Small-scale gold mining in developing countries

- Small-scale mining
- Legislation and linkages within Ghana’s mining industry
- From mine shaft to wedding ring
- Going for gold
- Mercury and health
- The retort
In November 2005 a project financed by Geocenter Copenhagen on the environmental and socio-economic aspects of small-scale gold mining in Tanzania was initiated. The project is a collaboration between human geographers from the Department of Geography and Geology at University of Copenhagen and the Geological Survey of Denmark and Greenland (GEUS). In this article, the concept of small-scale mining is introduced together with its use and global distribution.

Small-scale mining is a form of low technology mining widespread in developing countries. This form of mining is, with very few exceptions, practised by poor people. For millions of people it is a way of putting food on the table and only in very rare cases does it make people rich. The International Labour Union estimates that about 100 million people depend on small-scale mining. Of these, 20 million are directly involved in the mining, five million of whom are women and children. The number of small-scale miners is increasing. For instance, in 1995, there were no small-scale miners in Mongolia. Ten years later there were more than 100,000.

What is Small-scale Mining?

In a nutshell, small-scale mining can be described as three men and a wheelbarrow. However, the concept covers a wide field. From individuals, groups or families using hammers and chisels to work their way into the rock and find gold, to operations or cooperatives with several hundred miners using semi-mechanised methods to exploit the ore deposits. The number of small-scale miners varies greatly from continent to continent. In Europe and North America hardly any small-scale mining exists, while it is widespread in Asia, Africa and South America.

Small-scale mining has existed for thousands of years. One of the oldest stories about small-scale mining is the story of Jason and the Golden Fleece. For many years, people did not know how to interpret the legend. However, in “De re metallica” (the Nature of Metals), pub-
Global distribution of small-scale mining. Data from the 1990s.

Women are also involved in small-scale mining.

Source: A.J. Gunson. (http://www.casmsite.org/regional.html)

Peter W. U. Appel
Senior research scientist, GEUS
(pa@geus.dk)

Jesper Bosse Jønsson
Ph.D. fellow
Department of Geography and Geology
University of Copenhagen
(jbj@geogr.ku.dk)
lished in 1556, Agricola explained how shepherds in mountainous areas put ram's skins (fleeces) in the torrent in springtime. After a month the fleeces were taken out of the water, and if there was gold in the area, several grains of gold were often found in the fleeces. Jason's Golden Fleece was really golden after all. Even today the very same method is used by a small number of shepherds in the remote regions of Kyrgyzstan.

**Small-scale mining today**

Small-scale mining is the main supplier of many different metals and minerals for the world market. For instance, the world demand for beryllium and fluor spar is by and large met by small-scale mining, while the copper and phosphate market is completely dominated by large-scale, commercial mining.

There are two main forms of small-scale mining: extraction from primary and extraction from secondary deposits. Extraction from primary deposits means that the ore is taken directly from the rock. Extraction from secondary deposits means that the ore is found in sand and gravel in rivers and torrents. Mining of gold from quartz veins is an example of extraction from primary deposits. In its simplest form, it involves the small-scale miner working his way into the rock with a hammer and chisel, while trying to follow the gold-bearing quartz vein.

After mining the rock, the gold ore is crushed and ground and the heavy minerals, including gold, are concentrated by means of an old-fashioned gold diggers pan. In order to separate the gold from the other heavy minerals, the so-called amalgamation method is often used. In this process, mercury is added to the heavy-mineral concentrate. Mercury and the heavy minerals are mixed by hand and the amalgamates with the mercury. When all the gold has been dissolved, so to speak, in the mercury, the amalgam becomes pasty; it is placed in an iron cup and put over a fire. During heating, the mercury evaporates and the gold re-
mains. Amalgamation is an efficient method to extract the gold. However, mercury is released in large amounts into the environment where it enters the food chain. It thus becomes a long-term health hazard not only for the people in the immediate vicinity of the amalgamation site, but for the whole region. An additional problem is that mercury stays in the environment. Confirmed accounts of how much mercury is being led into the environment from small-scale gold mining indicate that it is as high as 1000 tonnes per year.

Mining from secondary or alluvial deposits includes material eroded from rock and then transported by wind and water to be deposited in layers of sand and gravel. Examples of this are gold, precious stones and tin. During erosion, transport and deposition, the minerals can become concentrated in sand and gravel layers. In these places the concentration can be high enough to make mining profitable for small-scale miners.

In Kyrgyzstan, small-scale miners work in small groups high up in the mountains to extract gold from sand and gravel. Every spring, when the snow melts, large quantities of sand and gravel are brought by the meltwater down the mountain slopes. The gold concentrates in certain places in the rivers and torrents in small and large grains. A skilled small-scale miner can easily find these places. He digs up the sand and gravel and pours it into a so-called sluice. The sluice is a box up to a couple of metres long and twenty to forty centimetres wide. The bottom of the sluice is covered by old rugs or rubber mats from scrapped cars. The sluice is placed in the torrent so the water flows through it slowly. The flowing water transports the sand and gravel through the sluice and heavy minerals such as gold stick to the rugs or mats.

**Legislation**

In most countries, small-scale miners operate outside the law. This means that they cannot get an official permit or licence for their mining operations. However, in a few countries, for instance, Tanzania, Ghana, Ethiopia and Zimbabwe, the concept of small-scale mining has been introduced in legislation. In these countries, small-scale miners can get an official licence. Still, only few small-scale miners have actually obtained such a licence. The legislation in Tanzania leaves room for the presence and development of a small-scale mining industry and promises increased support in the form of access to advice and training, credit, low-cost equipment and specially reserved mineral-rich
areas. But in reality, the large mining companies push the small, local operations out of the mineral-rich areas.

In most developing countries, government looks upon small-scale mining as a necessary evil, and in others, government obstructs it directly. The Mongolian government has several times sent in the police and the military to clear areas with small-scale mining. A general dissatisfaction with the illegal, small-scale miners has been the cause in some cases, while favouring commercial mining companies has been the motivation in others. In 1996, in Tanzania, thousands of small-scale miners were given one day’s notice to leave an area where they had been mining for decades, after a licence for the area had been granted to a large mining company.

In general, it is acknowledged that small-scale mining can contribute to the economic growth of an area. The sector employs thousands of people who have had short or no training. The profit made on the mining is often used and/or invested locally, which means that it has a positive effect on the local community. Furthermore, job opportunities in the small-scale mining industry reduce the migration from land to city, a phenomenon that is very common in developing countries. But at the same time, the industry creates social, political and environmental problems which prevent it from achieving its full potential.

**CONFLICTS**

Conflicts between large mining companies, existing local communities and small-scale miners over land and mining rights, compensations and taxes to the government are common and often lead to violent confrontations. The problem is increasing due to the growing number of people who are forced to go into small-scale mining to maintain or improve their living conditions. The largest environmental cost is the pollution from the use of mercury for the extraction of gold. Furthermore, the pits are mostly not backfilled when an excavation is left. This leads to erosion of the land and to accidents. Also, forests are cut down to make timber to support mine shafts and to provide wood for bonfires.

Only few small-scale miners prioritise safety on the job. The work below the surface in tunnels and vertical shafts is especially dangerous. Tunnels and shafts often collapse. Besides accidents and mercury poisoning, one of the most important health hazards to small-scale miners is silicosis (stone lungs). This disease is caused by the inhalation of quartz dust. The dust is produced when gold-rich quartz veins are crushed, and is inhaled when a breathing mask is not used. Also HIV is common in the mining areas due to the combination of men far from their homes and many prostitutes following in the wake of any gold rush. Moreover, crime rates often increase considerably in the small-scale mining areas.

On the one hand, it is important to stress that small-scale mining has a positive effect on a country’s economic development; on the other, it can also have adverse effects on individuals, the local community and the environment. If the small-scale mining industry is to realise its potential, an institutional, organisational and technological upgrading is necessary.
Photo: P.W.U. Appel, GEUS.
LEGISLATION AND LINKAGES WITHIN GHANAS MINING INDUSTRY

In recent years, mining legislation in Ghana and other African countries has been relaxed, giving the countries less control over the mining industry. This has drawn increased interest from transnational mining companies, which have opened or reopened a number of gold mines. The government owns shares in these mines, which yield a small income. Local companies supply simple spare parts and provisions, but there are no linkages between the transnational companies and small-scale mining.

At the end of 2006 new mining legislation was approved by the president of Ghana. The parliament had passed the laws in 2005, and the initial work on changing the existing legislation had begun as early as 2002, when the responsible ministry introduced the bill. The process was prolonged by lengthy, complicated political negotiations. There were intense conflicts of interest between the international mining companies, local Ghanaian owned companies, the local communities and politicians. In short, the problem was how to distribute the profits from the mining activities. In Ghana, these activities primarily mean gold mining. How can ‘satisfactory’ profits be ensured for the international companies investing considerable sums in the establishment and operation of the mines? How can the affected, local communities be compensated for the inconvenience, environmental and socio-economic, caused by the mining operations? How can business interests in Ghana be ensured the opportunity to join the activities either directly or as suppliers of goods and services to the mining operators? And finally, how can the government be sure of getting a ‘fair’ income, so that the national natural resources are used for the benefit of the entire population?

Declining investments by foreign companies at the end of the 1990s and just after the turn of the century led to the revision of Ghanaian mining legislation. The intention was to attract more foreign capital to the country by offering improved conditions for the activities of the foreign companies. Taxes were cut in half and the government and the mining companies entered into individual agreements allowing the companies to operate for up to 15 years. In special cases, if investments exceed US$ 500 million, the government can deviate from other requirements in the legislation, e.g. environmental demands and the resolving of conflicts with the local communities. In addition, a number of favourable economic arrangements can be made, which already existed in the original legislation (such as advantageous depreciation methods, exemption from import duty and permission to withhold foreign currency).

GHANA AND OTHER COUNTRIES IN AFRICA

The mining legislation in Ghana is now essentially identical to the most recent legislation in other African countries. It is a question of a race to the bottom. The African countries compete to attract foreign capital by offering international mining companies favourable conditions. In reality, this means that the governments lose influence as well as income.

Seen in a 20-year perspective, the legislation of the African countries, including the governmental regulation of the mining activities, has changed considerably. The changes have been gradual and have gone through several phases since the beginning of the 1980s. At that time, extensive changes in the economic policies of many of the debt-ridden African countries were initiated. The so-called structural adjustment programmes designed and financed by the World Bank were implemented. The programmes were aimed at a liberalisation of the national economies and a privatisation of the majority of governmental activities.

The structural adjustment programmes were especially important to the mining industry in Africa. After independence from the colonial powers, many of the mines were nationalised and the government took over their operation. National control of the natural resources was seen as crucial to financing an independent development strategy, which also aimed at establishing linkages between the mining operation and other industries. For various reasons these efforts were seldom successful. The state-operated mining companies suffered heavy losses and investments in new machinery and other equipment were low. But when liberalisation, privatisation and the new mining legislation framework were in place, foreign investments increased considerably.

GHANA’S MOST RECENT DEVELOPMENT

The development in Ghana is very typical. After the first change of the mining law in 1986, the international companies slowly but surely started to invest in the country. Old mines were re-opened and new gold mines were opened. Production and exports increased fast. By the start of the 1990s about 500,000 ounces of gold had been produced (1 ounce = 31.1 g); by the end of the same decade, this amount had grown to more than 2,500,000 ounces. Since then, production has fallen slightly again and the number of mining companies has been reduced. Only five international companies from South Africa, Australia and USA are now active, many smaller mining companies having been taken over or closed. The five companies account for about 90 per cent of Ghana’s gold exports, which again constitute between one half and two thirds of the total exports of the country.

The revenues from the mining operations are not very high. According to the mining law, the government owns stockholdings of 10% in the international companies’ subsidiaries in Ghana. The state gets a return like any other shareholder, while the mining industry continues to be dominated by foreign companies and contributes very little to the development of the country. Therefore, it is often discussed how this situation can be changed. Especially the importance of the linkages between the large-scale mining industry and other industries, including small-scale mining, is brought forward. The law actually stipulates that the mining companies involve local companies.
The possibilities, however, are few and depend on the mineral in question. There is a tendency in the gold mining industry for the large mining companies that purchase and operate the crushing and extraction facilities to purchase machinery for the actual mining of the ore also. A few years ago, the mining of the ore was outsourced to other international companies specialised in this. These companies mined ore in many different countries and thereby achieved the advantages of large-scale production and a high degree of technical mining know-how. However, the mining companies have centralised their activities due to recent years of high gold prices, low interest rates and the changes in the national mining legislation. In any case, the industry does not create many opportunities for local companies that cannot afford to invest in equipment and machinery or meet the technological requirements.

Nor are there any other links in the ‘gold chain’ that provide favourable opportunities for local companies. The exploration and surveying of new occurrences are undertaken by specialised companies, almost all of them foreign, whose workforces primarily consist of highly qualified geologists and technicians. These companies operate either independently or in cooperation with the large mining companies who find it profitable to share the costs with specialised partners. Due to the expensive and technologically demanding refining of gold, this is only done in a few places in the world, e.g. South Africa, Switzerland and Australia. Machinery and other equipment, i.e. everything from excavators, bulldozers, and drills to measuring equipment are imported from other parts of the world, since no Ghanaian company has the necessary production capacity. Chemical analyses of earth and rocks are also made by international companies with laboratories in selected African countries.

Even more basic services such as catering, cleaning and security have been outsourced to international companies. The same goes for accounting and environmental impact calculations. Only very few and simple goods and services are supplied by local companies, such as simple spare parts, fuel and food.

Linkages with small-scale gold mining operations are even more limited. The difference between the two branches of the mining sector as regards technology, organisation, logistics, and primary processing of the ore is simply too great. Even the legal part of the small-scale mining sector (i.e. activities based on legal mining rights) is working with very simple tools and the output is sold to more or less informal buyers. It can be concluded that at the moment there is very little connection between the two branches of the gold mining sector. And there are no prospects of establishing such linkages, which could have positive spin-off effects. Moreover, despite their mutual isolation, conflicts often arise between the large international mining companies and the small-scale miners. This is especially the case for the large groups of travelling men working without a licence or concession in the areas where they stay. If the profits do not match the efforts and expectations, the activities are moved to places where the prospects for gold are better.

The differences between small- and large-scale mining are enormous. The photo to the left shows a dump truck from a large-scale gold mine. The photo to the right shows a small-scale gold miner at work.
The ‘gold chain’ for small-scale mining in Tanzania is significantly different from that of large-scale mining. In small-scale mining the gold is extracted either from rocks or from river sediments. Small mine shafts are blasted into the rocks, while sand and gravel is dug from the river sediments near the surface and washed. The gold is refined locally and sold to gold buyers. A large part of the gold ends up as jewellery in India and the Middle East.

The ‘gold chain’ for small-scale mining in Tanzania works independently from the ‘gold chain’ for the large mining companies. The relations between the two sectors are, as in Ghana, very limited. Over the last year, the world market price for gold has exceeded US$ 900 per ounce, the highest ever. The increase in the gold price is partly due to international economic and structural changes and partly due to an increased demand for gold jewellery especially in India and China. Due to the growing demand, gold miners do not have any problems selling their gold. Today, the gold prices even in the remotest of mining communities in Tanzania follow the world market price. The Internet has meant that the current world market price for gold is available online, making it more difficult for gold buyers to cheat. Still, however, only few small-scale miners have direct access to the Internet.

Nevertheless, exploitation among people working in the small-scale mining communities still takes place. The price gold miners get for their gold varies from 50 to 90 per cent of the world market price depending on the buyer and the employer. Miners working in other persons’ mine shafts do not get paid wages; instead they get food, medicine and a commission for the extracted gold. Owners of mine shafts in other persons’ license areas must pay a percentage of the produce to the licence holder. The licence holder often demands that people working in his area sell their gold to him at a lower price than the local gold buyers offer.
The licence holders often do not mine the gold themselves, but instead collect a commission (often 30 per cent) from the people who have shafts within their licence area. Furthermore, they get the profits from the gold that is bought below the current gold price in the mining community. For instance, the licence holder may buy the gold from the shaft owners for 24 US$ per gram and sell it to the local gold buyers for 26 US$. There are no contractual obligations between the miners and the shaft owners and between the shaft owners and the licence holders, and their relations may be terminated without notice.

Gold miners working outside others’ mine shafts and licence areas get a better price for their gold, since they are able to sell to the highest bidder. The reason why gold miners choose to work in other people’s mine shafts is that even small-scale mining from primary deposits requires investments. Dynamite, equipment, timber to support the mine tunnels and food and medicine cost money that only very few gold miners can afford. In certain areas the gold is found deep below the surface and accessing it is expensive and time-consuming. Furthermore, a licence is needed to dig for gold. These licences cover ten hectares (0.1 square kilometres or about 25 acres), and it is only the most forward-looking and fortunate miners who succeed in obtaining a licence for the areas with gold-bearing rocks. During recent years, it has become increa-
ingly difficult to obtain a licence as most of the gold-bearing areas in Tanzania have been transferred to commercial mining and investment companies. In most cases, these are licences for prospecting, i.e. searching for occurrences. In other cases, the licences are for extracting known occurrences.

Mining from alluvial deposits is often done by individuals or groups. Especially during the rainy season many gold diggers focus on this type of mining, due to the large volume of water needed to extract the gold. An exception is gold nuggets found close to the surface. A metal detector can be used in these cases and no water is needed. Extraction of gold from alluvial deposits is attractive, the gold often being purer than the gold mined from solid rock.

Since loans from the bank by and large are impossible to obtain for small-scale miners the local gold buyers often grant loans to the gold miners they trust. The loans are repaid in gold and the interest is paid by the borrowers by selling their gold to the lender. In some cases, the borrowers even get a slightly lower price for the gold, but since the interest rate in the local banks is around 20 per cent this method pays, nevertheless.

**THE GOLD BUYERS**

Each goldfield of a certain size has its gold buyers, who again have their own network of sub-buyers financed by the gold buyer. Their job is to travel the small goldfields to ‘vacuum’ them for gold. The gold buyers typically go to one of the large cities of the country, most often the city of Dar es Salaam, to sell their gold. The gold price is higher here than in the remote gold mining communities. The majority of the gold buyers in Dar es Salaam are Indian goldsmiths. Before the gold is bought, most of the impurities, especially mercury, are burned off and the purity of the gold is tested. In this way, the gold buyers from the mining communities are paid for the actual amount of gold – and an inexperienced buyer, who has bought gold with low purity, may lose money. After this the gold is refined again, first by burning it at a high temperature and then treating it with nitric acid until it has a purity of between 99.6 and 99.9 per cent. Now the gold is virtually impossible to distinguish from the gold extracted by the large mining companies, which is purified at certified gold refineries.
Some of the gold is exported in its pure form, but most of it is alloyed with copper and silver and used for jewellery. This jewellery is often produced by goldsmiths brought from India by Tanzanian Indians. Some of it is sold in Dar es Salaam, but the major part is exported to India and in particular, to the gold trade centre of Dubai to be resold. To avoid taxes and export duties, the major part of the gold is smuggled, according to sources in the Tanzanian mining ministry, by women wearing the gold as jewellery and leaving the country through Zanzibar. In Dubai, one street full of jeweller’s shops follows the other, and many gold buyers and goldsmiths, from all over the world, especially from the Middle East and India, buy jewellery here. Today, developing countries constitute about two thirds of the world’s gold demand and especially in India, where gold is culturally important, the demand is high.
Going for gold

Over the last ten years Tanzania has become Africa’s third largest exporter of gold. Small-scale miners travel all over the country hunting for gold and riches. Sometimes they get lucky and make a lot of money, but more often they return home empty-handed or even fail to raise enough money for their return ticket.

The subsoil of Tanzania contains a wealth of valuable minerals and the mining sector is dominated by gold extraction. Within ten years the country has gone from being an insignificant gold exporter to Africa’s third largest after South Africa and Ghana. Fifty tonnes of gold is exported annually, corresponding to more than one billion US$. Today, there are six large gold mines in Tanzania, all of which are controlled by international companies. In addition there are about 300,000 Tanzanians working in small-scale gold mining and 250,000 involved in the extraction of a wide variety of precious stones, of which diamonds, tanzanites, rubies, sapphires and emeralds are the best known.

The dream of improving their living conditions and becoming rich makes thousands of Tanzanians travel all over their country hunting for gold and precious stones. But the road to wealth is long and paved with danger and uncertainty. Few are lucky; most work hard just to earn their bus fare home. In their efforts to improve their living conditions, small-scale miners demonstrate a high degree of mobility. Since 2000, Tanzania has had ten large gold strikes, each of which has attracted thousands of people in a matter of months, if not weeks. There is also a swarm of people who profit from the gold miners. This group includes people who open temporary shops, bars and hotels for the gold miners and buyers, as well as prostitutes and criminals.

In connection with an ongoing project on the mobility of small-scale gold miners in Tanzania, 120 gold miners from two gold mining settlements were interviewed about their mobility, life and expectations. One of the settlements, Londoni, was for many years a small community of less than 200 inhabitants living mainly from cattle keeping and subsistence farming. In July 2004, a local herder struck gold. News of the gold discovery spread fast and soon the gold rush was on. Within a couple of weeks between ten and fifteen thousand people had arrived in the area.

Masaka Kisena

One of these was 37-year-old Masaka Kisena, who in 1985, at the age of 14, ran away from home to seek his fortune in the adjacent gold mines. Within a few months he had made about 370 US$, a small fortune in those days. Proudly he brought the money home to his parents who invested it in cattle. Since then he has mined for gold, rubies, sapphires, tourmalines, spinel and garnets in 45 different localities throughout Tanzania, Burundi and Mozambique. The nature of the stays has varied a great deal. Sometimes he starts in a new area, digs for a day and gets lucky; other times, he digs for several months without finding anything. He has also worked as a gold buyer and tried his luck at dealing in rice, bananas, medicine and pesticides. Every time he lost all his money in the end, according to himself, due to lack of education. And every time he returned to mining.

In 1996, he was evicted from his well-producing mine shafts in the Kahama district when the area was sold to a foreign mining company. This company later sold the licence to Barrick Gold, the world’s largest gold producer, operating a large gold mine in the area today. In Mozambique he was attacked and shot in the back by robbers who stole 730 grams of gold, an amount it had taken him six months to buy. In fact, he has been attacked and robbed several times. Crime and lack of security always follow in the wake of large gold and precious gemstone discoveries.

He thinks that it is his credibility, his large network of miners and knowledge of all aspects of small-scale mining that have helped him earn rather large sums of money from mining several times. Yet as much as his strong points have helped him to make money, his weak points, especially his naivety and lack of talent for investing his money properly, have meant that he has lost the money as quickly as he has earned it. In 1999/2000 he earned close to 27,000 US$ and in 2004, close to 10,000 US$. Today, apart from a small house, 40 cattle and some land, as spread out as much as his travels over the past 22 years, he only owns some old mining equipment. In Londoni, he admittedly made close to 18,000 US$ in the first month, but that money was soon used to buy explosives, equipment, and food and medicine for his workers in the three mine shafts he was financing. The shafts did not produce as much as expected and lack of geological knowledge again turned out to be a major challenge.

In Londoni, he managed to send almost 3000 US$ to his parents. The money was used...
for school fees for his two children who live with his parents. The children are a result of relations with two women from different mining communities. It is not uncommon for miners to add to their families while staying in a mining settlement. The wife often remains at home, while the miner moves on. At the same time, the mining settlements attract a large number of women. They often live together with the miners, but are usually left behind when the miners return to their homes or move on to the next large discovery. In this way, some miners end up with wives, girlfriends and children spread over several mining communities.

Even though Masaka’s life has been full of ups and downs, he thinks that he has been rather successful. He has many friends and has travelled far and wide, seen places he never dreamt of, and tried several business ventures. Moreover, he is still in good health and does not suffer from silicosis (stone lungs), mercury poisoning or other consequences of his life in the mines. In March 2007, he left Londoni for Handeni district, where the gold rush is on. At that time he had a little over 50 US$ in his pocket. He is tired of his nomadic life, he says. His dream is to start a farm with vegetable production. For this he needs about 18,000 US$ for a tractor and an irrigation system. He bought the land several years ago. He is counting on earning the money on a trip he is planning to Congo, where the gold price is very low. His intention is to make a lot of money by buying gold in Congo and selling it in Tanzania. But as is the case with many other small-scale miners, Makasa has to know when to quit working in mining. The faith that large discoveries will always be followed by new ones is deeply rooted in many miners. This means that many of them several times in their lives experience having more money to their name than the average farmer ever dreams of, but end up in desperate poverty, sometimes not even able to raise enough money for a ticket back to their home region.

**WEALTHY GOLD MINERS?**

A previous research project estimated that small-scale miners have an average income six times higher than that of farmers. However, the cost of living in the mining communities is higher than in other areas, the mining communities often being situated in remote areas and the miners in general having more money to spend. But many male miners are part of a culture where money is spent on alcohol, parties, gambling and women. ‘Ukipata tumia, ukikosa jutia’ and ‘ponda mali, kufa kwaja’ in Swahili mean ‘if you get it, use it, if you don’t, loose it’ and ‘use your wealth, death is coming’. These proverbs are used by small-scale miners all over Tanzania. In 2006 in Londoni, a miner was lucky to strike gold in his mine shaft worth almost 200,000 US$. After that he bought a car and rented all the rooms in the most expensive hotel in Singida, a town nearby. He then invited all his friends to the hotel to eat and drink as much and as long as they liked. Today, he is back in Londoni, he has sold his car, has spent all his money and even owes people money. A more sensible person would have secured the future of his large family. Among the miners, however, there are people who have become wealthy and stayed so based on the money they made in the mines. These people use the proverb ‘fanya kazi kama mtumwa, uishi kama mfalme’, which means ‘work like a slave, live like a king’.

**JESPER BOSSE JØNSSON**

Ph.D. fellow
Department of Geography and Geology
(jbj@geogr.ku.dk)
Small-scale miners typically use mercury to extract gold. Since mercury is very poisonous and does not degrade it presents a major environmental and health problem. The miners can be poisoned, sometimes fatally. Moreover, mercury can cause brain damage in newborn babies in the mining districts.

During the burning of the gold-mercury mixture (the amalgam) in the gold extraction process, some of the evaporated mercury is inhaled by the miners and inhabitants in the local community. The mercury that is not inhaled condenses and falls to the ground. When the mercury comes in contact with the ground, it is absorbed by plants and animals, for instance, by grass that is eaten by cattle. Alternatively, some of it is absorbed by chickens pecking at the ground where gold and mercury are processed.

Later, the mercury finds its way into the drainage system. In streams and rivers the metallic mercury is transformed into methylmercury by bacteria. Methylmercury is even more poisonous than metallic mercury. The dangerous thing about this form of mercury is that it is more easily absorbed by organisms and thus enters the food chain. Inspections of fish from Lake Victoria in Tanzania near the Mugusu centre for small-scale gold mining show up to 0.41 mg mercury per kg fish. This content is below the danger line for consuming polluted fish, if fish is not eaten every day. However, local people eat so much fish that the total amount of mercury by far exceeds the danger line. In the Geita district by Lake Victoria, it has been demonstrated that women have absorbed 3.54 mg mercury per kg body weight. This exceeds the recommended upper limit of 3.3 mg per kg body weight.

**Lake Victoria**

In several areas surrounding Lake Victoria, people live at subsistence level, and their diet is by and large based on what fish they can catch. Since the fish are polluted by mercury the local inhabitants constantly exceed the upper limits
for intake of mercury-polluted food. In compari-
son, until a few years ago fish from the Baltic
Sea was so mercury polluted, that it was recom-
mented that Danes did not eat fish more than
once a week. Mercury poisoning has a large num-
ber of symptoms, the most important of which
are mentioned below. These symptoms depend
on how long a person has been exposed to mer-
cury, in which form and what concentration.

- Short-term exposure by inhaling mercury
  vapours induces severe pneumonia.
- Long-term exposure causes tremors. The
  person cannot keep his/her hands still.
  In the beginning, the tremors are only
  visible when the patient, for instance,
  drinks a glass of water. If the person is
  exposed over a long period of time, the
  tremors become static, and with even
  further exposure, the entire body
  trembles, out of control.
- Mental disturbance, called erethism, may
  also occur. The patient becomes acutely
  irritable, abnormally shy and often overre-
  acts to criticism.
- Chronic mercury poisoning makes the gin-
giva blue and the patient experiences a
metallic taste.
- Long-term exposure to high mercury doses
gives the patient tunnel vision and severe
brain damage.
- Pregnant women are especially exposed.
The foetus may concentrate the mother’s
content of mercury by a factor of up to ten.
This means that the child may be born with
permanent brain damage, even though the
mother only had minor symptoms of poison-
ing.

To estimate the effect of long-term exposure to
mercury on a population a number of studies
have been carried out on people living primari-
ly on fish and sea mammals. During the last 20
years the mercury content of the populations of
Greenland, the Faroe Islands, New Zealand and
the Seychelles has been studied. In these areas
sea animals have an above normal level of mer-
curry and the populations living on these ani-
mals thus consume high doses of mercury. The
study in the Faroe Islands demonstrated that
children borne to mothers with raised mercury
levels in the blood have reduced mental capac-
ity. This is why it is important, especially for
women of childbearing age, to avoid contact
with mercury and consumption of large quanti-
ties of food with high levels of mercury.

**Small-scale miners’ health**

Regional, systematic studies of small-scale
miners’ health have never been made. But spo-
adric, local studies of the small-scale miners
have shown that they often have increased lev-
els of mercury in their blood, urine and hair. Re-
ports of mercury-related diseases are not rare
and a few deaths from mercury poisoning origi-
nating from small-scale mining have been re-
istered. It is seldom that small-scale miners or
the people living near their activities die from
mercury poisoning. The critical issue is that
their children are born with brain damage.

On this background it seems odd that no
systematic studies have ever been carried out
in developing countries. This is due in part, to a
lack of resources and in part, to a lack of medici-
 nal doctors and nurses with knowledge of the
symptoms of mercury poisoning. Furthermore,
 it is often difficult to distinguish symptoms of
mercury poisoning from symptoms of other dis-
eases such as HIV/AIDS. Lack of equipment,
such as instruments for analysing blood and
urine samples for metallic mercury and methy-
lated mercury, also presents a problem.

**Raphael Chibunda**

Veterinary, Sokoine University of Agriculture
(chibunda@yahoo.com)

**Peter W. U. Appel**

Senior research scientist, GEUS
(pa@geus.dk)
It is very important to reduce the use of mercury, partly due to the major health problems it gives rise to and partly because mercury is expensive. Reduction is fairly easy to achieve if a so-called retort is used. The retort is inexpensive and can be made from a few pieces of iron pipe. This is why efforts are being made to familiarise the local gold miners with the retort.

In the previous chapter it was described how small-scale miners extract gold by means of mercury and how this process leads to the poisoning of the miners, their families and the nearby communities and to the pollution of the environment. It is therefore of vital importance to curtail or at best prevent the mercury from being introduced into the environment. This can be achieved very easily. With three or four lengths of ordinary water pipe, available from any plumber or smith, a so-called retort can be made, which can recycle 95% of the mercury. The retort, which is inexpensive, easy to transport and very robust, is made in several sizes. Originally, it was invented in South America, but its use has spread to other continents.

With very little training, anyone can work with the retort. When all the gold is dissolved in mercury, the amalgam is ready to be burnt off. The amalgam is placed in the retort, which typically is heated over a charcoal burner; but sometimes over a wood fire or propane burner. The mercury evaporates inside the retort, and the vapour travels through the long cooling pipe, which is kept cool by a wet cloth or the like. The pipe ends in a bowl of water into which the mercury falls in the form of small pearls, which can be recycled. When the process has been concluded the retort is cooled down and taken apart. Inside, the gold is left behind.

In spite of the evident advantages of the retort, it has proven difficult to persuade the gold miners to use it. In connection with previous projects introducing the retort to the gold miners, some of them maintained that it was too tiresome to use, that it took too long for the mercury to evaporate and that the gold sometimes became discoloured. In a previous project it was reported that some gold miners in Tanzania refused to use the retort because they were unable to see what happened inside it. They were afraid of losing some of the gold. As a consequence of this, retorts were made of glass, but they were too expensive for the mine workers (approx. US$ 500, while the iron retort costs between US$ 10–20). Furthermore, the glass retorts broke easily. Generally speaking, attempts to introduce the retort in developing countries have
failed to involve the gold miners sufficiently in the process. A technical approach has been taken, leaving out the socio-economic and cultural aspects of the small-scale mining setting.

**Good results**

In the Geocenter project, however, it has turned out that selected gold miners have been very interested in using the retort. The project has investigated the gold miners’ attitude and susceptibility to the retort and its usability and prospects. To avoid the sad fate of earlier attempts to introduce the retort, the project has prioritised involving and preparing the prospect users thoroughly, based on the special characteristics of gold mining communities. In the two gold mining communities where the project has been implemented, establishing a good relationship with the gold miners and the local leaders has been a key factor. In co-operation with both parties, two training seminars were arranged. The seminars were held in October 2006, had about 500 participants, and included the introduction, demonstration and distribution of the retorts to 20 selected gold miners. Information about mercury and mercury related health problems was also on the agenda. Since the seminars, the retort recipients have been monitored several times over a period of six months.

The results are very promising. Until the middle of March 2007, 18 of the 20 retort recipients had used them regularly and together they had recycled around ten kg of mercury, even during the rainy season, when gold extraction is limited. One of the retort users, Mushi Mussa, from Londoni, previously used two kg of mercury a month; now, thanks to the retort, he only uses about 250 grams. In this way he saves around US$180 a month on mercury. By and large, all the retort users praise the retort for its ability to recycle the mercury and thus radically reduce their mercury expenses. Health and environmental considerations are also reasons mentioned by the users for using the retort regularly, but the economic aspect is the most important. None of the retort users complained about not being able to see what goes on inside the retort. Several of them have lent the retort to other gold miners, who all were interested in getting a retort of their own. Another retort user, Faustin Babolia, from the Matundasi gold mining community, was so enthusiastic about the retort that he designed his own retort with a cooling system at a nearby smith’s. The ten recycled kilos may seem insignificant given that the annual global mercury discharge from small-scale mining is several hundred tonnes. However, it must be remembered that the ten kilos have been recycled by 20 gold miners in a country where about 300,000 people earn their living from small-scale gold mining.

Even though its use has been compulsory in Tanzania since 1998, the retort was by and large unknown. On a tour to 15 gold mining communities in six different regions of Tanzania, only two retorts were found and neither was in use. Nevertheless, the project has shown that the Tanzanian gold miners are prepared to use the retort, and that it can contribute substantially to reducing the consumption of mercury.

The results of the project are important to future strategies on how to handle mercury-related problems in gold mining communities. Contrary to the lack of success in some previous retort implementation projects, this project shows that it is possible to induce miners to use retorts provided that proper preparation, implementation and monitoring are carried out and the local context is properly considered. It seems appropriate to recommend a strategy of introducing retorts to gold mining communities in developing countries while a more environmentally sound mercury-free method is being developed. At present, gold extraction by means of mercury still seems to be the most efficient method, taking the gold miners’ technological capacity into consideration.  

---

**The Borax method**

In future, a method known from the Philippines using borax may be the solution to mercury problems. The method, which involves neither mercury nor other toxic substances, will be tested in Tanzania in 2008. Borax reduces the melting point of metals. Small-scale miners extract gold and other heavy metals from the gold ore. Instead of adding mercury, borax is used. When the mixture is heated, the gold melts and the other heavy metals are separated from the gold.

Peter W. U. Appel  
Senior researcher, GEUS  
(pa@geus.dk)

Jesper Bosse Jønsson  
Ph.D. fellow  
Department of Geography and Geology  
(jbj@geogr.ku.dk)
Further reading

Download reports, articles and fact sheets and read about GEUS’ small scale mining activities in Kyrgyzstan, Mongolia, Philippines and Tanzania.

http://www.geus.dk/program-areas/common/small_scale_mining-uk.htm

Abdallah Muhammed surfacing from a pit in Mabadaga mining settlement in Tanzania. He had just spent hours to rescue a large and venomous cobra that had fallen down into the pit. Miners saw it as a good omen of success and did not want to kill it.

Photo: J. B. Jønsson.
Department of Geography and Geology, University of Copenhagen.

Editor
Geoviden - Geologi og Geografi is edited by geologist Ole Bennike (responsible editor) from GEUS in collaboration with an editorial group at the university institutes.
Selected issues of Geoviden - Geologi og Geografi are translated into English.
This issue can also be downloaded from GEUS’ homepage:
http://www.geus.dk/publications/gen-info-uk.htm

ISSN 1604-6935 (paper)
ISSN 1604-8172 (electronic)

Production: Henrik Klinge Pedersen and Annabeth Andersen, GEUS.
Translation: Jane Holst, GEUS.
Print: Schultz Grafisk A/S.
Cover: Small-scale miners at work.
Photo: Dorthe Friis Pedersen.
Reprographic work: Benny Schark, GEUS.
Illustrations: Authors and Graphic, GEUS.
Reproduction is permitted, provided the source is acknowledged.

Geological Survey of Denmark and Greenland (GEUS)
Øster Voldgade 10
DK-1350 Copenhagen K,
Denmark
Phone: +45 38 14 20 00
E-mail: geus@geus.dk

Department of Geography and Geology
Øster Voldgade 10
DK-1350 Copenhagen K,
Denmark
Phone: +45 35 32 25 00
E-mail: info@geogr.ku.dk or info@geol.ku.dk

Geological Museum
Øster Voldgade 5-7
DK-1350 Copenhagen K,
Denmark
Phone: +45 35 32 23 45
E-mail: rcp@snm.ku.dk