua New Guinea's second petroleum field to begin commercial production. In 1999, total crude oil produced at the Gobe Oilfield was 12.5 Mbbl, which was substantially below that predicted owing to increased gas and water production and associated structural complications in the sandstone reservoir (Orogen Minerals Ltd., 1999, p. 14-15). Compared with production in 1998, production in 1999 from SE Gobe Oilfield was 6.4 Mbbl, which was an increase of 81%, and that from Gobe Main was 6.1 Mbbl, which was an increase of 71% (Oil Search Ltd., 1999, p. 16).

The Moran Central Oilfield, which was discovered in 1996, is in Southern Highlands Province in an area covered by two licenses [PDL-2 and Petroleum Prospecting License-138 (PPL-138)] that host commercially recoverable quantities of oil. The joint-venture participants were planning the development of Moran Central as a unit, with 45% of production to be attributable to PDL-2 and 55% to PPL-138. A proposed development plan was submitted to the Government, which could approve it by mid-2000 (Oil Search Ltd., 1999, p. 16). Chevron Niugini Ltd. would become the operator of the project, effective when PDL-5 was issued to replace PPL-138 and a variant to PDL-2 was approved. An extended well testing program of the geologically complex oilfield provided a small but important addition to the country's oil exports since 1998. Production of crude oil from Moran Central wells (4.3 Mbbl in 1999) was transported to the Kutubu production facilities by a 15-km flowline; spare capacity that had been recovered as production from the Kutubu Oilfield declined was used (Orogen Minerals Ltd., 1999, p. 16; Resource Information Unit, 1999, p. 20-21).

Natural gas produced by Oil Search Ltd. at its Hides Gasfield was sold to the Porgera joint venture for electricity generation at the Porgera gold mine in Enga Province. In 1999, a record 1.41 million cubic meters of gas was produced (Oil Search Ltd., 1999, p. 16).

The Chevron Asiatic Ltd.-managed group, which was working on the proposed pipeline from the Papua New Guinea highlands to the central east coast of Queensland, Australia, made progress during 1999 towards demonstrating the feasibility of the project (Orogen Minerals Ltd., 1999, p. 18). The project was to include 635 km of pipeline within Papua New Guinea (320 onshore, 315 offshore) and 2,455 km within

Australia (2,455 onshore, 160 km offshore). 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, down to the industrial city of Gladstone, and on to the Queensland State capital city of Brisbane for an estimated cost of \$2.5 billion. The project included gas wells and associated infrastructure at the Gobe, Kutubu, and, possibly, Hides oilfields and gasfields; a wet gas pipeline that would follow the route of the existing oil pipeline from the oilfields and gasfields to a processing facility off the coast in the Gulf of Papua that will separate the wet gas into its component product streams; and a dry gas pipeline linking with the Queensland markets.

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Major Sources of Information

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

Commodity 2/		1995	1996	1997 r/	1998 r/	1999 p/
Copper, mine output, Cu content	metric tons	212,737	186,665 r/	111,515	152,200	187,921
Gold, mine output, Au content	kilograms	51,701 r/	51,573 r/	48,482	61,641	65,747
Gas, natural	million cubic meters	1,832	1,990	1,192	1,378	1,353
Natural gas liquids	42-gallon barrels	77,000	110,800	94,764	105,527	105,460
Petroleum, crude	thousand 42-gallon barrels	33,624	38,641	27,592	29,479	32,020
Silver, mine output, Ag content	kilograms	65,153 r/	59,036 r/	49,165	59,294	66,542

p/ Preliminary. r/ Revised.

1/ Table includes data available through August 4, 2000.

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 information is inadequate to make reliable estimates.

TABLE 2
PAPUA NEW GUINEA: STRUCTURE OF THE MINERAL INDUSTRY IN 1999

(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 Korea, 50%; Government of Papua New Guinea, 50%)	Lae, Morobe Province	500
Copper	do.	Ok Tedi Mining Ltd., operator (BHP Ltd., 52%; Government of Papua New Guinea, 30%; and Inmet Mining Corp. of Canada, 18%)	Ok Tedi opencut, Western Province. 390 kilometers southwest of Wewak	210
Gold		Lihir Gold Ltd., 100%	Lihir opencut mine, Lihir Island, New Ireland Province. 700 kilometers northeast of Port Moresby	18
Do.		Misima Mines Pty. Ltd. (Placer Niugini Ltd., operator, 80%, and Orogen Minerals Ltd., 20%)	Misima opencut, Misima Island, Milne Bay Province	6
Do.		Ok Tedi Mining Ltd., operator (BHP Ltd., 52%; Government of Papua New Guinea, 30%; and Inmet Mining Corp. of Canada, 18%)	Ok Tedi opencut, Western Province. 390 kilometers southwest of Wewak	20
Do.		Placer Niugini Ltd., operator [Highlands Gold Properties Ltd., 25%; Goldfields Porgera Pty. Ltd.; 25%, Placer (PNG) Ltd., 25%; Orogen Minerals (Porgera) Ltd.; 15%, Minerals Resources (Porgera) Ltd., 5%; and Mineral Resources Porgera Ltd., 5%]	Porgera opencut, Enga Province. 620 kilometers northwest of Port Moresby	30
Do.		Dome Resources NL, 100%	Tolukuma underground, Central Province. 100 kilometers north of Port Moresby	2
Silver		Misima Mines Pty. Ltd. (Placer Niugini Ltd., operator, 80%, and Orogen Minerals Ltd., 20%)	Misima opencut, Misima Island, Milne Bay Province	100
Natural gas	thousand cubic meters per day	Oil Search Ltd., operator, 52.5%, and Esso Niugini Pty. Ltd., 47.5%	Hides Gasfield, Southern Highlands Province. Onshore Papuan Basin, Petroleum Development License 1	425
Petroleum	thousand 42-gallon barrels per day	Chevron Niugini Ltd., operator and manager, 19.37%; Oil Search Ltd., 27.14%; Orogen Minerals Ltd., 20.5%; Ampolex (Highlands) Pty. Ltd., 16.46%; BHP Petroleum (PNG) Inc., 9.69%; and Santos Ltd., 6.84%	Gobe Main Oilfield, Southern Highlands Province. Onshore Papuan Basin, Petroleum Development License 4	10
Do.	do.	Chevron Niugini Ltd., operator and manager, 19.37%; Oil Search Ltd., 27.14%; Orogen Resources Ltd., 15.75%; Ampolex (Highlands) Pty. Ltd., 11.62%; BHP Petroleum Pty. Ltd., 9.69%; Petroleum Resources (Kutubu) Pty. Ltd., 6.75%; Merlin Pacific Oil Co., 4.84%; and Merlin Petroleum Co., 4.84%	Kutubu Oilfield, Southern Highlands Province. Onshore Papuan Basin, Petroleum Development License 2	50
Do.	do.	Chevron Niugini Ltd., operator and manager, 19.38%; Oil Search (Kutubu) Ltd., 27.13%; Orogen Minerals Ltd., 15.75%; Mobile Exploration and Producing Australia Pty. Ltd., 14.52%; BHP Petroleum (Papua New Guinea) Inc., 9.69%; Japan (PNG) Petroleum Co. Ltd., 6.78%; and Petroleum Resources (Kutubu) Pty. Ltd., 6.75%	Moran Oilfield, Southern Highlands Province (includes Agogo and Iaqufi-Hedinia Fields). Onshore Papuan Basin, Petroleum Development License 2 and Petroleum Prospecting License 138	15
Do.	do.	Chevron Niugini Ltd., operator and manager, 19.37%; Oil Search Ltd., 27.14%; Orogen Minerals Ltd., 20.5%; Ampolex (Highlands) Pty. Ltd., 16.46%; BHP Petroleum (PNG) Inc., 9.69%; and Santos Ltd., 6.84%	SE Gobe Oilfield, Gulf and Southern Highlands Provinces. Onshore Papuan Basin, Petroleum Development Licenses 3 and 4	10

e/ Estimated.