SMALL SCALE GOLD MINING
AND MARKETING IN PAPUA NEW GUINEA

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1. INTRODUCTION

Papua New Guinea is located north of Australia, east of Indonesia and southeast of the
Philippines. Most of the 463 000 square kilometres of its total land area is sited on the eastern half
of the island of New Guinea; it also comprises a handful of other relatively large islands and
hundreds of smaller ones. It has a population of 4 million and the per capita is US$1150.

The country is rich in natural resources. It is well endowed in copper and gold and has
commercially viable oil and gas reserves. Some 80% of its land surface is covered by rainforests
which yield exportable timber. The mineral industry of Papua New Guinea is an important sector
of the economy. Mineral exports constitute nearly 70% of total exports and taxes, revenues and
dividends from the mining projects constitute about 20% of the total revenue of the government.

PNG is now amongst the top ten gold producers in the world. A major portion of gold and
silver production is refined in the Metals Refining Operations in Port Moresby while the remaining
portion is exported in dore bars to refineries in Australia and Japan, and copper is exported as
concentrate to Japan, Germany and Australia. There are no smelting operations in the country.

The country used to boast the fourth largest open pit mine in the world, ie Bougainville. While
Bougainville is presently closed due to insecure conditions, Misima, Porgera, Lihir and Tolukuma
mines are producing gold and silver. Ok Tedi is also a very large open pit mine handling over 70
million tonnes of material per year and produces copper, gold and silver.

A large scale petroleum exploration program is also underway and oil is being produced since
1992. Gas to Queensland is the next major project on the horizon. Major Mining and Petroleum
Projects are shown in Fig. 1.
Small scale mining contributes about 2 to 5 tonnes of gold per year in the above table.

Although the amount of gold produced by the Small Scale Sector is much smaller than the bigger mines, it gives very large economic benefits and support system to over ten thousand miners and their families, and contributes to a significant spin-off resources to the rural economy. The PNG Chamber of Mines and Petroleum estimates that there are about 30,000 people involved in small scale mining nationwide, earning about K55 million annually but it could be higher as some gold is thought to be smuggled out of PNG.

PNG small miners are a part of the growing number of people employed worldwide in or carrying out alluvial mining operations. Their big brothers (garimpos) are located in Brazil, who produce about 18 tonnes out of the total 60t of yearly Brazilian gold production.

The paper presents a brief history of small scale mining and its present status, alluvial gold processing, including mercury pollution, alluvial gold marketing and the socio-economic problems faced by small miners.

2. SMALL SCALE MINING

2.1 History

History of alluvial gold mining in PNG started in 1873 when Captain Moresby reported minor amounts of gold in the hills surrounding what is now Port Moresby Harbour. The Port Moresby discovery was not worked until 1877 when first gold rush started involving 100 European miners, who mined the Laloki and other rivers inland from Port Moresby.

Mining effectively commenced in Papua New Guinea in 1888 with the discovery of payable gold in Sudest Island (near Misima Island). Morobe Goldfield was discovered in 1922, which continued to operate till the Second World War. It was a world class goldfield by the standards of the time, reaching a peak production of 8.5 tonnes/year of gold in 1942. The Bulolo Gold Dredging Company which operated up to eight dredges in the Bulolo River valley between 1932 and 1965,
accounted for most of the production in an operation that was particularly remarkable for pioneering large scale air transport. With considerable ingenuity, the components of the 2 000 tonne dredges were airlifted in and assembled on site and the operation was largely supported by air transport as there was no road network in the country at that time.

About 70 tonnes of gold was produced from Wau-Bulolo goldfields up to 1942 and during 1945 to 1977, the production was 47 tonnes.

The discovery in the Wau-Bulolo area sparked further exploration in both the hinterland of New Guinea and the outer islands. Gold was found in Kainantu in the early 1930’s and a few years later alluvial gold was discovered in the Lagaip River, a tributary of the Strickland, from where Jim Taylor and J R Black traced the alluvial gold back as far as Porgera. However, the source of the alluvial gold was not discovered until 1945, when H J Ward located gold ore cropping out on the east side of Mount Waruwari.

There are 17 recognised alluvial goldfields throughout Papua New Guinea. Of these, 16 are located on the mainland and the remaining one is on Bougainville Island. The goldfields from west to east are: Amanab (West Sepik Province); Maprik, April River and Yuat River (East Sepik Province); Porgera and Timun River (Enga Province); Kuta (Western Highlands Province); Simbai (Madang Province); Kainantu-Goroka (Eastern Highlands Province); Lakekamu (Gulf Province); Wau-Bulolo and Waria River (Morobe Province); Gira-Yodda and Kereri (Northern Province); Milne Bay (Milne Bay Province); and Kieta (North Solomons Province).

Most productive regions amongst these are: Wau-Bulolo, Eastern Highlands, Porgera, Mt Kare and Sepik River. Recent peak production was 7.6 t of gold in 1988 during Mt Kare’s gold rush.

2.2. Alluvial Mining Techniques

Present day alluvial mining techniques can be categorised into the following two main types:

- Small Scale Artisanal Mining
- Small to Medium Scale Mechanised Alluvial Mining.

2.2.1. Small Scale Artisanal Mining

Very small family orientated miners, which are also called Artisan Miners, are analogous to subsistence farmers in the agriculture sector. The main livelihood of these miners depend on the amount of gold they collect per year, sometimes only 0 to 10 grams which feeds and supports themselves and their families.

In 1996 the United Nations calculated that this small scale mining sector provided employment for in excess of six million people worldwide, equivalent to 20% of global mining industry employment. Assuming an average of four additional family members per worker, the total number of people dependent on small scale mining could exceed 30 million.

However, the most recent new ILO report calculates that the world’s small scale mining operations employ a total workforce of up to 13 million people and estimates that as many as 100 million depend on small scale mining for their livelihoods. This is broadly similar to the number dependent on the mechanised mining sector. The report says that small scale mining activity in 35
African, Asian and Latin American countries has grown by an average of 20% over the past five years, and that growth seems set to continue at a similar rate in most countries surveyed.

The small scale artisan miners in many developing countries employ very basic tools and equipment to conduct mining operations. In PNG, small operations consist of less capital intensive manual excavations of alluvial gold deposits found in streams/rivers, puddles and ancient river terraces.

Panning dish, pick and shovel are the main tools used. Wooden boxes, in most instances without riffles and recovery mats are used to conduct sluicing operations. The capital investment required in such operations would be US$50-100 or even less.

This method of mining has been inefficient. It leads to loss of very fine – micron size gold particles due to poor design and construction of sluice boxes. The coarse fraction of gold is recovered near the top of the box using either cloth or sometimes dry grass.

The major drawbacks of sluice box operating practices in PNG are: the use of gravel with wide size distribution as feed material and the use of insufficient or excessive wash water flow rates.

To mitigate these problems it is recommended that:

• the feed should be pre-screened to remove excessively large gravel. In situations where coarse gold is present, two sluice boxes should be used in parallel to treat the oversize and undersize material separately.

• optimal wash water flow rate be used so that the recovery of gold particles is maximised and gangue recovery is minimised.

Recently, new steel or aluminium metal sluices are being marketed utilising expanded metal riffles and are gaining wider acceptance. These rely on higher wash water velocities to function and result in significantly higher throughputs for the miner and consequently higher returns. Our Department in Lae fabricates these improved sluice boxes designed by Hancock and supplies to small miners at a very minimal cost on non-profit basis.

The total throughput achieved by these operations varies considerably from about 1 m$^3$/day for hand picked sluice boxes to 5 m$^3$/day for the more efficient true sluicing operations.

Many times these improved sluice boxes, which also require motor driven pumps for higher wash water velocities, are beyond the reach of small artisanal miners with the result that these improved techniques are used more frequently by the relatively well-off mechanised small miners.

2.2.2. Mechanised Small to Medium Mining

Mechanised mining techniques commonly involve the use of hydraulic excavators or wheeled loaders feeding gravel wash through a trommel with gold recovery being achieved by a range of techniques from simple sluices to sluices with hydraulic riffles through to complex jig and Knudsen bowl or Knelson concentrator systems. These plant configurations may be either fixed or mobile plants with skids or floating on pontoons.

These systems have throughputs of between 25 and 200 m per hour (typically in the range of 40 to 120 m per hour).
These methods are both capital intensive and mechanically more complex and therefore are used only by Nationally owned companies, which have access to large capital, ie Eddie Creek Mine near Wau.

3.0. ALLUVIAL GOLD PROCESSING & REFINING

3.1. Mercury Amalgamation

The use of mercury has become popular among small scale miners because amalgamation is known to efficiently extract fine gold particles from concentrates obtained by panning or sluicing operations. Gold alloys with mercury to form an amalgam from which the gold could subsequently be separated by evaporating the mercury. The simplicity of the technique, low investment cost and its comparatively high gold recovery has made amalgam an integral part of the small scale gold mining operations.

In PNG, most of the gold deposits worked by small scale miners are alluvial deposits, in which the gold particles are liberated from the gangue particles. It is customary to use riffled sluice-boxes to recover the liberated gold particles. However, some of the gold particles, particularly the find gold, does not settle out in riffle compartments, and flow over to the discarded tailings. In the hope of catching some of these fine gold particles, they place some mercury in between the riffle compartments.

The most dangerous practice adopted by the miners is the gold recovery process from the amalgams. The gold is recovered by evaporating the mercury from amalgam over an open fire. This process is commonly known as “cooking”.

The inhalation of mercury vapour from “cooking” results in vomiting, gastroenteritis, complaints of the kidney and urinary trace, ulcerations in the gums, and extreme light sensitivity known as ‘photophobia’. If inhaled over a long period, it can cause chronic mercurial poisoning resulting in kidney ulcerations, HgS deposition in the body, speech disturbances and lack of concentration.

Mercury pollution has been recognised as the most disastrous aspect of the small scale gold mining industry around the world. In Latin America, over one million people are estimated to be involved in such operations, and invariably use mercury for “amalgamation” in order to recover the fine gold particles. The problem of mercury pollution arises from the primitive mining techniques and the ignorance of the health hazard associated with such pollution. Particularly in Brazil, mercury pollution has become a large social problem. It is estimated that up to 200 tonnes of mercury may be used per annum by small scale miners and even in Papua New Guinea, where over ten thousand miners are involved in such operations, the extent of mercury use can be over 10-15 tonnes a year. Remedial measures taken to eliminate the mercury pollution such as the legislation of mercury bans in other countries have been largely ineffective due to ineffective monitoring and illegal mining operations.

Strategies proposed to reduce mercury pollution are: education and training of people with regard to health hazards and safe handling of mercury; conducting regular health checks in alluvial mining areas and looking for other alternatives to amalgamation.

3.2. Gold Purchasing & Refining
Metals Refining Operations (MRO) in Port Moresby, jointly owned by PNG Governmental Financial Institutions and N M Rothschild owned by Golden West Refining Corporation, buys and refines almost all alluvial gold produced in the country. MRO deals with a wide variety of alluvial customers – from individual small miner to about 6 large gold buyers located in main small mining areas. MRO also produces gold from the mechanised mining operators. The important role of the gold buyers cannot be over emphasised as they provide an efficient link between the individual/clan/family mines and the refinery.

Providing the working capital, storage, security, transport and entrepreneurial functions allows MRO to act as the final destination and buyer. MRO refines about 50 000 to 100 000 oz of alluvial gold per year. MRO refines this gold into 99.99% gold bars and sells on to Asian markets through Singapore. Alluvial sector accounts for 10% of the total throughput of MRO. The other 90% gold comes from bigger mines like Lihir, Porgera, Misima and Tolukuma and is refined on “toll” basis.

MRO’s alluvial receipts vary greatly in type, individual lot size, customer characteristics and content. In volume terms, raw amalgam from the Wau/Bulolo area is most significant along with melt bars produced by some mines and the Government Mineral Laboratory. There is a wide variety of material from different areas with the Sepik “flake gold” and Mt Kare black pyritic sand being most distinctive.

A significant problem at the refinery is the mercury content of the amalgam and the health and environmental aspects of its melting and casting. A customised vacuum oven has been installed and all amalgam is treated overnight to remove mercury. Whilst adding somewhat to the time taken to settle lodgements it has been surprising to find the large amount of mercury collected from routine amalgam lots. This indicates incomplete treatment at the mine sites and a possible health and safety issue.

Nuggets are a significant receipt by the refinery and are of interest for subsequent sale to local and overseas jewellers and collectors. Nuggets collected are kept in stock for subsequent sale in the “raw” state. MRO has regular customers in Australia, USA, Canada and Austria.

The Government Mineral Laboratory plays an important role in handling many smaller lots from grassroot miners. These lots, with their relevant assay certificates, are then sold to gold buyers or MRO. MRO is prepared to accept the assay certificate as the basis of advance payment, but MRO’s own melt sample/assay applies for the final settlement.

4.0. ENVIRONMENTAL & ECONOMIC PROBLEMS

4.1. Mercury Use Health Hazards

Although the recent study by Subasinghe and Okada (1998) does not show alarming levels of mercury pollution in the Bulolo River Valley area as compared to those in Brazil, the authors have witnessed very dangerous practices of handling mercury by small scale mines, including direct inhalation of mercury vapour during the “cooking” process and careless and accidental spillages of mercury into the river during the panning and sluicing operations. Considering that “cooking” is usually carried out in close proximity to the dwellings, especially in the presence of women and children around, the potential health hazard to those communities cannot be ignored.
4.2. Economic Problems

Start-up finance is the main problem facing these small artisanal miners. Lack of bank or venture capital credit is a major handicap because banks or other financial institutions would readily give loans for real estate or small businesses, but would not lend to these artisanal miners because these miners cannot provide any asset security backup.

Although the leases for alluvial mining are reserved exclusively for the local landowners – called Alluvial Mining Lease, the alluvial mining activities are not yet considered as an industry whereas coffee growing is considered as an industry and there are many governmental and grower promoted organisations like Coffee Industry Corporation, etc.

4.3. Education and Training

Small Scale Mining Branch of the Department of Mineral Resources in Port Moresby have secured the expert assistance of Geoff Crispin via AusAID funding program to create education and training materials for these small miners.

Geoff is based in Wau and is assisted by two of our ex-graduates: Howard Lole and Gideon Tongo. Fourth member of this team is Vele Gabu. They have produced a 40 Minute Video on Mercury Use in Small Scale Mining, Introduction to Small Scale Alluvial Mining and Small Scale Mechanised Alluvial Gold Mining. These videos are in English as well as in Tok Pisin.

The tapes highlight education and health issues to show the hazards and safe handling of mercury, teach improved ways of alluvial mining using hand techniques and demonstrate how to use more complicated mechanised equipment such as front end loaders and washing plants.

This team will also produce seven booklets entitled: Mercury / Simple Gold Mining / Basic Mining Practice / Advanced Mining Practice / Occupational Health and Safety / Environmental Issues / Economics of Mining.

This effort is the culmination of many years of planning and will greatly assist grassroots level people who are involved in this activity. The major focus of the program is to help people mine safely as well as mine effectively to earn more income. The education program will begin in the Wau/Bulolo area where there is the biggest concentration of alluvial gold miners and then extend to other parts of the country.

5. CONCLUSIONS

Alluvial mining everywhere is driven by gold rush mentality. In PNG, there have been frequent occurrences of these gold rushes: Moresby in late nineteen century, Wau-Bulolo in thirties and more recently in Mt Kare during late eighties. We are therefore waiting for another such rush to rekindle the interest in small scale mining.

Meanwhile, the government has recognised the importance of this industry for the rural economy and significant steps are being taken to provide more education, extension and training facilities to the grassroots miners. AusAID funding is a great help in this effort. There is an urgent need for providing some start-up capital to assist these miners and the Rural Development Bank can possibly help in this area. If this eventuates then the small mining sector in PNG can also grow at an annual rate of 20% to match the trends in other countries.
BIBLIOGRAPHY