Small-scale gold mining in Cambodia

A Situation Assessment

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Acronyms

DoG - Department of Geology
DIME - Provincial Department of Industry, Mines and Energy
EFCT - Environmental Forum Core Team
HP - Horse power
MIME - Ministry of Industry, Mines and Energy
MoU - Memorandum of Understanding
EIA - Enviromental Impact Assessment

Foreword

The impacts on health, livelihoods, and natural resources of gold and other mineral mining represent a serious challenge to sustainable development in countries around the world. Many of the world's poorest countries depend on mining as their most important economic sector. In such countries, more than half of total exports may come from the sector. Unfortunately, the economic benefits of mining, which rarely reach the poorest communities, are often accompanied by serious social and environmental impacts. Large-scale industrial mining operations use massive amounts of toxic chemicals like cyanide, produce massive pits (that can be as big as two miles across and a mile deep in some cases) and; generate thousands of tons of waste rock and tailings, a toxic rock/chemical slurry produced by the extraction process. Perhaps most troubling, these operations can generate acids that cause ground and surface water contamination that can last thousands of years.

As an organization dedicated to fighting poverty and supporting sustainable community livelihoods, Oxfam America has worked for the past five years with communities around the world impacted by mining. We have helped provide technical and strategic support to organizations working to defend the rights and livelihoods of these communities. Recently we have joined together with our local partners in a global campaign that is calling for reform of the sector. (See www.nodirtygold.org for more information.)

As damaging as these large-scale operations can be, small-scale mining carried out by informally organized companies or individuals can be even worse. In developing countries such operations typically operate completely outside government regulation and oversight. Worker and environmental protection is often nonexistent. Miners and surrounding communities can be directly exposed to large quantities of toxic chemicals like mercury, which are often dumped directly into local waterways - thus rendering them unfit for human and livestock consumption or crop irrigation.

In Cambodia, small-scale mining has increased significantly in recent years, accompanied by a concurrent rise in serious impacts on human heath and natural resources. As this study demonstrates, mine operators have acted with little concern for worker safety or environmental impacts. The Royal Government of Cambodia, meanwhile, has simply lacked the administrative and technical capacity to effectively regulate these operations. The result in the country's mining areas has been exposure of workers and communities to mercury and other toxins, huge chemical spills, poisoning of rivers, large-scale fish kills, and even human fatalities. Health care treatment in mining settlements has also been poor or nonexistent, thus leading to higher risk of contracting HIV/AIDS and malaria.

Clearly, there is a need for government action to remedy this situation. The Royal Government of Cambodia should increase its oversight of the sector and provide more technical training to its regulators and to mine operators. It should commit itself to fining and shutting down operations that are in violation of health and environmental protection standards. Small-scale mine operators too, must become more responsible and improve their health and environmental management. International donors can play a role in supporting increased government technical capacity and a more effective oversight role.

Whether large or small-scale, mining is by definition an unsustainable activity; once the gold or other metal is taken from the ground it cannot be regenerated. Thus mining cannot be a source of long-term "sustainable development." It is a reality, however, that in desperately poor countries like Cambodia, few other income generating options may exist for poor communities. The challenge is to find ways to make this activity less dangerous and damaging to worker and community health and the environment than it is currently. We believe that this report helps illustrate the severity of the problems generated by unregulated mining and offers some insight as to how they could be addressed. We hope the report will be a useful contribution to reform efforts within Cambodia itself and to larger global debates about the appropriate role of mining in sustainable development.

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Executive Summary

The gold mining industry within Cambodia is currently in a state of transition. Although considered small-scale by international standards, the scale and extent of operations is increasing. Sector growth has been characterized by an increasing number of miners employed, ever more complex and deeper mine excavations (some up to 80 meters deep), and the introduction of chemical-based gold recovery techniques that represent a movement up the technology curve. As a consequence of poor mining practices due to a lack of effective Government management and a lack of training amongst gold miners, increasingly serious impacts on natural resources, human health and rural livelihoods have resulted.

This report documents the current situation of the gold mining sector in Cambodia based on the results of a survey conducted by the Department of Geology in four gold mining areas, namely: Sampeou Loon gold deposit, Memot district, Kampong Cham province; O Tron gold deposit, Sambo district, Kratie province; Phnom Chi gold deposit, Sandan district, Kampong Thom province; and Prey Meas gold deposit, O Yadao district, Ratanakiri province. The goal of the survey was to determine the nature, extent, environmental impacts, and socio-economic impacts of small-scale gold mining in Cambodia and to make recommendations to address issues identified. Two supplementary surveys of Phnom Chi are also presented; one conducted by the NGO forum on Cambodia's Environmental Forum Core Team; a coalition of environmentally concerned NGOs and the other by a team of independent researchers.

There are currently 19 known gold deposits in Cambodia. Annually gold mining has becoming an increasingly important profession and it is conservatively estimated that the sector currently employs between 5,000 and 6,000 miners during the peak mining season. The Law on Management and Exploitation of Mineral Resources was ratified in July 2001 and defines all gold mining as illegal in Cambodia unless permission is granted by the Ministry in charge of mining. In some cases previously open-access mining areas have been designated as mineral concessions that are controlled by concessionaires. While exclusive access rights are rigorously enforced by the company and taxes/fees levied against independent gold mining, making poor miners' livelihoods increasingly precarious, environmental and health and safety safeguards that are also a part of the license agreement with the Government are often disregarded. The deposits at Sampeou Loon and Phnom Chi, investigated in the present study, are designated mineral concessions and operated by SUN Trading Co. Ltd. and Neoneer Cambodia Ltd. respectively. In other cases, gold deposits are effectively controlled by the local military or police forces. The deposits at O Tron and Prey Meas fall under this latter category.

Gold miners can be broadly categorized into four key groups of people: local people; poor migrant workers; wealthy migrant miners; and concessionaires. In general, local people and unskilled migrant workers earn around US$ 1.5 to US$ 2.5 per day. Skilled workers and supervisors earn slightly more. Wealthy miners that own machinery or excavations can earn around US$ 10 to US$ 15 per day. While there are in Cambodia many independent gold mining individuals and small groups, it would appear that the number of independent miners is decreasing in the face of increasing control over mining areas by concessionaires and wealthy miners.

Trenching and shafting/tunneling excavations are the two primary methods of ore recovery conducted in Cambodia. Pocket mining is also conducted on the surface placers, although many of these locations are now exhausted. Excavation is still conducted using hand tools, but the use of explosives is becoming increasingly common practice.

Traditionally, only sluicing and panning have been conducted in Cambodia to process the gold-bearing ores. However, as the gold mining sector has developed both in size and technology, chemical extraction techniques that can recover lower concentrations of gold have been increasingly adopted. The two most common techniques are mercury amalgamation and heap leaching using cyanide. Both mercury and cyanide are highly toxic chemicals known to seriously affect human health and severely damage ecosystems if released into the environment. Mercury amalgamation is widespread at Prey Meas deposit and has previously been conducted at Sampeou Loon deposit. Heap leaching is practiced at Phnom Chi deposit, O Tron deposit, and perhaps most prolifically at Sampeou Loon deposit.

Grave damage to human health is associated with poor practices in the handling of dangerous chemicals.

Of particular concern in this regard was the heating of mercury amalgam in the open atmosphere in Prey Meas to recover the gold precipitate, resulting inevitably in high levels of exposure by inhalation to the worker. Massive releases of mercury into the environment can poison drinking water resources and contaminate the food chain, leading to a broader population being affected. Mercury is known to bioaccumulate within the body and biomagnify up the food chain. When mercury pollutes water sources fish are readily contaminated. Most Cambodian people are dependent on fish as a staple food and this may be resulting in significant exposure of local populations to mercury based toxic compounds.

Serious environmental consequences from heap leaching were observed, particularly surface water pollution and groundwater pollution at Phnom Chi and Sampeou Loon. This has resulted from the poor operation of the heap leaching tanks, accidental toxic chemical solution spillages and the inappropriate disposal of toxic chemical tainted tailings. A severe pollution incident at Phnom Chi in July 2003 resulted in mass fish kills, together with the death of cattle and wildlife and was allegedly the result of a mass cyanide release. Most seriously, there were also reports of human fatalities as a result of the pollution incident. At Sampeou Loon, mining activity has resulted in the heavy poisoning of O Antap River, with serious repercussions for those villages living downstream that depend on the river for potable water. While some villagers now have to journey two km to collect drinkable water, others decided to leave their village and establish a new settlement away from the polluted river.

Other significant environmental impacts were found to have resulted from gold mining activity at almost of the deposits visited. These included: deforestation resulting from clearance of mining areas and the demand for timber for housing, fuel and timber supports for shafts; damaged landscapes that were not remediated following cessation of mining activity, leaving behind open shafts into which people and animals may accidentally fall; and wildlife depopulation as a result of increased hunting activity.

In addition to the untrained handling of dangerous chemicals, other health and safety issues were also identified to be of concern. Safety standards are low and informal. Tunnels and shafts have poor ventilation. No miner was observed to wear a hard hat. Training levels are poor and there is a lack of adequately qualified engineers and mining foremen, which is a significant impediment to improving health and safety at work. Over 20 miner fatalities were documented to have occurred from the collapse of tunnels and shafts that were inadequately supported.

The remoteness of mining settlements has led to a weak or non-existent health care system, and often a poor diet, both of which are further compounded by the level of poverty. The non-traditional structure of mining communities leads to an elevated risk of STDs and HIV/AIDS transmission. Malaria was a serious problem in all mining communities visited. For families with children, even basic education and health care services were not available. In some cases, children do, to a limited extent, assist their parents in light gold mining activity. However, in other cases children stay with relatives in provincial centers where they can be educated and gain access to health care services.

It is concluded that recent developments in the gold mining sector have increasingly led to extensive environmental destruction, serious impacts on human health and a poor health and safety record. Where mineral concessions are granted it is found that, in some cases, concessionaires are not abiding by the terms of their contract with the Government. While the gold mining sector is now well-established in Cambodia and small-scale mining does alleviate poverty to some degree in areas where very few other means of livelihood exist, the sector must take steps to reform. This report identifies that the most significant barriers to improvement in environmental protection, workplace health and safety conditions, and local community wellbeing, is a lack of Government management of the sector and a lack of training amongst the gold miners.

This report recommends that local mining companies and wealthy miners take greater responsibility for their operations, in accordance with the law, regarding operating standards, environmental protection, health and safety in the work place, and towards the local dependent mining communities. It may be necessary to develop the capacity of local authorities to effectively enforce mining regulations. Miners who work independently should receive training via outreach programs to raise their awareness of technical, health, safety, environmental, and labor issues. In areas where mining concessions are granted, the Government should ensure that the concessionaire abides by the terms of the license agreement. Further research in technical, environmental, health, socio-economic, and legal fields should be conducted to provide practical and locally applicable solutions to the issues identified by the present study.

1. Introduction

Gold mining within Cambodia is small-scale by international standards. The sector is however experiencing a period of growth accompanied by technological improvements; the number of miners employed in the sector is increasing, mines are excavated to greater depths, and chemical-based gold recovery techniques have been introduced. In some cases previously open-access mining areas have been designated as mineral concessions that are controlled by concessionaires. Other gold deposits are effectively controlled by the local military or police forces. In both cases, fees and royalties are levied against independent mining activity making the livelihoods of poor miners increasingly precarious. As a consequence of poor mining practices, in particular resulting from a lack of effective Government regulation and a lack of training amongst gold miners, increasingly serious impacts on natural resources, human health, and rural livelihoods have resulted. An urgent need for progressive change within the sector has been increasingly recognized by the Royal Government of Cambodia, provincial authorities, NGOs, and the public.

In 1975 twelve gold deposits were known to exist within Cambodia having been identified by French geologists. Ten gold deposits were located in the western regions of Cambodia with a further two located in northwestern Cambodia. The latter regions however were comparatively inaccessible as a result of thick jungle and in later years the presence of the Khmer Rouge. However during the Vietnamese

occupation throughout the 1980s however the northeastern region was one of the safest in Cambodia and thus favorable for gold prospectors. Within a few years seven new significant gold deposits had been discovered by local farmers in the northeast, instigating a 'gold rush' to the region. There are currently 19 known gold deposits in Cambodia.

Year by year gold mining has become an increasingly important profession in Cambodia, both for full-time professional migrant gold miners who move from one gold deposit to another, and for local farmers who supplement their income between agricultural seasons. At present, it is estimated that between 5,000 and 6,000 people are employed during the peak mining season in Cambodia, which begins in November and finishes in May, i.e. Cambodia's dry season (Department of Geology, Pers. Comm., 2004). New mining settlements, whose population can number up to 1,000 people, have appeared close to many major gold deposits. These transformations place stress on local communities and additional pressures on the local environment.

Traditionally in Cambodia gold has been recovered from placer materials using manual sluicing and panning. In recent years however mercury-based amalgamation and cyanide-based heap leaching techniques have been introduced to recover trace quantities of gold from gold-poor ores. The untrained use of these highly toxic chemical substances introduces a high risk of damage to the environment and can seriously affect the health both of the worker and members of the broader community. Furthermore, improper storage of the toxic chemical tainted tailings can act as a longer-term source of pollution. A short survey carried out in 1999 in Sampeou Loon gold deposit, Memot district, Kampong Cham province by the Department of Geology (DoG) identified several fatalities that had resulted from people using river water that had been polluted by chemicals used in mining activities. Local people were unaware of the hazards associated with mercury and cyanide.

This report documents the current situation of the gold mining sector in Cambodia based on the results of a survey conducted by the DoG in four gold mining areas during September and October 2003. The goal of the survey was to determine the nature, extent, environmental impacts, and socio-economic impacts associated with small-scale mining in Cambodia and to make recommendations to resolve any issues identified. The survey represents the first reconnaissance study of the gold mining situation in Cambodia to date.

2. Methodology of the survey

The DoG survey team was led by Mr. Sieng Sotham (Team Leader), and included Mr. Ben Bunnarin (Environmental Expert), Mr. Im Sim (Technical Expert), and Mr. Bin Thet (Socio-economic Expert). Staff from the provincial Departments of Industry, Mines and Energy (DIME) provided invaluable assistance to the DoG survey team at each location, acting in a role of provincial coordinator. In addition, local people (often gold miners) with extensive local knowledge of the mining situation were employed as guides during the survey. Security was an issue necessitating security guards from the local armed forces to be hired at each survey site to ensure the team's safety.

Objectives of the overall project were:

- To identify the types and extent of gold mining and processing in operation within Cambodia;
- To assess the socio-economic conditions within the gold mining settlements;
- To define and quantify the major negative environmental and health impacts caused by gold mining operations in the study areas;
- To evaluate practical solutions, appropriate to the local context, to mitigate the negative impacts.

Four active mining sites located in Cambodia's most sensitive areas were selected as targets for the study and fieldwork conducted in each, namely:

- Sampeou Loon gold deposit, Memot district, Kampong Cham province.
- O Tron gold deposit, Sambo district, Kratie[1] province.
- Phnom Chi gold deposit, Sandan district, Kampong Thom province
- Prey Meas gold deposit, O Yadao[2] district, Ratanakiri province.

To determine the types of gold mining and processing in operation observations of the practices of gold miners were made. Further information was collected by interviewing the miners.

Socio-economic questionnaires were conducted to gather information on origin, lifestyle, habits, and composition of the local population. A broad range of stakeholders including gold miners, local concessionaires, mine owners, village chiefs, community chiefs, workers, local peoples, and tribal peoples were interviewed. At least ten interviews were conducted per deposit.

Assessment of the environmental damage resulting from the mining activity was made through field-based water quality measurements and visual inspection[3]. Specific pollution incidents attributed to mining activity in the past were recorded by interviewing people.

The dates below which the fieldwork was carried out are detailed below in Table 1. Activities during the fieldwork period include travel to the location from Phnom Penh, meetings with local officials and experts, and survey of the gold mining area itself.

Table 1: Fieldwork dates

Fieldwork location	Fieldwork dates*
Sampeou Loon gold deposit	23rd – 26th September, 2003 (2.5 days)
O Tron gold deposit	30th September – 3rd October, 2003 (2 days)
Phnom Chi gold deposit	9th – 14th October, 2003 (3 days)
Prey Meas gold deposit	16th – 21st October, 2003 (3 days)

- *Bracketed numbers indicate the number of days surveyed in the gold mining area.*

[1] *Kratie province is alternatively known in some reports as Kraches province*

[2] *O Yadao district is alternatively known in some reports as O Yadav district*

[3] *A limited number of samples were collected for analysis of mercury and heavy metals in the laboratory to indicate overall contamination levels.*

All four gold deposits surveyed are located in remote areas and were difficult to access due to poor infrastructure, which was further deteriorated because the survey was conducted during the rainy season. Transportation was by 4-wheel drive vehicle where conditions were permitting and otherwise by motorcycle.

In the rainy season gold mining activities are significantly reduced due to flooding and the elevated risk of malaria. As such, only a limited amount of gold mining was observed that would represent only a fraction in the peak mining period.

Symptomatic of the nature of discipline imposed by the military and concessionaires who control access to the gold mining areas, it was found that some local people and miners were unwilling to give information to the survey team for legitimate fear of retribution against them by the local armed forces or mining company security guards. In some cases the local armed forces would not allow the survey team to visit gold mining areas.

3. Characteristics of gold mining in Cambodia

3.1 THE LEGAL FRAMEWORK FOR GOLD MINING

The Law on Management and Exploitation of Mineral Resources was ratified in July 2001. Under the current Law all mineral resources are considered to be property of the State (Article 2) and all mining activities, including gold mining, are illegal unless permission is granted by the Ministry in charge of the mineral sector, presently the Ministry of Industry, Mines and Energy (MIME) (Article 5). According to the current Law mineral licenses are classified into six categories: the Artisanal mining license; Pits and quarry mining license; Gemstone exploitation license; Mineral cutting license; Mineral Exploration license; and Industrial mining license (Article 11).

Before the ratification of the law in July 2001, combined licenses were issued for the exploration and exploitation of mineral resources. Further permits were then required to conduct exploration and exploitation activities within the licensed area. The current Law differentiates this previous license into the Mineral Exploration license and the Industrial mining license. Permits are still required to conduct either exploration or exploitation activity. However, inconsistent with the current Law, such combined licenses for mineral exploration and exploitation are still issued to mining companies. Several licenses to explore and exploit mineral resources have been issued to both local and foreign mining companies. Before being granted permission to exploit a resource following exploration, technical, financial, environmental, social, and economic reports must be submitted and approved by the Minister in charge of the mineral sector detailing socio-economic feasibility of the mining operation (Article 11).

In order to conduct mineral resources exploration numerous approved documents must be submitted, including an exploration work program, environmental impact assessment (EIA) and environmental management plans (Article 21). In the case of EIA's, these must also be approved by the Ministry of Environment. Unfortunately, the EIA is weak as a practical working document that should assess potential environmental damage and propose mitigation steps.

Article 21 of the Law on mining outlines the standards required for conducting exploration and exploitation of mineral resources. The responsibility for maintenance of these standards is identified to lie with the concessionaire and contractors. Responsibilities include standards on: protection of the environment; health and safety of employees working the mine; provision of adequate training for employees; and protection of public safety in and around the mining site. Article 18 declares that issued mineral resource licenses may be suspended or cancelled if the concessionaire is found to be in violation of the Law.

The Artisanal mining license appears to be the most applicable to present small-scale gold mining operations found in Cambodia. Under this license exploitation is limited to gold found in placers and shallow ore deposits and may be issued only to persons of Khmer nationality. Only the use of hand tools is permitted. In reality, gold placers and shallow ores deposits are almost exhausted. Miners dig shafts to mine gold deposits located deeper beneath the surface. The depth of the shafts in many cases exceeds that permitted by the Law, which is five meters. Also in infringement of the current Law, miners use explosives to blast the hard bedrocks and use mechanical equipment to hoist the ore up from the bottom of the shafts.

While many provincial authority officials are aware of both the scale of mining and the pertinent regulations, these regulations in reality are only weakly enforced. Potential explanations include the power of the individuals running the mining operations to exert influence over the relevant authorities, and a lack of funding and resources for enforcement activities.

3.2 STRUCTURE OF GOLD MINING

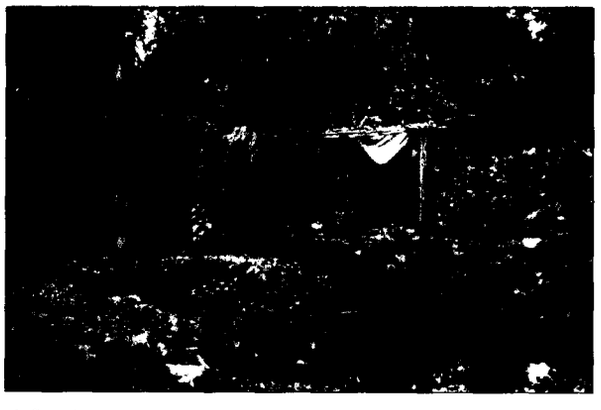
One of the major differences between the mining industry in Cambodia and those in other countries is the organizational grouping of the miners. Mainstream international mining companies are not represented and the sector appears increasingly dominated by local, Korean or Chinese backed small companies. There are many independent gold mining individuals and small groups, but it would appear that the number of independent miners is decreasing in the face of increasing control over mining areas by concessionaires, companies, and wealthy miners. In addition, military personnel are posted to operations partly to maintain control and

partly for civil order. Political overtones create an added dimension that shapes the Cambodian gold mining sector.

3.3 TYPES OF GOLD MINING

Two types of small-scale mining operation are found to be predominantly conducted in Cambodia: open trenching, and underground shafting/tunneling. The choice of mining method is dependant on the location of the gold-bearing ore. Pocket mining is also conducted on surface placers and shallow deposits, although many of these locations are now exhausted and unprofitable.

Mining is conducted primarily using hand tools. In general, home-made equipment such as manual winches and wooden rails are used to hoist miners and the ore from the bottom of the shafts and trenches. In some cases machinery is used to pull wooden ore wagons and small water-pumps used to control water flow in the excavation. All deep trenches, shafts and tunnels dug into loose alluvial materials have timber supports to prevent the collapse of the excavation. However, no support is used when excavating into hard rock. The use of wooden supports in shallow pocket mines is also comparatively rare. No ventilation was observed to be used, even in deep shafts and tunnels. Miners use candles to confirm the presence of oxygen. In some places surveyed, such as Phnom Chi and O Tron, explosives are used to blast hard rock ores. The practice involves drilling small blast holes of about 20 millimeters in diameter and up to 0.8 meter depth using hand-held mild steel tools that are then packed with explosives and detonated to shatter the gold bearing ore.



A flooded trench in O Tron deposit.

3.4 TYPES OF GOLD PROCESSING

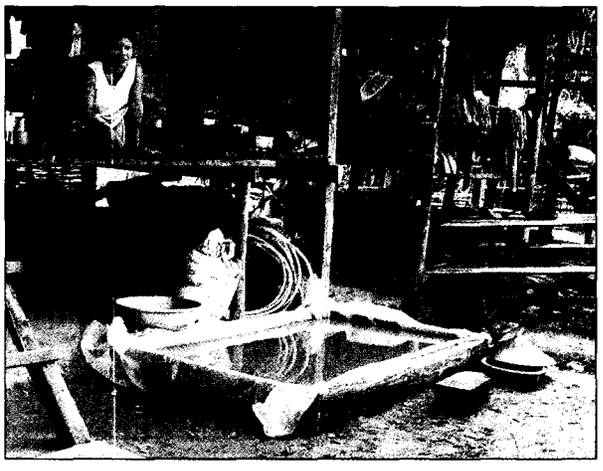
Three gold processing techniques are utilized in Cambodia to extract gold from ore: sluicing and panning; mercury amalgamation; and heap leaching cyanidation (see Glossary). Traditionally, only sluicing and panning has been conducted in Cambodia. However, as the more readily available deposits of gold become exhausted and the industry develops both in size and technology, the latter chemical extraction techniques have been increasingly adopted. The use of mercury, cyanide and strong alkalis incurs serious risk of damage both to human health and the environment if appropriate 'best practices' are not adopted. These issues are outlined in sections 4.1 and 4.2 respectively.

The sluicing and panning method was extremely common at all gold mining locations surveyed. In general, once gold-bearing ore is extracted from the deposit it is ground into a powder using rock crushers and mills available on site and then sent for sluicing. The gold and heavy mineral concentrates that accumulate in the sluice boxes are then manually scooped out and panned. Wooden sluice boxes of many different sizes were observed, sometimes covered by rubber mat or woolly tissue. Home-made iron sheet gold pans of around 0.5 meter in diameter are typically used. Black sand is then treated with strong acids or mercury amalgamation to recover trace quantities of gold. Miners usually use nitric acid to recover gold from the black mineral concentrates. Nitric acid is somewhat less dangerous than the sodium cyanide used in heap leaching, although dangerous none the less especially in the hands of the untrained. In other cases the miners sell the black mineral concentrate directly to a trader, who will conduct the strong acid process instead. Complex home made machines combining pumps, mills, and sluice boxes are widely used by local miners. A minimum of three people are required to achieve efficient sluicing and panning.

Heap leaching cyanidation was practiced at Phnom Chi, O Tron, and perhaps most prolifically at Sampeou Loon, where extensive environmental damage has resulted. Heap leaching tanks are often located next to major water courses. Spillage of cyanide chemical solutions, together with inappropriate storing of toxic chemical tainted tailings that may then be washed or leached into the river, resulted in damage to fish, cattle, wildlife, and also has been blamed for human illness.

The use of mercury amalgamation was widespread amongst miners in Prey Meas and had previously been practiced at Sampeou Loon. In the method adopted by Cambodian miners, mercury vapor is released directly to the atmosphere with grave ramifications for worker health, the environment, and the broader community.

Amongst the chemical processing techniques employed, there would appear to be a trend for a reduction in the use of mercury amalgamation and increasing popularity for cyanidation, which has a larger processing capacity. This is most likely a result of the transition organization of miners from small independent groups to larger scale excavations funded by wealthy miners or local companies that employ poorer miners as laborers, as well as the exhaustion of rich gold deposits.



A heap leaching tank below a house in Phnom Chi.

4. Issues related to gold mining in Cambodia

4.1 HUMAN HEALTH

Numerous health risks are faced by miners and, more broadly, local communities. Health problems are exacerbated by the weak health care systems in present mining settlements. Often, mining communities are in remote, poorly accessible regions distant from major population centers where improved health care is available. Some mining settlements, such as Yeak Baing Prey Meas village and O Tron village are not even officially recognized as settlements by the Ministry of Interior. Poverty acts as a further barrier to health care access, which in some cases has led to a dependence on traditional medicines.

Regarding general health, the remoteness of mining communities from centers of trading and diverse farmlands can result in an unbalanced diet and lead to general weakness of health, heightening proneness to disease. Most mining regions in Cambodia are located in deep forest and the prevalence of malaria is a serious problem, particularly in the rainy season. Finally, the non-traditional social structure of mining communities can result in increased rates of transmission of STDs and HIV/AIDS.

The working environment within mine excavations can lead to several long term health problems, particularly if the mine is poorly managed. High levels of dust can lead to lung damage and diseases such as silicosis. It was noted throughout the survey that tunnels and shafts are poorly ventilated. Weakly lit underground tunnels can lead to eye strain and eventually blindness.

Severe damage to health can result from the improper use, storage, and disposal of the mercury, cyanide, and strong acids that are used in gold processing methods. A lack of training and the complete absence of protective clothing observed by the survey team at all mining sites results in Cambodian miners placing their health at serious risk. Furthermore, releases of these chemicals into the environment that subsequently poison drinking water resources and contaminate the food chain will lead to a broader population being affected than just those working with the chemicals. Scientific measurements evaluating the extent of environmental contamination and hence risk to the broader population remain to be conducted. Field observations are however indicative of the extent of potential damage that has occurred.

Mercury in particular is considered dangerous because, in contrast with cyanide, health impacts are

Human health effects from exposure to mercury and cyanide

Mercury: Exposure to mercury can be through ingestion, skin contact, or by vapor inhalation. Mercury is stored within the body for long periods of time, concentrating in the brain and kidneys. Symptoms from acute mercury poisoning include: permanent damage to the brain, kidneys, and developing fetus. Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems. Short-term exposure to high levels of metallic mercury vapors may cause effects including lung damage, nausea, vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation. In extreme cases of poisoning victims will suffer an paralysis, convulsions, and even death. Chronic illnesses associated with mercury include damage to the kidneys, central nervous system, heart, and immune system. Young children and fetuses are particularly vulnerable to the effects of mercury, resulting in abnormal or impeded child development.

Cyanide: An extremely small dose of cyanide can be lethal within a few minutes. Exposure can be through ingestion, skin contact, or inhalation. Unlike mercury, cyanide is not stored in the body for long periods of time. Acute doses of cyanide result in cellular asphyxiation. Physical symptoms include: headache, drowsiness; weak and rapid pulse; and shallow breathing. Coma and death may follow. Chronic exposure has been linked to demyelination, lesions of the optic nerve, ataxia, hypertonia, Leber's optic atrophy, goiters, and depressed thyroid functions.

References: ToxFAQs (1999); Mallinckrodt Baker, Inc. (2001)

not immediately obvious. During the amalgamation process, the amalgam is placed in an open container and heated over a fire by miners who wear no masks and therefore freely breathe the released mercury vapor. In some cases, this process was conducted in the home, contaminating the room and concentrating the vapors breathed. No special consideration was given to minimize the exposure of young children and pregnant women to mercury.

Mercury is known to bioaccumulate within the body and biomagnify up the food chain. When mercury pollutes water sources fish are readily contaminated. In Cambodia, many communities are dependant on fish as a staple food and this may be resulting in a significant exposure to local populations to mercury derived compounds. It is widely cited that 75% of the Cambodian populations animal protein intake is derived from the consumption of fresh and processed fish (McKenney and Tola, 2002). Concentrations of one part per million mercury in fish tissue are considered to be a health hazard for human consumption by the US Food and Drug Administration (FDA, 1995).

The survey team noted a broad unawareness amongst people living in the mining areas of how the environment had been contaminated and might affect their health. They used water from wells of high acidity, potentially contaminated with heavy metals and chemicals used in gold processing. In villages downstream of the mining area, people continued to use the river water not realizing it could damage their health.

4.2 ENVIRONMENTAL ISSUES

Unregulated and poorly managed gold mining can result in serious environmental damage. Once forests are felled, agricultural soils destroyed, wildlife hunted, and water resources polluted it is difficult and expensive to remediate the damage.

The dangerous chemicals used in gold processing in Cambodia hold great potential to pollute surface water and groundwater resources. Cyanide is extremely toxic and relatively small quantities released into surface waters leads to the rapid and indiscriminate death of all aquatic fauna. Cyanide breaks down quickly in the environment, within hours or days, and does not bioaccumulate or biomagnify. Hence, pollution incidents tend to be relatively localized although potentially devastating in magnitude. Unwitting use of cyanide polluted rivers as a drinking water source will result in the illness or death of cattle and wildlife, as well as human illness or death. Such a case, reported in *The Cambodia Daily*, occurred at Phnom Chi deposit in late 2003, resulting in mass fish kills, the death of cattle, and human illness along the Porong River (Barron, 2004).

Mercury is also a highly toxic compound to all species. Once released into the environment bacteria fix elemental mercury into methyl and ethyl mercury complexes, which are water soluble and highly mobile. Methyl and ethyl mercury complexes are readily stored in organic tissue, where they stay resident for long periods (usually several years), concentrating in the organs of longer lived species higher up the food chain. Mercury is a long term environmental contaminant and may be transported away from the gold processing site by wind, rainfall, and water currents contaminating a wider area. Exposure to small doses of mercury over a long period of time has been proven to lead to serious damage to living organisms. Although scientific measurements were not made in the current survey, it is likely that mercury contamination is severe in the immediate vicinity of gold processing areas in Prey Meas deposit, where mercury use is prolific.

Mining tailings (the waste extracted ore) if inappropriately discarded can act as a significant long-term source of pollution in several ways. Tailings treated with cyanide, mercury or strong acids retain small amounts of these chemicals bound to the of the ore surfaces. Subsequent rainfall leaches the toxic chemicals from the ore surface into the wider environment. Depending on where the tailings have been discarded surface water or groundwater pollution can consequently result. In a similar manner, many gold bearing rocks contain trace concentrations of naturally occurring toxic heavy metals, such as arsenic, which can be leached into the wider environment.

At Phnom Chi and Sampeou Loon deposits cyanide contaminated tailings stored close to river banks were observed by the survey team. Inevitably, heavy rains would wash cyanide into the river with environmental damage ensuing. It might be speculated that the mass poisoning at Phnom Chi described above occurred as a result of these circumstances.

Tailings stored close to river banks can also be washed into the river resulting in siltation, make the river shallower and affecting river hydrology. This phenomenon was observed at Sampeou Loon deposit. For prevention of both chemical leaching and siltation the only solution is appropriate storage of tailings.

Deforestation, as a result of mining activity, has been extensive within the locality of mining activity. Timber is required as supports in the mine shafts and

tunnels, to build housing in settlements, and as fuel. Furthermore, land for mining, settlement, and access is also required, necessitating the clearance of forest. Many gold deposits in Cambodia are located in mature primary forest; of the sites investigated in the current survey this is the case for Phnom Chi, O Tron, and Prey Meas.

Hunting of wildlife is also common in the vicinity of mining settlements. Because local agriculture and animal husbandry is limited, wild animals are hunted as a source of food. In a survey conducted by the Environmental Forum Core Team EFCT in March 2004, 64% of those interviewed at Phnom Chi deposit thought that the wildlife population had decreased.

Landscapes are damaged during mining by trenches and shaft excavation, tailings disposal, and other associated activities. It appears that no attempt is made to rehabilitate mining areas following completion of mining activities, leaving the landscape scarred. Of great concern is that deep shafts are left unfilled and unmarked, presenting a potentially fatal hazard into which humans and animals may fall.

4.3 ORIGIN AND SOCIO-ECONOMIC STATUS OF THE MINING COMMUNITIES

There are four key groups of people involved directly in the mining sector: local people, migrant workers, wealthy miners, and concessionaires. In addition, numerous other people are employed in various mining support sectors, for example small businesses, karaoke bars, and brothels.

Local people have lived within the mining areas for generations, own agricultural land, and are principally farmers. They prospect for gold to earn additional income only outside of the farming season. In general, only the men mine for gold while women and children complete other tasks within the village. Traditionally, local people panned for gold and do not own any machinery including sluices. More recently however, some local people have become employees of wealthy miners, mining companies or concessionaires conducting mining activities. Unlike other groups of miners, local people only work close to their home village and do not seek mining work further afield.

Migrant miners tend to be professional miners, and seem to mainly originate from the southern provinces of Cambodia, such as Kandal, Prey Veng, Svay Rieng, and Kampong Cham. Migrant workers may however also originate from communes/districts located close to the deposits. Many migrant miners do not own agricultural land and derive their livelihood by traveling from one deposit to another prospecting for gold. Sometimes they build a semi-permanent gold mining village and practice mining throughout the year within its vicinity. With the migrant worker group, often all family members including children are involved in the mining activity. While a few children may go to school if the family has relatives living near a district or provincial city centers, it is more common for the children to stay with their parents and hence move from place to place to mine gold.

A second group of migrant miners are wealthy and live in district or provincial centers. They employ local people and poorer migrant miners to mine gold on their behalf. Typically, they invest capital in building heap leaching tanks to extract gold from ores at a larger scale than local communities and poorer migrant workers. These wealthy migrant miners are sometimes backed by the local authorities or armed forces. In places where gold deposits are located in concession areas, they obtain permission to mine from the concessionaire by paying fees and royalties.

The final mining group is the extremely wealthy concessionaires who obtain licenses to develop a mineral industry in significant gold deposits from the Government. The gold deposit is designated as a mineral concession, with mining rights given exclusively to the concessionaire. A field office is installed in the mining area and the concessionaires employ local people and migrant miners to work their mineral operations. As described above, in some concessions wealthy miners pay the concessionaire for permission to conduct gold mining activities.

It is estimated that around 80% of gold miners can be classified as poor, in that they mine ore only using hand tools and own no machinery, not even water pumps. These miners, when working independently, can exploit only the surface or shallow ores deposits and process the gold using either panning or manual sluicing. All local people and most migrant workers belong to this group. During the mining season they commonly work for wealthy migrant gold miners. During the rainy season the local miners work in agriculture and the poor migrant miners continue to mine for themselves. Working in this manner, poor miners can earn between 6,000 and 10,000 Riel per day, which is equivalent to between US$ 1.5 and US$ 2.5 per day[4].

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[4] 4000 Cambodian Riel = 1 US dollar. For purpose of this report all monetary figures are given in US$, although Riel is the National currency.

This income is just only enough to survive because the cost of living in mining settlements is high due to their remoteness. However, the hard working conditions and poor diets of these miners inevitably results in an elevated risk of infection by malaria and other diseases. For this group of miners gold mining is their main livelihood.

Wealthy miners own machinery that facilitates more efficient, large-scale ore extraction and gold processing. They are able to hire workers to operate the machines and can earn a net profit of between US$ 10 and US$ 15 per day. Some of the wealthy miners are keen to expand their operations further. Others however said they have had to stop mining due to the high levels of taxation imposed by concessionaires.

Mecury amalgamation carried out in Phnom Meas, without any protective clothing.

4.4 HEALTH AND SAFETY AT WORK

Mines are dangerous working environments anywhere in the world and there is a real risk of serious injury or death for those employed. In a professionally managed mine rules on worker safety are usually in place and miners usually receive at least some training, although accidents are not uncommon. However, in Cambodia a complete lack of regulation and adequately qualified engineers and mining foremen is a significant impediment to improving health and safety at work. Over the course of the survey, over 20 deaths resulting from the collapse of shafts or tunnels were reported; in all cases the collapses occurred due to the absence of wall and roof supports in the excavations. In fact, even basic safety precautions were absent, for example no miner was found to wear a hard hat as protection against falling rocks.

The improper usage and storage of explosives, where used, was a second major health and safety issue noted by the survey team. It was found that explosives and detonators used for blasting ore were sometimes stored in the home in inappropriate storage containers with no labeling.

4.5 LABOR ISSUES

Working conditions and labor issues for miners vary between sites. Professional, technically skilled miners received a higher salary and better working conditions than unskilled laboring miners. In general, it appears that for poorer miners, working for a wealthy miner will often result in a higher income than working independently. This is because wealthy miners possess appropriate mining equipment and are able to dig shafts or trenches, thus accessing the deeper gold rich deposits. Poor miners are only able to pan gold-poor tailings or placer deposits, which at many sites are near exhausted. Working independently, poor miners furthermore take on the burden of uncertainty that they will indeed strike gold.

The casual nature of the work means that miners have few, if any, labor rights. Entitlements to sick and other benefits are virtually non-existent. No union exists for gold miners. Such conditions however are common to many industries in Cambodia.

4.6 CHILDREN IN MINING

Children do, to a limited extent, work in the Cambodian gold mining sector. While no children were found to be mining at Prey Meas deposit. Where children do help their parents with gold mining, typical tasks include collecting ore and panning. While these tasks are not particularly heavy or dangerous, potentially fatal hazards do exist within the gold mining areas where the children live, work, and play, such as operating machinery and abandoned mine shafts.

There is in fact a mixture of cases; some migrant families' children stay with relatives in district/ provincial centers where they receive an education and basic health care, while other families keep their children with them at the mining settlements where no such services exist. The lack of access to even basic health and education services for children living within the mining settlements is perhaps the most important child rights issue that will affect their future prospects.

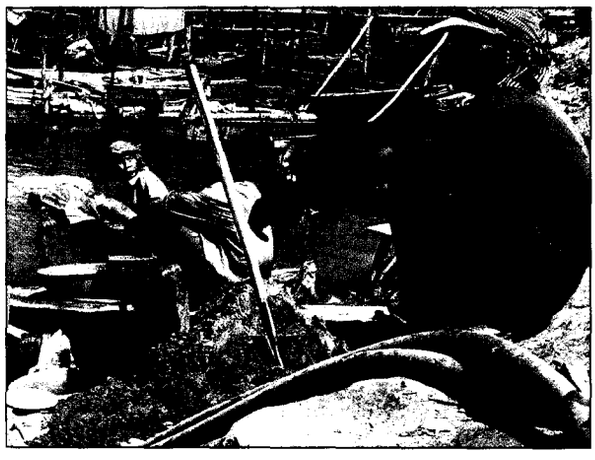
4.7 LAND ACCESS ISSUES

In early times, access to gold deposits and the right

to exploit them was available to anybody who had appropriate knowledge and equipment. However, with the advent of mineral concessions granted to large companies by the Government, in numerous instances local people have been denied freedom of access to their ancestral land and mines.

Taken to its extreme, independent miners, either local or migrant are banned from conducting mining activities. For example, at Phnom Chi deposit all independent mining activity was banned from early 2001 to early 2002 following the arrival of Neoneer Cambodia Ltd. From early 2002 onwards mining has been permitted, but only under the tight control of the company who levies fees and a mineral royalty system on the miners. This is in fact in violation of the company's license agreement with MIME, which permits Neoneer Cambodia Ltd. exploration rights only. A similar circumstance exists at Sampeou Loon deposit, licensed to SUN Trading Co. Ltd. where independent underground mining activity has been banned since 1998. Despite the company ceasing mining activities in 2001 the ban remains in place, enforced by company security guards.

O Tron deposit and Prey Meas deposit are not currently designated as concessions, although mineral exploitation companies have at various points expressed interest. Both mining settlements are not legally recognized by the Ministry of the Interior and the regions are essentially controlled by the military rather than the police. Under the present circumstances, people are allowed in theory to mine freely, although in practice payment of fees to the local military or police is not uncommon. However, particularly at O Tron, the military is very powerful and people are afraid to travel to some areas of the forest where allegedly the military are conducting illegal mining activities.



Small scale sluicing at Phnom Chi deposit.

5. Four case studies of gold mining in Cambodia

The following sections describe in detail four surveys conducted by the DoG team. Supplementary information from two additional investigations at Phnom Chi deposit by the EFCT, (2004) and independent researchers (Galabru and Lon, 2004) are also presented. A location map showing each site is presented in the Introduction.

5.1 PHNOM CHI GOLD DEPOSIT, SANDAN DISTRICT, KAMPONG THOM PROVINCE.

5.1.1 Location of Phnom Chi gold mining area

The Phnom Chi gold mining area is located in Sandan district, Kampong Thom province, approximately 100 km east-northeast of Kampong Thom city. The mining area is in the mineral concession of Cambodia Evergreen Company, whose field headquarters are located in Snang An village, a mining settlement close to the gold deposits.

Phnom Chi deposit consists of two active mining areas: Snang An mining area, located approximately five km northwest of Phnom Chi mountain; and Phnom Chi mining area located in the southwest foothills of Phnom Chi mountain. There are four active mining sites in the Snang An mining area, namely: Bo Toch; Bo Thom; Bo Kbal Damrey; and O Phaav. In the Phnom Chi mining area there are two active sites: Roluos Thom; and Rolous Toch.

5.1.2 Description of survey activities

The DoG survey was conducted over a three day period between the 10th and 12th of October, 2003. The survey was facilitated by Mr. Nhek Kunthea, Deputy Director of DIME, Kampong Thom province, and Mr. Rath Sieng Hay, Chief of the Environmental Control Office of the Provincial Department of Environment, Kampong Thom province.

Due to time constraints and the absense of access roads Phnom Chi mining area was not visited. The survey only focused on the Snang An minging area.

The EFCT conducted interviews on 25th March, 2004 (EFCT, 2004). 48 gold miners and two non-gold miners from Snang An were interviewed, together with eleven non-gold miners from Srei Pring and eight non-gold miners from Sok Chet.

Independent researchers (Galabru and Lon, 2004) investigated gold mining activity at Phnom Chi on 31st January, 2004.

5.1.3 History of gold exploitation in Phnom Chi gold deposit

The Phnom Chi gold deposit has been known to exist for a long time. In the past, gold was seasonally mined from rich placers by farmers who lived in villages nearby. At this time, panning was the sole method of gold processing in use.

As a result of the civil war in Cambodia during the 1970's all gold mining activity stopped. During the early 1980's the Phnom Chi area was under the control of the Khmer Rouge. Driven by extreme poverty, some people living in Kratie and Kampong Thom provinces would risk their lives to come and mine the deposit. At that time, they would pay taxes to the Khmer Rouge soldiers who controlled the area.

The intensity of gold mining activity at the Phnom Chi deposit has boomed since the early 1990's. Following the establishment of the official Royal Government in 1993, a section of the Royal Army was sent to supervise the area. The gold miners paid the military for the right to mine the gold in the area.

In 1998, a license for exploration and exploitation of mineral resources was issued by MIME to Cambodia Evergreen Company, a local company owned by Dr. Nang Sothy, a Cambodian national. However, due to access difficulties and a poor security situation the company was not able to operate within the concession until 2001.

Mining activity by independent miners has been intensive since the beginning of the 1990's. Following the Cambodia Evergreen Company's arrival, all independent mining activity was banned in early 2001. Permission for mining was then granted once again by the Company in early 2002, but under the tight control of the mining company, who regulate the quantities of explosives used by miners and impose a mining fee and tax system. Cambodia Evergreen Company only holds a permit for exploration and does not conduct mining activity itself. However, neither does this permit entitle the

Company to regulate active mining activity within its concession.

Cambodia Evergreen Company is closely affiliated with Neoneer Cambodia Ltd., and it is in fact this latter company that exerts control over the deposit.

5.1.4 Socio-economic conditions of the communities

The sole activity of the inhabitants of Snang An village is gold mining. The village was founded in 1980 when there was an initial gold rush into the area. According to Cambodia's census conducted in February 2003, a total population of 923 persons live in the Snang An gold mining settlement.

Miners who originate from districts close to Phnom Chi and who now live in Snang An village represent the majority of miners. Other migrant miners came from Prey Veng and Kampong Cham provinces. Both of these groups can be considered professional miners. Local people also mine gold in Phnom Chi to generate desperately needed income. The local people however are not professional miners and possess no gold mining equipment with the exception of gold pans.

Before the arrival of Neoneer Cambodia Ltd., gold mining was relatively prosperous for all involved. At the Phnom Chi deposit gold bearing ore can be mined all year round. Poorer miners usually prefer to work for wealthy miners, who have appropriate mining equipment, because they can receive a higher salary than if they work independently. A worker will receive around US$ 2 per day together with three daily meals. The wealthy miners that employ the workers would obtain between eight and ten chi[5] of gold per day.

Pocket miners, who independently mine the gold-poor surface layer, can recover between two and five huns of gold per day, which is equivalent to between US$ 6 and US$ 15 per day. A similar income is received by villagers who exploit gold from the tailings and gold poor ore mined from the shafts. Although this is greater than the poor miners who work for wealthy miners, high yielding deposits are hard to find. As such, migrant poor workers prefer to work one day at a time for wealthy miners.

However, now independent miners' incomes have dropped to between two and five li of gold per day, equivalent to on average US$ 1.5 per day, as shaft owners do not permit the miners to exploit the gold poor ore from their shafts anymore.

This is because the shaft owners now have to pay significant fees to the mining company and must exploit all gold resources at their disposal to make a profit.

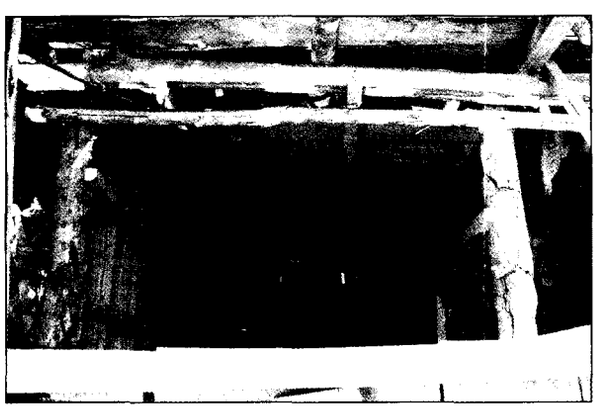
Presently, miners must pay a fee of approximately 150,000 Riel, equivalent to US$ 37.5, to the company for permission to mine per shaft. Furthermore, miners must pay a 30% mineral royalty to Neoneer Cambodia Ltd. on all gold exploited.

5.1.5 Gold mining

Only shaft mining is conducted in the Snang An gold mining area. Typical exploitation shafts are excavated 2 by 2 meters in cross-section and to a depth of between 8 to 15 meters. Wooden supports tress the excavated shafts. Machinery is used to pump water from the shafts and to mill the excavated ore. In general, ore is winched to the surface manually, although mechanical winches were observed to be used in Bo Thom.

Up until 2002, only manual equipment was used for excavating the shafts. Since 2002 however, Neoneer Cambodia Ltd. has introduced the use of explosives. Detonators and explosives are imported into the gold mining area by the company, which are then sold to local miners to blast the ore. The Company strictly controls the consumption of explosives. Blasting is permitted once a day and one kg of explosive is used for each blasting.

Poor miners, who have no means to conduct shaft mining practice pocket mining in the shallow ore layers. The holes dug by pocket miners are not deep, normally between two and three meters, but dug into loose ground and lacking wooden supports this method of mining is dangerous. Galabru and Lon (2004) found that some local companies mined gold-



A shaft at Phnom Chi deposit.

[5] Note on the local units of gold measurement: 1 Li = 0.0375 g of gold; 10 Li = 1 Hun; 10 Hun = 1 Chi; 10 Chi = 1 Damloeung = 37.509 g of gold; The exchange rate at the time of the survey was 1 chi = US$ 40

bearing ore from shaft excavations and then sold this ore to villagers or family scale operators at US$ 1.25 per kg to process.

5.1.6 Gold processing

Initial processing of the gold-bearing ore is by panning and sluicing, thus obtaining the mineral concentrate. Typically, the gold is then recovered from the concentrate using strong acids. Mercury amalgamation processing has not been used at the Phnom Chi site. Over the last three years however, heap leaching cyanidation has been conducted at some sites to extract gold from low grade ore, such as at Bo Thom. At this site, a total of 15 heap leaching tanks of typical dimension 5 to10 m by 5 m by 0.8-1 m were observed. The heap leaching tanks were full of ore, indicating that heap leaching continued to operate at the site.

In mid-2003, the use of cyanidation was common at Snang An village. Almost all mining families possessed their own heap leaching tanks. The heap leaching tanks were small and built just below their houses on the banks of the Porong River. Waste cyanide solution was regularly spilled into the river. Mining tailings were also discarded into the river, the combined effect of which resulted in the death of aquatic fauna. Within a few months, seeing the damage caused, the provincial authorities banned cyanidation. Mr. Rath Sieng Hay, Chief of the Environmental Control Office within the provincial Department of Environment told the survey team that the department has set up guidelines about chemicals banned in gold treatment. However, according to observations of the survey team the enforcement of the guidelines has not been effective and heap leaching tanks are still in operation.

Galabru and Lon (2004), interviewing villagers from Snang An, report that the use of unidentified acids is also common place. Interviewees said they used approximately half a liter each month. Because of the bad smell of the acid and to protect villagers' health acid waste was buried in the forest. EFCT interviews determined that 46% used acid or cyanide to process their gold, 13% used 'other chemicals' and 41% gave no answer.

It is likely that out of economic necessity miners will continue to use cyanidation techniques, because they need to recover the gold from the low grade ore in order to cover the fees imposed on them for permission to mine by Neoneer Cambodia Ltd.

5.1.7 Impacts

Environmental

The use of heap leaching tanks and acids in close to the Porong River resulted in poisoning. The pollution originates both from accidental spillage of the chemicals used and leachate from the mining tailings stored close to the river. Cases of cattle, wildlife, and possibly human deaths were reported that coincided with the period when cyanidation was practiced intensively by miners (see case study page 21). Furthermore, contaminated tailings stored close to water courses, are often washed into the water courses during the rainy season, polluting the water and potentially seriously impacting aquatic life. Almost all respondents of the EFCT survey said they took their drinking water from the Porong River.

The EFCT asked interviewees whether they thought there had been problems with the river during the past as a consequence of mining pollution. Of non-gold miners, 43% said yes and 48% said no. Of gold miners, 29% said yes and 56% said no. Asked whether the river ever changed color from mining

Case Study: Mass cyanide poisoning, July 2003

According to independent researchers who interviewed three local women from O'Tampang village, sometime in 2003 all large fish in the Porong River died as did the otters (Galabru and Lon, 2004). The crocodiles also disappeared. Villagers that ate the dead fish were violently ill with vomiting, diarrhea and swelling. In The Cambodia Daily (Barron, 2004), it was reported that nine families fell ill as a result of this incident. According to those interviewed, mining activity upstream has meant that the villagers are now unable to fish the river and must buy processed fish such as Prahok; a considerable and negative impact on their livelihood - the river used to be home to 40 kg fish.

In the survey conducted by EFCT (2004), villagers reported that the river had changed color at this time, thought to be a result of toxic tailings being washed into the river from Snang An. They said the incident occurred in July 2003 and that two cattle had died in Srae Pring village for which the owners had received US $250 in compensation each from the company. Far more seriously, they also said that two people had died from drinking the polluted water. It is not known whether the company accepted liability for these deaths and if compensation was paid.

pollution 71% of non-gold miners and 65% of gold miners said yes. Of the people which answered yes 63% said it changed color every day, 11% said once per month and 26% said occasionally. Several people commented that sometimes the river turned yellow and sometimes the river turned red.

The EFCT also asked interviewees whether they had noticed fish kills in the river. Fish are sensitive to aquatic pollution and fish kills would indicate a severe pollution incident. Of non-gold mining respondents, 71% said yes, 10% said no and 19% did not know. Of gold mining respondents, 40% said yes, 48% said no and 12% did not know. Of those respondents that answered yes, 6% said that they saw fish kills every day, 12% said once per month and 82% said occasionally. Furthermore, of the interviewees, 45% had seen dead domestic animals, 20% dead wildlife and 17% birds that they thought had died from drinking the river water. Of great concern, eight people knew of somebody who had died from drinking the river water. Several people said the deaths had occurred within the last half year, and they were probably referring to the incident described as a case study on page 21.

The burial of toxic element tainted tailings to avoid the spreading of contamination is not an appropriate mitigation measure, as leachate from the buried tailings will continue to pollute the ground water and soil. Equally unacceptable however is the current method of disposal, in which cyanide or acid contaminated tailings are left on the surface in piles that are open to the elements and therefore leached into the groundwater or rivers when the rainy season arrives.

The EFCT survey found that most people, both non-gold miners and gold miners, considered agricultural land to be of good quality and not to have been damaged as a consequence of the gold mining activities. It is readily seen that extensive damage to the overall landscape has occurred within the mining areas. None of the abandoned exploitation shafts have been restored and many remain unmarked.

A degree of deforestation has occurred near the gold mining site. In the EFCT survey, just over half of non-gold mining respondents said that there had been an adverse affect on the forest through clearing land for mining, and taking timber for houses and excavation supports. Amongst gold mining interviewees, 46% said mining activities had cleared forest land for mining, 81% said that trees were felled to provide timber for houses, and 69% said that timber was taken for wooden supports for shaft excavations. Several interviewees went on to say that illegal logging occurred in the area, and that the mining company, local businesses or local people were to blame.

When mining activities are complete the forest does not regenerate to its original form and abandoned shafts remain uncovered. Eventually, these shafts become covered with vegetation and then represent a potentially fatal hazard to people and animals.

According to people interviewed during the EFCT survey, over half thought that gold mining activities had had a detrimental affect on local wildlife populations. 75% of respondents said that wildlife had been common in the area in the past. 61% of respondents said that wildlife populations had decreased, while 28% thought that population levels had remained the same. Asked if people killed wildlife for food and income, 43% of respondents said yes, 41% said no and the remainder did not know.

Human health

The most significant risk to human health observed in the Phnom Chi gold mining area was exposure to cyanide, which is widely used. Besides the large tanks built by shaft owners, each family possessed a small heap leaching tank built just below their houses. Inevitably, cyanide gas would spread from the tanks into the peoples' houses, which is very harmful to human health and potentially fatal. The Porong River is a drinking water source for many families and its contamination by cyanide, as well as other acid chemicals used in mining, represents an additional hazard to human health.

In Galabru and Lon's (2004) survey, one villager from Snang An said that he had recently been poisoned so severely as a result of using the gold processing acids that he had to seek medical attention in Kampong Thom provincial town. His symptoms were diarrhea, vomiting and swelling.

The EFCT interview revealed that 62% of non-gold miners and 56% of gold miners thought that gold mining activities could damage their health. Asked whether they though that their health had suffered from gold mining activities, 48% of non-gold miners and 40% of gold miners said yes. 10% of gold miners did not know whether gold mining had affected their health or not. One gold miner in Snang An said he had been poisoned by the river water when the company had used cyanide. His symptoms were diarrhea, skin condition, and vomiting.

With regard to health and safety at work, the DoG found a lack of appropriate safety equipment, particularly for handling dangerous chemicals. The

introduction of explosives for mining by Neoneer Cambodia Ltd. also introduces new hazards to the workplace. The EFCT interview determined that 46% of gold miners wore masks, 19% wore gloves, and only 1% wore protective glasses. No miners wore hard hats.

Malaria is prevalent in forested areas of Cambodia and the Phnom Chi area is no exception. Miners working in the Phnom Chi area face a continuous risk of contracting malaria. With extremely limited medical facilities, affected people must travel to population centers for treatment at the risk of infecting others. The migrants' traveling lifestyle also risks transmission of malaria to relatives and neighbors when they return to their homelands during the rainy season.

5.1.8 Summary

The livelihood of people living in Snang An village is dependant entirely on gold mining. Prior to the arrival of Neoneer Cambodia Ltd. gold mining was able to provide a reasonable income to professional miners. For local people, gold mining was a valuable source of additional income to supplement their income from agriculture, particularly in years that suffered a bad harvest. As local people do not own any mining equipment, they would collect the low grade ore abandoned by shaft owners and professional miners and pan it for gold.

The arrival of Neoneer Cambodia Ltd. has made the lives of miners and locals increasingly difficult. The Company, which holds a license only for exploration at the present time has not conducted any exploration surveys and instead has moved to take control of the current gold mining activities, imposing fees and mining royalties. Now, people are not able to mine freely and must pay the company to get permission.

All miners have seen a decrease in their income and this has necessitated changes to the previous mining arrangements. Now, wealthy miners are unwilling to let local people pan the low grade ore from their shafts, because in order to make a profit they must recover the gold themselves, often using environmentally damaging techniques such as heap leaching. In order to keep the ore safe, the wealthy miners have been forced to build fences around their mining camps. The only ore left for the local villagers to pan remains the tailings, which contains very low quantities of gold, too little in fact to provide enough income for their daily lives. The survey team noted that most villagers did not have enough food to eat.

It was the common wish of all miners that they should be allowed to mine as before. Although the work was hard, the income from gold mining was reasonable. Gold mining does however continue to be a hazardous occupation and has led to significant environmental degradation within the deposit's vicinity.

5.2 SAMPEOU LOON GOLD DEPOSIT, MEMOT DISTRICT, KAMPONG CHAM PROVINCE

5.2.1 Location of Sampeou Loon gold mining area

The Sampeou Loon gold mining area is located in Choam Tamao commune, approximately 12 km to the north of Memot district center, Kampong Cham province. The mining area is in the mineral concession of SUN Trading Co. Ltd., a Korean mining company whose field headquarters are located in Bos Ta Em village.

Gold mining is conducted in two villages: Sampeou Loon village; and Bos Ta Em village.

5.2.2 Description of survey activities

The survey was conducted over a two and a half day period between the 24th and 26th of September, 2003. The survey was facilitated by Mr. Suon Dy, director of DIME Kampong Cham province, and Mr. Sam Sreu, Chief of Memot district Office of Industry, Mines and Energy.

Over the survey period half a day was spent in Bos Ta Em village (the location of SUN Trading Co. Ltd. HQ), one day at the gold mining and processing sites in Sampeou Loon village and gold mining area, and one day in Chumnum Pol Thmei and Chumnum Pol Chas villages, both of which are located downstream of the gold mining area.

5.2.3 History of gold exploitation in Sampeou Loon gold deposit

Gold was originally discovered in alluvial materials in Sampeou Loon by local farmers in 1985. A gold rush ensued and by 1992 approximately 2,000 gold miners were working the area. In 1993, a license for exploration and exploitation of mineral resources was issued by MIME to SUN Trading Co. Ltd., The mineral concession has an area of 112 km^2. Two

geological mineral surveys were commissioned by the company in 1995 and 1997.

While still operating under the exploration term, the company violated its contract with MIME in 1997 by commencing gold exploitation from surface placers and shallow ores. The company had installed a small ore dressing plant at its field headquarters to extract gold by mercury amalgamation. Over 100 staff were employed by SUN Trading Co. Ltd. at that time, including both migrant miners and local people. To ensure security of their field heaquarters, SUN Trading Co. Ltd. also recruited soldiers stationed in the area, who continue to work as guards up to the present time. In late 2000, SUN Trading Co. Ltd. began processing gold using the heap leaching process.

In order to protect its assets, the company issued an order in 1998 to independent miners working in the area to cease all underground mining activities in its concession. The order was not disputed because the company had been granted the right to explore the gold by MIME. Independent local miners continued to prospect for gold in placer materials, although these resources have since become exhausted.

SUN Trading Company Ltd. ceased mining operations in Sampeou Loon in 2001. However, the companie's license remains valid up to date, despite their contract violations and the fact that according to the Law the maximum exploration period duration is six years. Despite the companies' inactivity the underground mining ban issued to independent miners remains enforced. To this end, the company maintains an on-site staff of approximately 20 personnel, most of whom are security guards.

5.2.4 Socio-economic conditions of the communities

Sampeou Loon village and Bos Ta Em village had populations of 900 and 300 people respectively before the gold rush. In fact, Sampeou Loon village is split into two villages, old Sampeou Loon village and new Sampeou Loon village; the result of a mass influx of migrant workers during the gold rush. Only professional migrant gold miners live in new Sampeou Loon village, while mostly farmers live in old Sampeou Loon village. Following termination of mining operations by SUN Trading Co. Ltd., many professional miners left the area in search of other mining work. Some however remain and continue to prospect in near-surface deposits or panning the sluiced tailings.

While the company was operating in the area company workers received a monthly salary of between US$ 75 and US$ 125. Mining independently, miners could earn between US$ 1.25 and US$ 1.5 per day.

Bos Ta Em village: The village chief stated that almost all families living in Bos Ta Em practiced gold mining before the arrival of SUN Trading Co. Ltd. When SUN Trading Co. Ltd. was operating, approximately 10% of the village became their employees, earning an average salary of US$ 75 per month.

Since 2000 many people have stopped gold mining and returned to farming, because the shallow ore has become exhausted and is only profitable to wealthy miners who can afford to operate heap leaching tanks. While gold remains in deeper layers (between 12 and 20 m depth), the required capital investment is high, estimated to be between US$ 500 and US$ 700. Besides, most local people were unfamiliar with deep-ore mining techniques; to date there have been seven deaths from the village as a result of shafts collapsing during deep shaft mining. Furthermore, any deep-shaft mining conducted by the villagers would be in contravention of SUN Trading Co. Ltd's ban on deep-shaft mining.

Old Sampeou Loon village chief, Mr Hul Loy, stated that the village housed 160 families with a current total population of 1,370 people (455 women). 30 families are migrants who work only as gold miners. Members of these families do not live permanently in the village, as the local shallow ore is exhausted and underground gold mining has been banned. All of the other families in the village are farmers. Before 2000, most farming families practiced gold mining in the dry season, either as independent miners or employed by SUN Trading Co. Ltd.

In order to mine now, people must pay the companies security guards a fee. Only manual equipment is permitted and the use of explosives is forbidden. There are presently about ten families still practicing gold mining, despite it being the rainy season. During the dry season more people come to mine gold, although not as many as before.

New Sampeou Loon village chief, a migrant professional miner from O Raing Ov district, Kampong Cham province has mined gold in the area since 1989. He said that 30 families, all professional migrant miners live in the village. All members of their families practice gold mining including children. The families often travel to other gold deposits to work.

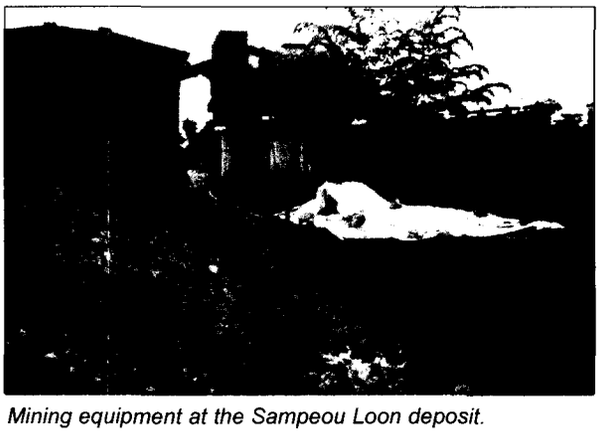
5.2.5 Gold Mining

Mining activity in Sampeou Loon gold deposit is mostly conducted during the dry season, with the exception of shallow excavations in the superficial layer. During the rainy season deeper shafts become flooded. At the time of the survey, which was conducted in rainy season, only ten miners were working the area.

A typical exploitation shaft is square in cross section and excavated vertically into the ground. For shafts of between three and seven meters depth: cross sections would typically be 1.5 by 1.5 meters. For deeper shafts a slightly larger cross section of 2 by 2 meters was usual. Shafts in unconsolidated materials are excavated using hand tools such as hoes, shovels, and picks. Hammers are used in harder layers. Ores are raised to the surface by manual winch and basket. Miners work in teams of between two and five. Women also work both in the shafts and raising the ore to the surface. Children help their parents by gathering ore. Mining activity is conducted from dawn until dusk.

In the past, underground mining was common. Shafts were dug to reach hard rock and then tunnels driven in different directions to extract the ore, which was blasted with explosives. This type of operation is currently forbidden by the SUN Trading Co. Ltd.

During the survey, around 60 exploitation shafts were counted. They are concentrated in locations within SUN Trading Co. Ltd's concession. Some of the shafts had been recently abandoned and were flooded. The distance between shafts is four to five meters.



Mining equipment at the Sampeou Loon deposit.

5.2.6 Gold processing

At first, panning and sluicing were used to extract gold from the rich placer material. As the placer material became exhausted and shafting reached into the deeper ore layer, the ore gravels were crushed and milled before sluicing and panning. Local miners sold the gold concentrate obtained from sluicing and panning without further treatment to gold traders who would then treat the concentrate with acid to obtain pure gold before sale on the local market. No use of mercury in gold processing has been reported.

When the placer became exhausted, wealthy miners introduced cyanidation processing to extract gold from the gold-poor soil and sluiced tailing. Approximately 20 heap leaching tanks were built along the Prek Chas River in Sampeou Loon village. Tailing from the tanks were stored alongside the river. Leachate from the discarded tailings completely destroyed the river's ecology. Seeing the problem, MIME sent a letter to the provincial authority of Kampong Cham province in June 2003 ordering heap leachate tank operations to cease. At the time of the survey, all heap leaching tanks were inactive and according to local people had been abandoned three months ago.

The survey team identified one heap leaching tank still being operated, located in a mining area far from the river. Its owner, Mr. Meng was originally a gold merchant who bought gold concentrate from the local miners. When the placer became exhausted, he constructed a heap leaching tank to extract gold from the sluiced tailing. In late 2001, he received a permit from SUN Trading Co. Ltd. to process the superficial ore layer and tailings from the companies gold pit. Following MIME's closure orders, he relocated his cyanidation operation from next to Prek Chas river to the SUN Trading Co. Ltd. mining site where he continues his operation. The operation employs ten workers (one woman) who earn US $1.5 per day plus a food supplement.

5.2.7 Impacts

Environmental

Despite the fact heap leaching tank operation has effectively ceased, mining tailings discarded alongside Prek Chas River's banks continue to act as a serious source of pollution in which leachate from the tailings, including unrecovered cyanide and heavy metals present within the ore, migrate to the river. As such, Prek Chas River, the sole water source for the area, remains seriously polluted as a result of the gold mining activity. According to local people, the water is completely unusable and fish and other aquatic fauna, which were abundant in the past, have disappeared from the river. Cases of cattle death due to the consumption of water from the river were also reported.

Measurement of groundwater pH revealed relatively high acidity, ranging between 4.4 and 5.6. Most wells

used by local people as a source of drinking water had pH 5.3 to 5.6. According to a well owner in new Sampeou Loon village, the well water corroded water containers; the well water pH was measured to be 4.4. Typical pH values for groundwater are between 7 and 8 (Howard, 1998). These results would indicate that acidic compounds have polluted the water sources, and considering the activity undertaken in the area cyanide or other gold processing acids are prime suspects. While surveying the gold processing site a strong smell of acid was in the air making it difficult to breathe. This air contamination represents a significant hazard for workers on site, as well as a source for airborne dispersion of pollutants further afield.

Some rice fields located near the Prek Chas River have been rendered completely unusable. During the rainy season, the Prek Chas river floods and deposits heap leaching tailings originating from the gold processing sites, onto the rice fields. After the flood has receded the tailings tainted top soil hardens making cropping impossible. Mercury contaminated tailings, originating from SUN Trading Co. Ltd's now decommissioned amalgamation plant, were also observed to have been dispersed over the land as a result of the river's flooding cycle. This dispersed mercury will continue to contaminate the areas soil, plants, and water resources for many years to come with potentially serious consequence.

Deforestation has resulted from mining activities at the Sampeou Loon deposit and areas that in the early 1990's were covered in thick forest are now completely bare. Similar to Phnom Chi, the landscape has also been damaged by abandoned shafts and discarded mining wastes.

Contaminated heap leaching tailings stored by river bank in Sampeou Loon deposit.

Human health

Cyanide has been widely used in Sampeou Loon gold deposit in gold processing. Despite its toxicity, no personal protection equipment was used by the miners who as a consequence risked serious damage to their health.

In Sampeou Loon village, both surface water and groundwater are highly polluted, yet local people have no choice but to continue to use the water for drinking, cooking and bathing. In the dry season, when the water levels are lowest and mining activity most intense, pollution levels are greatest.

In the villages of Chumnum Pol Thmei and Chumnum Pol Chas, located four km downstream of the gold mining activity, villagers reported that the water of O Antap River, previously clear and of good quality, has become so polluted as to be unusable and was now murky and oily. Villagers said that they knew when the river had been heavily poisoned because they noticed mass fish kills, usually following a heavy rainfall. Presently, there are no fish in O Antap River in the dry season and the water is dangerous to drink for both humans and animals. Dead fish found in the river cannot be eaten because they have been found to cause skin disease to the people eating them. People that used O Antap River for bathing and drinking sometimes became afflicted with serious skin and throat diseases.

Originally, all the people lived in Chumnum Pol Chas village. When the mining began upstream the river became polluted and the villagers were forced to collect water from Prek Chhlong River located two km to the North of Chumnum Pol Chas village; a significant burden. Villagers tried to dig wells, but unfortunately Chumnum Pol Chas is located on siltstones that are not conducive to water transmission and hence inappropriate for well construction. Some villagers therefore decided to relocate two km over the O Antap River where they could dig wells, establishing Chumnum Pol Thmei village. Unfortunately, the wells in Chumnum Pol Thmei village go dry in the dry season and villagers have to use wells located closer to the polluted O Antap River.

5.2.8 Summary

Gold has been mined in Sampeou Loon since its discovery in 1985. However, in more recent times following designation of the deposit as a concession to SUN Trading Co. Ltd., gold mining has become more extensive and new technology, in particular cyanidation, has been introduced. Independent miners were banned from 1998 onwards from mining underground deposits and placer deposits have become essentially exhausted. Although the

company has stopped its mining activities the ban on underground mining remains in place, enforced by company security guards. Local authorities, because of their limited legal knowledge, feel powerless to defend the rights of the local population against the concessionaire.

Environmental damage has resulted from gold processing activities. The extensive contamination of both ground and surface water sources, particularly from cyanidation, has resulted in significant ecological damage, such as fish kills. Villagers from Sampeou Loon have no choice but to use water from contaminated wells as they are not able to find better sources. Villagers downstream of the gold mining area in Chumnum Pol Chas often have to travel two km to collect potable water. Villagers in Chumnum Pol Thmei actually relocated from their old village as a consequence of the pollution. Significant health implications can be expected from the consumption of this contaminated water.

Local people know that heap leaching is the cause of the contamination and want these activities to stop in order to restore the river ecology. They have complained to the village chiefs and requested that the tanks be removed. However, the village chiefs feel unable to confront the company because the right to explore and exploit the gold has been granted by MIME to the company, who in turn grants permission to wealthy miners. Villagers are unaware of their right to live safely and cannot see how to improve the situation.

5.3 O TRON GOLD DEPOSIT, SAMBO DISTRICT, KRATIE PROVINCE.

5.3.1 Location of O Tron gold mining area

The O Tron gold mining area is located approximately 45 km northeast of Kratie provincial town in Kbal Damrey commune, Kratie province. O Tron village is an unofficial settlement established by migrant workers close to the gold deposits and O Tron river.

O Tron gold deposit consists of five active mining sites, namely: Thmor Ro; Tuol Kdoeung; Tuol Chen; Thmar Baing; and Bek Buon.

5.3.2 Description of survey activities

The survey was conducted over a two day period between the 1st and 2nd of October 2003. The survey was facilitated by Mr. Div Pisey, DIME Kratie province. Mr. Sam Sokchea, vice chief of the army controlling the site, unexpectedly also guided the survey team around the gold mining area.

5.3.3 History of gold exploitation in O Tron gold deposit

Mining activity at O Tron deposit began in 1983. A mass influx of people soon resulted in the establishment of O Tron settlement, so called because of its vicinity to O Tron River. The village is not officially recognized by the Ministry of Interior; hence there is no police presence within the mining village. Instead, the provincial authorities have sent a group of soldiers to supervise the mining area.

When first discovered, gold mined from O Tron deposit was taxed both by the Government and Khmer Rouge armed forces. Currently, people mine gold without taxation, although they have to pay some money to the armed forces that control the mining area.

No license for exploration and exploitation of mineral resources has been issued to a mining company for the O Tron deposit. In early 2003, a local company signed a MoU of six month duration with MIME to conduct exploration at the site. However, at the time of the survey the company had ceased operation because the MoU had expired.

5.3.4 Socio-economic conditions of the communities

O Tron village is home to 49 families and has a total population of 330 people, all of whom are professional gold miners. Of these, 30 families live permanently in the village and originate from Kratie and Sambo districts, of Kratie province, and also from Tbong Khumum district, Kampong Cham province, and Kampong Speu province. The remaining 19 families come from local villages in Sambo district and only live in O Tron village part-time. The number of migrant miners working O Tron increases in the mining season (dry season), originating from nearby communes in Sambo district, as well as from Kratie town.

The survey team found that only adults mine gold. Families' children in general live with relatives in their home towns, where they can get an education.

Mr. Yim Khut, a trench owner who had previously worked in Sampeou Loon and Memong gold deposit, said that the standard salary for a worker is US$ 30 per month. Supervisors receive a salary of around US$ 37.5 per month. In addition, food and accommodation are provided by the employer for their workers. In general, poor miners prefer to work for

trench owners as they can earn more money compared to panning for gold independently.

5.3.5 Gold Mining

Trenching is the sole mining methodology employed at O Tron gold deposit. Typically, trenches are between four and five meters wide, up to 40 meters long, and up to 20 meters deep. To transport gold ore from the trenches, miners use home-made wooden railways and wagons assisted by machines. Blasting is conducted when mining in hard rock.

The extent of gold mining activity in O Tron is very dependent on seasonal weather conditions. Very little mining activity is conducted between March and May due to a deficiency of water. During the rainy season, lasting from June until October, all trench mining activities stop due to trench flooding and the high risk of malaria. The peak mining season begins in October and finishes in March or April, depending on water availability. Some panning and sluicing continues all year round on the gold poor ore previously extracted from the trenches.

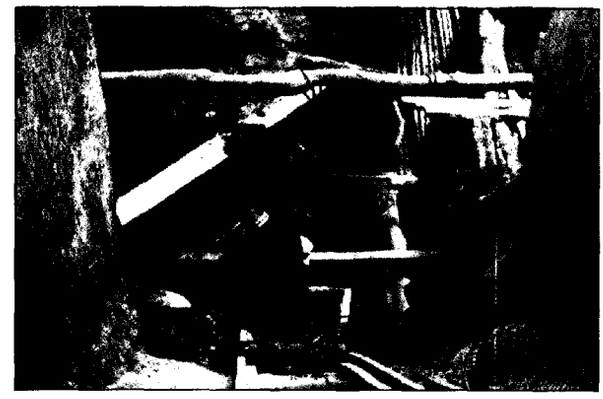
Anyone who has sufficient technical knowledge and capital to invest in the necessary mining equipment (hand tools, machinery, and explosives) is entitled to open a trench. Sometimes groups of miners from different families share resources to operate a trench together. Poorer miners either work for miners that own a trench or exploit gold from abandoned ore of low gold content.

During the peak mining season, workers are hired from nearby villages to exploit the trenches and operate the milling machines. For a big trench up to ten workers are employed. According to Mr. Kul Ye, a trench owner at Thmor Ro mining site who has worked in O Tron since 1987, gold mining and processing is typically carried out by a team of three or four miners. In one month, working an active trench (i.e. the overburden is already removed), a team of four miners can excavate between five and seven carts of ore, each cart containing approximately 600 kg of ore. From each cart an average of six chi of gold (ranging between three and ten chi) can be recovered. Hence, on average each team member earns around nine chi of gold per month.

5.3.6 Gold processing

Local miners sluice and pan gold-bearing soil to recover the gold in the form of a concentrate. Ore from the trenches must be crushed and milled first before being sluiced and panned. The gold concentrate is then treated with acid to extract the gold from other black minerals.

At the sites visited by the survey team neither mercury nor cyanide was observed to be used to process the gold ore. The team was told however that three miners, who had worked previously at Sampeou Loon deposit, had used the cyanidation technique two years ago but had been ordered to



Trench mining at O Tron deposit.

stop by the Kbal Damrey commune authorities after a few weeks operating when they discovered how environmentally damaging it could be. There were also reports from local miners that cyanidation heap leaching tanks were presently being operated in the forest approximately six km from the village under the protection of the armed forces controlling the area. The local people however were unwilling to take the survey team to the site, fearing the soldiers.

5.3.7 Impacts

Environmental

During the time heap leaching was conducted at the deposit it was reported that fish deaths occurred. Heap leaching was banned within a relatively short period of time, although improper disposal of tailings by local miners along the creeks continue to act to some degree as a source of pollution for surface waters and groundwater, as well as soils. It is of particular importance to protect the surface water courses in this area because the O Tron River is a tributary to the Prek Kampi River, habitat to the endangered Irrawaddy dolphin. The mining area has been deforested and is damaged by abandoned mining trenches that have not been refilled.

Human Health

Unsafe work practices when processing gold concentrates represent a health risk to miners at O Tron. No safety equipment, such as masks, gloves and protective glasses, are worn when using the strong acids to treat black minerals. Acids can burn the skin, and if splashed in the eye can lead to blindness, and as such requires the use of safety equipment. Furthermore, to collect the gold concentrate miners burn off the acid over an open fire. The released acid vapor is extremely damaging to lung tissue if inhaled.

A second identified risk was the improper disposal and storage of explosives. For example, it was observed that miners stored explosives in their houses, where they also had an open cooker. There is a high risk of explosives accidentally detonating because of the proximity of a naked flame.

A third significant risk, similar to the other gold mining areas is contraction of malaria. Almost all miners and their children have been affected by the disease and several cases of death have been recorded in the area.

5.3.8 Summary

Gold mining is able to provide a reasonable income to the miners working in O Tron deposit. Gold mining is these worker's sole source of income and an important means for them to alleviate their poverty. Independent miners benefit from the area not being under the control of a concessionaire, although instead the military control the area and require the payment of fees.

Regarding health and safety during mining, very few safety measures are taken while mining, particularly when using acids, which have the potential to seriously damage the miners' health. The risk of malaria is also very high in the area.

Gold processing by cyanidation seems to be present in the area under the protection of the local soldiers. The sites were unable to be visited because local people feared the soldiers. Cyanide releases can completely destroy river ecology. Protection of the O Tron River is important because it is a tributary to the Prek Kampi River.

While surveying the gold mining area, the survey team noted that people in O Tron village felt threatened by the soldiers that controlled the mining area. To keep secret their participation in illegal gold mining activities, the soldiers limit the area in which O Tron villagers can live and work, thus affecting the rights of people to live and travel freely. The villagers said they would prefer to have a police force enforce the Law in the area.

5.4 PREY MEAS GOLD DEPOSIT, O YADAO DISTRICT, RATANAKIRI PROVINCE

5.4.1 Location of Prey Meas gold mining area

The Prey Meas gold mining area is located in O Yadao district, Ratanakiri province approximately 48 km east-southeast of Banlung city, Ratanakiri's provincial center. Currently, the mining area is not designated a mineral concession although has been in the past (see section 5.4.3).

There are six active mining sites in Prey Meas gold deposit: Bay mot; Bay Hai; Bay Ba; Bay bon; Prey Meas; and Prey Thmei. The first four are Vietnamese names, reflecting the fact that many Vietnamese miners also work the mining areas. An additional mining site, Prey Samraong, is exhausted and has been abandoned.

Gold miners have formed a settlement at Yeak Baing Prey Meas village.

5.4.2 Description of survey activities

The survey was conducted over a four day period between the 17th and 20th of October, 2003. The survey was facilitated by Mr. Sok Sambath, a member of the provincial Mineral Resource Office. Mr. Luy Toom, Governor of O Yadao district, arranged for two policemen to accompany the survey

Over the survey period, one day was spent working with Mr. Yos Sithoeurn, Deputy Director of DIME of Ratanakiri province, and Mr. Luy Toom, O Yadao district governor, Ratanakiri province. Three days were spent surveying the Prey Meas gold mining area.

5.4.3 History of gold exploitation in Prey Meas gold deposit

The Prey Meas gold deposit was discovered in the mid 1980's. The first known mining activity in the area was conducted by Vietnamese miners working illegally in 1985. In 1994, there was a gold rush to the area and Yak Baing Prey Meas mining village was established, although it is still not officially recognized as a settlement by the Ministry of Interior. The miners are all migrants, originating from Takeo,

Phnom Penh, Kampong Cham, Kratie, and Kampong Thom provinces, as well as some of the nearby districts of Ratanakiri province.

In 1995, a license to explore for mineral resources in the area was issued by MIME to Brewer Natural Resources Development Co. Ltd. (BNRD), a mining company owned by Gansondara J. Brewer. In March 1996, BNRD contracted Pro-Mack Mining Inc. to conduct a dredge sampling survey of the Se San River to evaluate the potential of gold placers. This was followed by a second survey, also carried out by BNRD, in January 1997. However, in 1998 BNRD had to terminate all mineral operations due to financial difficulties. As such, in 2001 BNRD's mineral exploration license was terminated by MIME.

In early 2003, MIME signed a MoU with Yeah Boh, a joint Chinese-Cambodian mining company that permitted them to conduct a geological survey of the deposit area for a six month period. The MoU expired a few months prior to the survey team's visit to the deposit.

5.4.4 Socio-economic conditions of the communities

A total population of 150 people consisting of 35 families live in Yak Baing Prey Meas village. Only seven families live permanently in the village, while the others are migrants mainly from Kratie and Kampong Thom province, Phnom Penh, and Bo Keo, Ban Lung and O Yadao districts, Ratanakiri province. All families who live permanently in Yak Baing Prey Meas village are professional miners. They all possess complete sets of mining equipment, including rock mills. Due to this, they are known by other migrant miners as 'rock mill owners'. They will either conduct mining by themselves or rent the equipment to migrant miners working the area.

When the rainy season is over, people from nearby districts and provinces come to the deposit to mine gold. In the peak mining season the number of miners in the area can increase by several hundred. Due to poor road conditions, these migrant miners do not bring with them equipment for mining or processing gold. Therefore, these migrant miners must co-operate with the resident 'rock mill owners' to mine gold.

Wealthy migrant miners have funds and will hire other people to work for them. In many cases, these migrants are experienced, technically skilled gold miners and can manage the mine well. They are called 'shaft owners' and represent a second type of gold miner. The 'shaft owners' and the 'rock mill owners' share the profit from mining equally, employing poorer miners to labor in the mining operation.

Laboring workers employed by the shaft owners are mainly Lao, Phnong, Jaray, and Tumpuon minorities living in the vicinity of the gold mining site (Takok Phnong, Takok Jaray, Phut Som, Do Toch and Do Thom villages of Bokham commune, O Yadao district). According to Mr. Min Sambath, Chief of Yak Baing Prey Meas village chief, in earlier years local minority people were only employed as laborers in the mines, but now some of them have carts and provide ore transportation services. Their typical daily income for operating the carts ranged between US$ 1.75 and US$ 2.5.

At the time of the survey, which was conducted in the rainy season, 70 people were working in the mining area. During the fieldwork, the team noted that there were 15 Vietnamese males conducting mining in the area. All cross the border illegally to exploit gold at the deposit. They are hired either as laborers or for their technical expertise to open a mine. Laboring workers receive a wage of US$ 1.25 per day during normal mining periods. During the peak mining season this wage can increase to US$ 2.5 per day. Accommodation and meals are provided by the 'shaft owner'.

In some cases, workers opt to become stakeholders in the mine, with the mine owner only providing food and accommodation. When mining is successful the workers are paid in gold at the rate agreed previously with the owner.

Mining activity was conducted only by men. A limited number of women work in rock milling. Children were not involved in any mining activities.

5.4.5 Gold Mining

Gold mined from Prey Meas is located in rich, deep secondary deposits that require underground mining to access, although some gold is also present in the superficial layer. Shafts are dug up to 30 or 40 meters deep, usually of 1.2 by 1.2 meters cross section. At the bottom of the shaft tunnels are driven horizontally into the ore layers. The height of the tunnels varies between 1 and 2.5 meters, depending on the thickness of the ore layer, and can be up to 100 meters long. Both the shafts and the tunnels have strong timber support. Only hand tools are used in mining. No explosive is required as the area is formed of loose materials.

Mining is conducted all year round as there is not a

problem with shaft flooding. However, there is a high risk of malaria infection in the rainy season, and as such mining activity is far more intense during the dry season. During the peak mining period a 'shaft owner' will employ up to ten workers.

According to Mr. Sun Sam, a rock mill owner working Bay Hai mining site, the mining output for half a months work is between five and ten chi gold, but sometimes he recovers only five hun of gold, which is not enough to cover mining costs. Mr. Sin Lin, a rock mill owner working Bay Mot mining site, said that he used to be able to mine between one and two chi of gold per day, although now his mine is exhausted. Presently, he extracts gold from the mines tailing and obtains between five hun and one chi of gold per day. He employs two Vietnamese workers living in Prey Meas illegally.

5.4.6 Gold processing

The use of the mercury amalgamation technique to recover gold from the mined ore is prolific throughout the Prey Meas deposit. Having milled the ore into a powder, it is mixed with water and poured down an inclined box covered with metallic sheets. The surface of these metal sheets is covered with liquid mercury. To recover the gold the amalgam is heated in an open earthen or metallic crucible over an open fire. Mercury is imported from Vietnam and costs between US$ 12.5 and US$ 17.5 per kilogram. One kilogram of mercury can extract on average ten chi of gold.

Pure gold from the Prey Meas deposit is sold to gold shops in Phnom Penh. Some gold is also exported to Vietnam by the Vietnamese miners.

5.4.7 Impacts

Environment

Contamination by mercury originating from the amalgamation process and the improper disposal of mercury tainted tailing is extensive, serious and long-term in Prey Meas. Miners heat the mercury/ gold amalgam in an open container to vaporize the mercury and make no attempt to collect the vaporized mercury for re-use, and instead all is lost to the atmosphere. Subsequently, the mercury will precipitate as the air cools, resulting in the formation of mercury deposits on the surface of soils, fauna and water sources. On entering the ecosystem mercury, or its microbiologically mediated derivatives methyl-mercury and ethyl-mercury, bioaccumulates with serious repercussions.

Degradation of forest in the Prey Meas gold mining area is extensive. Miners use huge quantities of timber to support the mining shafts and tunnels. The timber is not removed from abandoned shafts and tunnels reused in other mining excavations. Instead, miners cut down fresh trees.

Human Health

The lack of safety equipment when working with mercury places the health of miners in serious jeopardy. Miners wear no protective gloves when preparing the amalgam. Furthermore, when vaporizing the amalgam no protective steps are taken to prevent the worker, together with people in the vicinity, from breathing the vapors. The burning of amalgam in closed environments, such as houses is very dangerous, inevitably leading to high levels of direct exposure, as well as contamination of the homestead environment.

Indirect exposure to mercury will occur to people living in the vicinity of the mining area as a result of the environmental contamination described above, in particular contamination of food sources such as fish and plants. It was noted by the survey team that almost all miners working in the area suffered from diseases typified by stomach aches and intestinal problems, which are quite possibly caused by the absorption of mercury.

Similar to the other mining sites, malaria is a serious problem in Prey Meas. The poor health of the miners, weakened by exposure to mercury, makes the risk of malaria all the more grave.

5.4.8 Summary

Prey Meas is a high yielding gold deposit and provides a good income to miners and some indigenous people, although this comes at a cost. There has been environmental damage, impacts on human health, and impacts on livelihoods, both for the mining community and other local, often minority, communities living in the vicinity of the mining area.

Environmental damage is particularly associated with the use of mercury during gold processing. Mercury vapors from the amalgamation process widely contaminate the area, as do mercury tainted tailings, the mercury ultimately ending-up in the food chain and damaging ecosystems. Mercury contamination is long lasting, and if dispersed not easily remediated.

Degradation of forest resources and fertile soil in the mining area has affected the livelihoods of minority groups living close by, who depend on forest

products, hunting, and farming to survive. For these people, the forests are both their home and their food source. Furthermore, whereas many miners drink bottled water thus avoiding the contaminated water, minority populations have no choice but to drink from polluted rivers and streams.

The miners are exposed to extremely high levels of mercury and take no measures to protect themselves. This has resulted, at least in part, from the miner's very limited knowledge of mercury's toxic effects and health consequences. They said that they did not detect any strange feelings when breathing the mercury vapor released when heating amalgam. Even though they accepted that they have stomach problems, some rejected the idea that these diseases are linked with the use of mercury as they considered themselves strong and fit. The use of a retort set-up in the amalgamation process would reduce miner exposure, as well as significantly reduce the amount of mercury released into the environment. The method entails considerable economic benefits, as the caught mercury can be reused in the amalgamation process.

The district authorities of O Yadao, as well as the DIME of Ratanakiri, are well aware that there are extensive gold mining operations being conducted at the Prey Meas gold deposit. However, little attention has been paid to the processing methods employed to treat gold from the ore. Even the authorities have a very limited knowledge of the cycle of mercury and its toxic effects and have therefore underestimated the magnitude of the problem.

It is worth noting that, in contrast with deposits such as Sampeou Loon, the miners do not have fees imposed on them by mining companies and neither do they pay Government taxes. According to some miners, they have to pay money to the district police and local soldiers when they visit the village.

6. Conclusions

This report has presented an overview of the gold mining sector in Cambodia, highlighting four case studies. Many issues identified to exist within the sector are common among all of the case studies. Undoubtedly, small-scale mining alleviates poverty to some degree in areas where very few other means of livelihood exist. However, weak or even non-existent regulation enforcement together with limited professional expertise has led to a sector that is increasingly becoming environmentally destructive and hazardous to human health.

Key conclusions of this study are:

• The Law on Management and Exploitation of Mineral Resources, ratified in July 2001, defines access rights to gold deposits. As concession rights to Cambodia's gold deposits are granted to large national or international companies, the livelihoods of small-scale independent miners who currently extract the deposits become increasingly precarious. The companies rigorously enforce exclusive access rights granted to them. However, despite operating under exploration permits, some companies are also known to levy taxes and fees against independent gold mining although this is not a part of their agreement with the Government. Environmental and health and safety safeguards, that should protect local communities and are a part of the license agreement between companies and the Government, are often disregarded. Enforcement of existing regulations by the relevant authorities is poor and ineffective.

• Article 28 of the Law on Mineral Resources Management and Exploitation exempts concessionaires holding mineral exploration licenses from paying royalty on the value of mineral resources exploited. In cases where concessionaires are exploiting minerals while operating under a mineral exploration license, the State is deprived of royalties entitled to it from exploitation of mineral resources, which are State property according to Article 2 of the Law.

• Gold mining in Cambodia has been characterized in the past as small-scale, low technology mining. Although still small-scale, recent developments have seen the introduction of higher technology gold processing techniques, namely mercury amalgamation and heap leaching cyanidation.

• Severe environmental consequences from heap leaching have been found, particularly surface water pollution and groundwater pollution, with subsequent ecosystem damage such as fish kills and death of wildlife. Human fatalities were also alleged to have occurred. Pollution originates from the inappropriate disposal of toxic chemical tainted tailings together with toxic chemical spillage or inappropriate disposal.

• Other significant environmental impacts found to have almost ubiquitously resulted from gold mining activity are: deforestation resulting from clearance of mining areas and the demand for timber for housing, fuel, and timber supports for shafts; damaged landscapes that were not remediated following cessation of mining activity, leaving behind open shafts into which people and animals may fall; and wildlife depopulation as a result of increased hunting activity.

• Severe human health hazards have been documented relating to poor practices in chemical processing techniques. No safety clothing is worn and there is little regard for the safe handling of chemicals.

• Remoteness of mining settlements led to a weak or non-existent health care system, and often a poor diet. Furthermore, food sources such as fish are potentially contaminated by chemicals used in mining activity. The non-traditional structure of mining communities leads to an elevated risk of STDs and HIV/AIDS transmission. Malaria was a serious problem in all mining communities visited.

• Concepts of health and safety at work are non-existent. Safety standards are low. Tunnels and shafts have poor ventilation. No miner was observed to wear a hard hat. Training levels are poor and there is a lack of adequately qualified engineers and mining foremen, which is a significant impediment to improving health and safety at work. Over 20 miner fatalities were documented from the collapse of tunnels and shafts that were inadequately supported.

7. Recommendations

The gold mining sector is now well-established in Cambodia and an important livelihood for at least 5,000 Cambodians. While this report does not call for the cessation of gold mining in Cambodia, effective regulation and appropriate training by outreach programs should be implemented to eliminate or minimize many of the serious impacts of gold mining identified.

The overarching recommendation of this report is that where local mining companies operate they should be made to adopt better operating standards, take greater responsibility on safety, health and environmental issues, provide fair remuneration, and take greater responsibility for the dependent mining community. If necessary this must be achieved by improved enforcement of the law by the relevant authorities. For independent miners, awareness on technical, health, safety, environmental, and labor issues should be raised via outreach programs. Mineral concessions, where delineated, should be operated according to the terms of the license agreement between the Royal Government of Cambodia and the concession company.

Additional recommendations about studies and points of action are also put forward by this report:

Key areas for improvement are:

• More detailed analysis of current mining excavation practices leading to the identification of methods that are effective and safe.

• Improvement of the efficiency of gravity methods of gold processing by introducing better equipment design. Better returns by gravity techniques may preclude the necessity of more hazardous chemical-based processing techniques entirely.

• Introduction to miners of the mercury retort technique (see glossary), which requires a simple modification to current mercury amalgam gold processing practice using apparatus that may be constructed using locally available material.

• Research to determine how heap leaching can be implemented safely where conditions necessitate its use.

• Identification of improved methods of tailings and waste material impoundment appropriate to local circumstances to reduce environmental damage.

7.1 TECHNICAL

Numerous shortcomings exist in current methods of gold mining and gold processing. More detailed studies of current practices throughout Cambodia's gold deposits, together with assessment of locally available resources, will allow for the determination of best methods and practices in gold mining and processing within the context of the local situation. Increased efficiency introduced by technical improvements should go a long way towards ensuring gold miners adopt the technologies, because income would increase as a result of reduced costs and improved gold recovery.

7.2 ENVIRONMENTAL

Qualitative observations made throughout the survey indicated varying degrees of environmental damage as a result of mining activity. Further scientific study should be conducted to determine the precise extent of impact by quantitative measurement. Year-round systematic sampling programs of water, fish, sediments, and soils should be conducted at all active mining deposits in Cambodia. Together with visual observation and photographic evidence, a clear picture of the extent of environmental damage and the necessary remediative measures that should be taken can be determined. The data will provide a baseline assessment for any environment rehabilitation program implemented.

7.3 HEALTH

Studies that determine direct and indirect health impacts from mining activity should be conducted. Comparison with average levels of illness in nearby traditional villages would indicate the extent of health impact, allowing health programs to be prioritized. The implementation of awareness programs, for example on the safe handling of chemicals, would significantly improve miners' health while at the same time safeguarding the environment and protecting local communities.

7.4 SOCIO-ECONOMIC

Systematic data collection that documents the dynamics of the mining community is required so that community-specific programs can be implemented effectively.

7.5 LEGAL

Legal research is required to adapt legislative tools to the current situation of gold mining in Cambodia. Regulations related to small-scale gold mining should be set up to regulate mining activities with the protection of small-scale miners and local communities in mind.

A collation of applicable laws that clarifies acceptable practics and the responsibilities of those involved in the gold mining sector should be produced and disseminated to stakeholders.

Appendix A: References

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Appendix B: Glossary

Bioaccumulation: The process by which chemical substances are ingested, absorbed through the skin or taken up during inhalation and then retained by an organism within its body. The chemical substances accumulate because they are either very slowly metabolized or excreted.

Biomagnification: The process by which prey organisms that have accumulated chemicals via the process of bioaccumulation are eaten by predator organisms higher in the food chain, passing on these accumulated chemicals to the predator organisms body. Should a predator eat large numbers of prey, very high levels of chemical can become present in the predator's body with potential health consequences not manifest in the prey organism.

Chi: Local of gold measurement = 10 hun.

Damloeung: Local of gold measurement = 10 chi.

Heap Leaching: Heap leaching at a basic level simply involves percolating cyanide solution through milled ores. The gold dissolves into the cyanide solution and is collected. The gold is subsequently recovered using zinc powder and either a chemical-based or heat-based process.

Hun: Local of gold measurement = 10 li.

Leaching: A process in which chemicals are dissolved into water as it passes through a solid medium, such as soil, and transported away for example into groundwater or water courses.

Li: Local of gold measurement = 0.0375g.

Lode gold deposits: Located within hardrocks, lode (or primary) deposits are the original sites of gold deposition. The gold is concentrated in the form of veins.

Mercury amalgamation: In this gold processing method milled gold-bearing ore is mixed with liquid mercury. The gold forms an amalgam with the mercury, which is then separated from the waste ore. The gold is recovered from the mercury using one of several possible methods including: heating the amalgam, during which the mercury is volatilized leaving behind the concentrated gold as a precipitate; or using a filtration or acid chemical reaction method.

Mercury retort technique: The technique reduces handling of mercury and prevents mercury vapour escaping during burning off in the amalgamation process by keeping the mercury in a closed system. The burnt off mercury can be reused, introducing economic benefits for miners as well as reducing impacts on human health and the environment.

Placer: Placer (secondary) gold deposits contain gold derived from weathered lode deposits that are transported by hydrological processes and concentrated by gravity usually in depressions or pockets of sand and gravel bars where water flow is reduced. Placer deposits may be located near or on the surface in an inconsolidated form, or may be buried under rock debris and possibly even cemented back into a 'hardrock' form.

Pocket mining: A small scale of mining practiced by individual or small groups of miners. Only gold bearing ore very close to the surface is recovered for processing. Excavations do not usually exceed a couple of meters in depth.

Sluicing, jigging and panning: These gold processing methods, known as gravity methods, separate out gold particles from waste ore by virtue of the fact that gold particles are denser than other geological materials with which it is mixed. Minimal impact on human health and the environment is incurred by this method, although the efficiency of gold recovery is comparatively low; only coarse gold particles, such as those found in river beds, are recovered.

Tailings: Waste mining ores that have been discarded once the gold content has been recovered.