DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2005/4

Small-scale mining in Mongolia – a survey carried out in 2004

Peter W.Uitterdijk Appel

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Before embarking on a long travel in Mongolia you walk around a pile of rubble marked with blue cloth. Each traveller ads a rock to the pile

Summary

1. In 2003 World Bank carried out a survey: *Mining sector Sources of Growth study.* The Sources of Growth study dealt briefly with small-scale mining, but the Bank decided that further investigation into the sector was warranted. However, in 2003 a very comprehensive baseline survey of small-scale mining was carried out in Mongolia financed by Canadian funding[1]. Another relevant study on small-scale mining and its role in mercury pollution in Northern Mongolia[2] was published in 2003. Since a recent baseline study of small-scale mining had already been carried out it was decided that the present World Bank project should describe the development and changes in the patterns of small-scale mining during 2004 with emphasis on the objectives of a needs assessment. The present survey was financed by Danish trust funds and carried out by a consultant from the Geological Survey of Denmark and Greenland (GEUS), Copenhagen, Denmark. During both in country visits the consultant liased closely with officials from several ministries (see list in Annex 1).

2. Small-scale mining also termed artisanal mining did not start in Mongolia until 1998. The popular term for these miners in Mongolia are Ninja miners. This term comes from the circular green pans many of the gold miners hang on their backs while walking from the gold fields, making them resemble the 'Ninja turtles' of movie and cartoon fame. The Canadian funded report estimated that 100.000 small-scale miners were active in Mongolia in 2003. There is no indication that this number is decreasing. As pointed out by the Canadian funded report the number has increased over the last years and in all likelihood will increase considerably. The drastic increase is partly due to severe weather conditions making herding very difficult and also the general lack of other working opportunities. The very good and only little explored potential for gold in Mongolia supports the assumption that small-scale mining for gold will increase over time. Small-scale miners in Mongolia mine several commodities but the by far most important are gold, fluorspar and coal. Few are mining dimension stone and mercury.

3. There has been a significant change in the distribution patterns of small-scale miners in Mongolia. Prior to 2004 virtually no small-scale mining was carried out in the Gobi desert. Early 2004 very rich vein gold deposits were discovered in the southern part of the Gobi desert. Some of these occurrences unfortunately occur in protected areas. This, however, did not deter small-scale miners to move in and start mining. The government immediately sent in the police and military to clear the area. Shortly after having been forced out a new group of small-scale miners moved in and this has been going on ever since. The area was visited during this mission and several small-scale miners were interviewed. This took place during night since the small-scale miners only work at night in order to avoid being caught by the police. There are strong indications for the police receiving bribes from the small-scale miners. Small-scale mining for placer gold is rap-

[1] Ninja miners of Mongolia. Assistance to policy formulation for the informal gold mining sub-sector in Mongolia. By Mongolian Business Development Agency for Canada fund Mongolia (2003)
[2] Action research on mercury pollution in Boroo area Mongolia. Compiled by B. Tumenbayar for Japan International Cooperation Agency Mongolia Office (2003)

idly increasing in the Gobi desert. An estimate based on talks with officials from several aimags and what was observed during a field trip through Gobi desert gave an excess of 5000 small-scale miners active in the area.

4. Some of the hard rock small-scale miners in Gobi claim that they truck ore either to Ulaan Baator or even further north in Mongolia for extracting the gold. Newspapers have indeed reported that several large trucks carrying gold ore have been spotted and confiscated by the police in Ulaan Baator. Several of the hard rock ninjas in the Gobi desert, however, only truck their gold ore to nearby milling centres. These centres are not located in villages or soum centres, but far away from populated areas.

5. Mercury is used widely in Mongolia for extracting gold. It is so far mainly used by hard rock miners and not by placer miners. This is in contrast to other countries e.g. Kyrgyz Republic where mercury is used by virtually all placer miners but not by hard rock miners. There are some placer miners using mercury and it is likely that many more placer small-scale miners will use mercury in the future since it increases their recovery of gold. During the field trip in the Gobi desert one milling and gold extraction centre for hard rock gold ore was visited. This centre used as much as 5 kg of mercury for every 3 to 4 tons of gold ore. Fortunately the owner of this particular centre had learned the technique of recycling mercury by using a retort. The owner did, however, admit that 30% of the mercury he used was released to the environment through the fines and overflow. The mercury in the tailings is likely to contain appreciably amounts of gold. The owner was very keen to learn alternative gold extraction methods. He was also informed that the mercury and the gold in the tailings could be recovered. The total amount of mercury used and lost to the environment in Mongolia is difficult to estimate. In 2003 Japan International Co-operation Agency Mongolia Office carried out an: Action research on mercury pollution in Boroo area Mongolia (cited above). This report concluded that in Bornuur soum, a small area North of Ulaan Baator, about 500 kg of mercury is released to the environment by small-scale miners every year. This represents just a small fraction of the total number of small-scale miners in Mongolia. Questioning small-scale miners during the present project in Bornuur area reveal that the number of small-scale miners has increased and the release of mercury likewise since the Japanese survey took place.

6. One of the main problems encountered for hard rock small-scale gold miners and owners of local gold extraction centres is the release of mercury during the amalgamation process for extracting gold. Most of them are aware of the toxicity of mercury, but in most cases they have no knowledge of how to recycle mercury or knowledge of alternative methods of extracting gold without the use of mercury. When confronted with the method of recycling mercury most of them claim interest in learning this technique. One teaching and training course was held in the Bornuur area North of Ulaan Baator. This course was highly successful and several mercury-recycling devices (retorts) were given to the participants of the course. The distributed retorts were copies of retorts invented in South America and described in detail in numerous UNIDO reports. The lack of knowledge of how to recycle mercury combined with the lack of knowledge by local medical doctors on diagnosing mercury poisoning has made it appropriate to suggest a new follow up project. A teaching and training project for medical doctors and small-

scale miners in handling problems with mercury in Mongolia has been discussed with the Mongolian Government.

7. Some small-scale miners sell their gold to Mongol Bank whereas most of them sell their gold to dealers in the field or to dealers in towns and villages. Signs with Buying Gold are seen in many shops in soum and aigmag centers. The price they obtain is close to world market price with a deduction for refining the gold. Placer small-scale miners sometimes recover gold nuggets. Few miners get an extra few percent on top of the gold price for gold nuggets whereas most only get the official gold price. Gold nuggets are collectors item and thus often fetch as much as 20% over the world market price. It would be good for small-scale miners if they could sell their nuggets to the proper price. Present estimates indicate that small-scale miners recover about 7 tons of gold per year (≈ 60 Mio. US$)[3].

8. The geologic setting of Mongolia and the fact that commercial mining companies as well as small-scale miners frequently make new discoveries of gold occurrences indicate that small-scale mining for gold is not a passing phenomenon. It is likely that it will go on for several decades and will sustain an increasing number of small-scale miners.

9. Small-scale miners can so far not obtain any license since no mining law for small-scale mining has been passed through the Parliament. Due to their illegal status many of the small-scale miners are harassed by officials and bribing of police officers is often necessary. However, in one aimag placer miners have obtained an agreement whereby they pay 4000 tugrug (3.3 US$) per mining group per month. A mining group is typically one family. For this sum the authorities leave the small-scale miners alone.

10. The majority of small-scale gold and fluorspar miners are men, but during summer time many women and children participate in the mining operation. The ratio in summertime is 50% men and 50% women and children. In the summer season many students carry out small-scale mining in order to finance their studies. This information was collected by the Canadian funded survey and the present survey confirmed the figures in the areas investigated.

11. Fluorspar small-scale miners work in an area south of Ulaan Baator. Their main problem apart from safety problems in the pits is that they have to stockpile the fluorspar until a buyer turns up. It often takes several months before they can sell the fluorspar. These miners have obviously a serious cash flow problem. If the government can establish funds giving microcredits to the fluorspar miners their cash flow problem will be solved. The ore is generally mined by men, but breaking the ore into smaller pieces and bagging it is often done by children and women.

12. Small-scale coal miners mainly work during the period October to April. During summertime many of them are small-scale gold miners. Coal production by large commercial mines cannot meet the needs of private households, so small-scale coal miners

[3] Ninja miners of Mongolia. Assistance to policy formulation for the informal gold mining sub-sector in Mongolia. By Mongolian Business Development Agency for Canada fund Mongolia (2003)

play an important role in supplying coal for cooking and heating. The small-scale coal miners have serious safety problems. They dig tunnels more than 100 meters down. The roofs in the tunnels are not supported and frequent collapse of tunnels cause fatal casualties. In order to prevent a major disaster due to destabilisation of the area where small-scale coal miners work a mining engineer should be brought in to check the ground and give recommendations. There are a number of mining engineers employed by the commercial coal mines in the area, so it should not be too costly to bring some of them into the field of small-scale coal mining for short term jobs. Following the recommendations of the mining engineers the necessary material, mainly timber, should be supplied. Often methane in the coal seams explodes causing severe and sometimes fatal casualties. Methane detectors could be of great help. There is a well functioning mining rescue group in the coal mining area also supporting the small-scale miners, which does a good, job but lacks resources.

13. Small-scale mercury miners recover mercury from a large mercury spill from a closed down Chinese placer mining operation. There is so much mercury so droplets of metallic mercury can be seen on the surface. This mercury travels downstream and dangerous high mercury contents are recorded in river water, river sediments, in human tissue and urine[4]. A pilot project of cleaning up an area of the Boroo River has been negotiated with the Mongolian Government.

14. Small-scale mining cause degradation of land surface. The problem in hard rock mining is minor. Placer gold mining results in many small holes and tunnels dug in riverbanks. Small-scale miners should of course level the heaps of gravel and fill the holes they have dug. It should, however, be emphasised that much of small-scale mining activity takes place in areas, which have previously been exploited by commercial companies, and these companies have left the areas without reclaiming. The small-scale mining degradation is very minor compared to what the commercial companies have caused. It may therefore be difficult to persuade them to reclaim the land they have spoilt considering that most of the major placer mining companies do not reclaim the areas where they have mined. In the Gobi Desert where no commercial placer gold mining has taken place but thousands of small-scale miners mine placer gold some degradation takes place. Especially holes pose a danger to people. These holes are not fenced off and people and animals can easily fall into the holes was fatal results.

15. There is still no legislation in Mongolia dealing with small-scale mining. There are several versions of a draft mining law in circulation. In May 2004 during the first in-country visit a general election was due in July. Thus nobody had any interest in a dialog of how the future mining law for small-scale miners should be written. During the second in country visit September-October the ministers for the different ministries had not been elected so no dialog was possible at this time either.

[4] Action research on mercury pollution in Boroo area Mongolia. Compiled by B. Tumenbayar for Japan International Cooperation Agency Mongolia Office (2003)

Introduction

Small-scale mining (artisanal) mining is practised in many parts of the world. In 1999 the International Labour Organisation (ILO) estimated that at least 10 million people were directly engaged in artisanal and small-scale mining activities in developing countries, with another 80 to 100 million people directly or indirectly dependent on them. There is a general reluctance of many governments to accept small-scale mining as a necessity for millions of people. The reluctance stems from in part from the serious environmental and social problems arising from the small-scale mining activities. There are, however, also significant advantages with a well-developed small-scale mining. It supports a large group of people and it significantly reduces the migration from rural areas to cities.

In Mongolia small-scale mining started in 1998 with few small-scale miners, but the number has increased rapidly ever since. Presently an estimated 100.000 depend on small-scale mining. People have had to find their own solutions, most often outside the formal economy. Serious cuts in production of the state owned coalmines resulted in massive loss of jobs and a shortage of coal supplies for household cooking. Many of the mineworkers formerly working in the state owned coalmines thus turned to small-scale coal mining. General loss of job opportunities has forced many people into placer and hard rock small-scale gold mining.

Much criticism on small-scale mining has come from various groups. Commercial mining companies claim that they have problems with small-scale miners exploiting within their concession areas. This is partly true, but in most cases small-scale miners exploit minor deposits which cannot be exploited on a commercial basis by large companies. It should also be pointed out that there are many examples from different parts of the world where small-scale miners have discovered mineral deposits, which have later been exploited by commercial companies. Criticism has also come from central and local government. Criticism from administrative side is mainly on the land degradation, pollution of the environment and the social problems arising from small-scale mining. Many of these problems can be dealt with by a good regulatory framework and education of the small-scale miners. It should be emphasised that one of the major advantages of small-scale mining is that it keeps thousands and thousands of people in the rural areas and prevents their migration to urban areas.

The present report address the inherent development dilemma of small-scale mining: Can the potential negative impacts of this activity be avoided, minimised or mitigated, while maintaining or even expanding its income, business, and employment generating potential?

Field investigations

Small-scale mining takes place in most parts of Mongolia. The exact number of small-scale miners is difficult to obtain, but an estimate from the Canadian funded project carried out in 2003[4] gathered that about 100.000 people were dependent on small-scale mining. Talks during the present survey with officials from aimag centres and government officials indicate that the number is rapidly increasing. During the present project small-scale gold mining operations in the area North and North-West of Ulaan Baator have been visited. In an area South-East of Ulaan Baator small-scale mining for coal and for fluorspar have been visited. Finally a significant part of the Gobi desert has been traversed and talks with small-scale gold miners, owners of gold extraction centres and aimag officials have been held.

Small-scale miners extract a number of commodities in Mongolia but the vast majority of the small-scale miners work on gold, coal and fluorspar.

Small-scale mining for gold

The majority of the estimated 100.000 small-scale miners in Mongolia mine gold. This started as early as 1998 in Northern Mongolia and has since gradually spread to other parts of the country. Early 2004 the first small-scale gold miners appeared in the Gobi desert, and it is estimated that in excess of 5000 people mine gold in the desert on a small-scale basis.

Gold mining in Mongolia has not been carried out for hundreds of years. The geologic setting of the country, however, seems very favourable for gold mineralizations and many small and medium sized gold mining companies are already in operation. Small-scale gold miners not only follow the footsteps of the commercial companies, but also discover new profitable gold occurrences themselves. Commercial companies will in all likelihood mine some of the discoveries made by small-scale miners in the future. On this background it seems likely that not only can many more small-scale miners as the present number earn a living from mining gold, but the mining period during which small-scale mining for gold can take place before the resources are exhausted my last for many decades. If this is the case then small-scale mining for gold in Mongolia is not a passing phenomenon and must therefore be dealt with as a long lasting activity giving a significant contribution to the wealth of the country. At present it is estimated that small-scale gold miners produce in the order of 7 tons of gold per year[5].

There are two types of small-scale gold miners, hard rock miners and placer miners. Both types are active in Northern Mongolia as well as in the Gobi desert.

[5] Ninja miners of Mongolia. Assistance to policy formulation for the informal gold mining sub-sector in Mongolia. By Mongolian Business Development Agency for Canada fund Mongolia (2003)

Small-scale hard rock gold miners

Hard rock gold mining by small-scale miners has up until recently been carried out in Northern Mongolia only. However early 2004 the first small-scale miners appeared in the Gobi Desert. The first ones started mining in a protected area in southernmost Gobi desert (Fig. 1). Rumours of very rich quartz veins spread over Mongolia. There is some controversy as to where the rumours originated. Some sources say that an exploration company trespassed into the protected area and sampled quartz-veins. Later assays revealed very high grades of gold (50 to 300 grams per ton). This attracted small-scale miners. Other rumours tell that small-scale miners indeed discovered the rich quartz-veins. Some of them have a fairly good knowledge of how promising quartz-veins look. These small-scale miners could, however, benefit from basic training in geology and from support from geologists. As an example: It should be possible to trace the very rich gold occurrences in the protected area of Gobi Desert into the non protected part of the Desert, where small-scale miners then quite legally could exploit the gold.

Figure 1. *Two pits from hard rock gold mining of very rich quartz veins in a protected area in Southern Gobi Desert*

In hard rock mining shafts are sunk down to several tens of meters depth. From the bottom of the shafts tunnels are dug, often by using explosives. These tunnels are up to several hundred meters long, but connected to the surface by shafts in order to increase circulation of air. The mining is carried out by blasting, hammer and chisel. Ore is hauled to the surface by hand. At the surface the ore is broken by hammering to pieces a few centimetres in size.

Extraction of gold is carried out in two slightly different ways.

1. The centimetre sized rock chips are milled to sand size in milling machines mostly manufactured in China. The crushed ore is handed over to female small-scale miners who transport the sand-sized fraction to a nearby river. At the river they add mercury to the sand sized ore and concentrate the heavies. During that process gold is amalga-

mated with mercury. Mercury is subsequently burned off in open air and the residual gold is sold.

2. The centimetre sized rock chips are milled to sand size, and up to 5 kg of mercury is added to the mill per 4 ton of rock during the milling (Fig. 2). Up to 30 % of the mercury is released directly to the environment with the overflow. The milled sand sized material with mercury is given to the small-scale miners who concentrate the heavies and the mercury with gold. The mercury is subsequently burned of and lost to the environment.

Figure 2. *Milling of hard rock gold ore. Five kg of mercury is added for every three to four tons of ore. One third of the mercury is lost directly to the environment with the overflow.*

Needs assessment hard rock small-scale gold miners

During shaft sinking and tunnelling the small-scale miners rarely support the roofs. Therefor cave in with injuries and causalities frequently take place. Teaching and training by mining engineers can to some extent avoid this. Mining engineers can teach small-scale miners how to secure roofs and walls of tunnels with timber or alternative materials such as parts from abandoned cars and trucks.

Release to the environment of mercury used in extracting gold by amalgamation is a very serious problem not only for the small-scale miners, but also for the population of Mongolia. It is not possible to estimate the total amount of mercury released to the environment per year in Mongolia. However, recent studies and present talks with the small-scale miners in the Bornuur area North of Ulaan Baator indicate that in this small area alone an excess of 500 kg of mercury per year is released to the environment. A recent survey of mercury content in urine from the population in Bornuur shows more than 10 times the recommended maximum value[6].

[6] Action research on mercury pollution in Boroo area Mongolia. Compiled by B. Tumenbayar for Japan International Cooperation Agency Mongolia Office (2003)

It is, however, not difficult to recycle mercury during the amalgamation process (see Annex 2). Implementing a devise, which has been used in South America during many years, can do this easily and cheaply. It is called a retort. This devise which is constructed of three common pieces of plumbing tubes is very robust and can last for years. It can recycle up to 95% of the mercury used in amalgamation.

In co-operation with ILO a teaching and training course (Fig. 3) was carried out for small-scale miners in Bornuur town 04 October 2004 (see Annex 3). The course was highly successful and the small-scale miners were very interested in obtaining retorts. A number of retorts were distributed to the small-scale miners.

Figure 3. *Teaching of small-scale miners in Bornuur town northern Mongolia*

In Kyrgyzstan and elsewhere an alternative method to extract gold has been developed, called acid treatment. This method is probably not in use in Mongolia yet, but may soon be 'imported' from Kyrgyzstan. Acid treatment does not use mercury at all and yields a very pure gold concentrate. The method is highly toxic, but only for a few minutes. In order to prevent future fatal accidents with the method small-scale miners should be advised of the dangers of the method (Annex 2). During a recent small-scale mining mission for WB in Kyrgyzstan a hand out was prepared explaining the dangers of using acid treatment. The hand out was printed and distributed by the Swiss Red Cross to village nurses in a large part of Kyrgyzstan. The nurses could then contact local users of nitric acid. A similar approach could be used in Mongolia.

Small-scale placer gold miners

This type of small-scale mining is carried out in Northern Mongolia and in the Gobi Desert. Some of these miners work on abandoned mining sites whereas others mine sites where no commercial companies have worked. The small-scale miners sink shafts or dig tunnels several tens of meters into unconsolidated sand and gravel. They have no knowledge and no means of supporting the roofs in the tunnels. Thus frequent collapse of tunnels take a heavy death toll on the small-scale miners. In Northern Mongolia where timber is available

teaching of small-scale miners in supporting roofs and walls will significantly reduce the number of accidents.
The small-scale miners in Northern Mongolia where water is abundant concentrate gold by standard method that is washing pans, the so-called Ninja pan. In the Gobi desert where water is scarce a dry 'washing' technique is used (Fig. 4). Both techniques used in placer gold mining only capture the fairly coarse gold grains. This means that the small-scale miners loose a lot of gold and they probably only have a recovery of 50 to 60 %, since all or most of the fine-grained gold is lost.

Figure 4. *"Dry washing" of gold in the Gobi Desert. The gold is concentrated by means of airflow from an airpump*

Needs assessment

The present project show that there is a great need for teaching and training of small-scale hard rock gold miners in Mongolia in recycling mercury and in how to support roofs and walls in the tunnels they dig. Questioning officials in soum and aigmag centres as well as the Ministry of Health in Ulaan Baator also show that there also is an urgent need for teaching local medical doctors in recognising the various symptoms on mercury poisoning. See section below on suggested teaching and training course for small-scale miners and medical doctors.

Placer small-scale gold miners have mainly too low recovery of gold. However, during discussions with them they did not appear to be interested in increasing the recovery. This could be done for the placer miners in North Mongolia by better equipment such as better sluices. It will be more difficult to help the small-scale miners working in the dry Gobi desert. Equipment, which can be used under dry conditions, has been developed in the US. It is suggested to look into this equipment and see whether it can be purchased at a reasonable price for use in Mongolia.

Small-scale mining for coal

Field investigations

Nalikh area South of Ulaan Baator is the centre of coal mining in Mongolia. The main Mongolian coalmine was flooded and closed down. There are, however, a number of commercial Mongolian and Chinese coalmines in the area. The commercial coalmines supply coal to the powerplants of Mongolia.

Coal for household cooking and heating is supplied exclusively by small-scale miners. The coal produced by small-scale miners is transported to Ulaan Baator and other large towns. A security officer from the local mining rescue group regularly inspects the small-scale miners in the Nalikh area. He makes monthly statements as to the number of small-scale miners and keeps statistics on number of accidents and casualties. He is in charge of rescuing operations for the small-scale miners. During the first three months of 2004 the maximum number of coal small-scale miners were 1882. They were mining coal from 56 tunnels. The number of small-scale coal miners in September 2004 was 1135. The number will increase in the autumn and winter when the need for coal for household increases. Furthermore a number of gold small-scale miners turn to coal mining when the working conditions for gold mining get too harsh.

The small-scale coal miners work in groups of five to six people. They dig tunnels down to a depth of more than hundred meters (Fig. 5). The coal seams they mine are up to a meter in thickness, but often much less. They climb down the tunnels and use a small torch for light and hammers and chisels for mining the coal. Locally the miners encounter permafrost, which makes mining of coal difficult. In these cases they use explosives. They chisel holes into the coal seams and fill them with explosives. Burning fuses increase the risk of methane from the coal explodes. They collect the coal in a bucket holding about a hundred-kilogram. This bucket is pulled to the surface by a cable attached to a tractor. When the coal reaches the surface it is screened and the large pieces are broken to smaller pieces. When the heaps of coal are on the surface, they are targets of small boys (called “Small birds”). These boys steal as much coal from the small-scale miners they can (Fig. 6). They collect the coal and sell a bag of 10 kg for about 700 tugrug (~ 0.6 US$). The small-scale miners mine on average 6 tons of coal per day for which they get in the order of 80.000 tugrugs (100 US$). However, not all goes to the small-scale miners. Most of the land in the Nalikh area is covered by small mining licenses. The license owners employ small-scale miners to do the mining. The owner of the license takes 10 % of the income. The owners of the tractor pulling the coal to the surface take another 10% of the income. The remaining 80% of the income are split between the 6 members of the team.

Figure 5. *Inclined shaft for small-scale coal mining*

Figure 6. *"Small Birds". Young boys stealing coal from small-scale coal miners*

There are severe safety problems for the small-scale coal miners. The tunnels they dig are rarely supported so collapse happens frequently (Fig. 7). There are now so many holes dug by small-scale miners over a comparatively small area so there is an obvious risk of destabilising the whole area. Lack of air at the bottom of the deeper tunnels also cause problems. Finally methane from the coal seams take their toll of small-scale miners. During the first nine months the Mining Rescue office had more than ten rescue operations. During that period, twenty small-scale miners were rescued from tunnels, but eight died. Most of the small-scale coal miners are between 18 and 45 years old, and less than 20% are older than 45. There are virtually no women and children engaged in small-scale mining for coal.

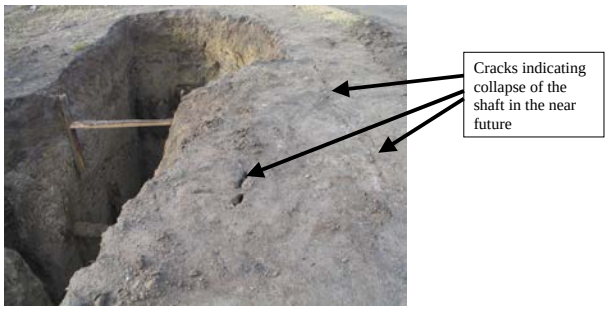

Figure 7. *Cracks near a shaft. These cracks indicate that there will be cave in of the walls in the near future.*

Needs assessment

The major problem for small-scale coal miners is safety. A death toll of almost one every month and many serious injuries during their work is obviously not acceptable. Next to the area where the small-scale coal miners work are several operating commercial coalmines. These mines operate underground have thus the expertise and staff to teach the small-scale coal miners how to operate more safe underground.

In the coal mining district there is a Mining Rescue office which also serves the small-scale miners. Given some limited funding this office could hire staff from the commercial mines to teach the small-scale miners. Teaching is obviously not enough. Collapse of tunnels can only be prevented if sufficient timber or alternative materials are available. Considering the importance the work of these small-scale miners is for supplying coal for household heating and cooking it would be reasonable to supply them with supporting material either timber or metal. It must be borne in mind that the supporting material can be re-used from one tunnel to the next.

There is a risk that the whole small-scale mining area will be destabilised due to the large number of holes dug by small-scale miners. Quite deep cracks observed during the field visit is an indication of initial destabilisation. In order to prevent major disasters an experienced mining engineer should have a close look at the area and subsequently teach the small-scale miners how to support roofs and walls.

Another safety problem for the small-scale coal miners is lack of fresh air in the tunnels. This problem can only be overcome by using airpumps.

Methane is frequently present in appreciable amounts in coal and when coal seams are exposed the methane starts to leak from the coal seams into the tunnels. Methane is toxic and it is highly explosive. Methane in the tunnels frequently causes casualties. Methane indicators could avoid this. Such indicators are available on the international market. The price is about 45 US$ each. This price can of course be negotiated if large quantities of indicators are ordered. Carbon monoxide is also frequent in tunnels were coal seams are mined. Cheap non-electronic indicators for carbon monoxide can be purchased and distributed to small-scale coals miners. This could be organised by the mining rescue officers.

Small-scale mining for fluorspar

Mongolia is one of the world leaders in mining of fluorspar (fluorite), and probably the world's largest exporter of bulk fluorspar of metallurgical grade. Mongolian-Russian JV "Mongolrostsevetmet" is the largest and leading fluorspar producer and exporter in Mongolia. JV has an underground mine and processing plant at Bor Undur fluorspar deposit in Hentii aimag (produces annually 120,000 tons fluorspar flotation concentrates of 95-97% grade), and open pit mines at Airag, Orgon, and Hajuu Ulaan fluorspar deposits in Dornogovi aimag. In total the JV produced in 88,500 tons of flotation conc., and 72,400 tons of metallurgical grade fluorspar in 2002; and 123,600 tons of flotation conc., and 85,900 tons

of metallurgical grade fluorspar in 2001. It is estimated that 2500 people are employed with commercial companies mining fluorspar. Well over 500 small-scale miners carry out small-scale mining of fluorspar.

Field investigations

The fluorspar deposits visited during the mission occur in an area south of Ulaan Baator. The general pattern is that the potential areas for fluorspar are licensed. The license owners employ small-scale miners to mine the fluorspar. The mining is exclusively done by hand and the pits are often more than 5 meters deep. They mine with hammers and chisels, sometimes using explosives. The fluorspar ore is either broken to smaller pieces (~5 cm) on the spot or in nearby villages. This work is carried out by hand (Fig. 7). The fluorspar is then bagged. The bags hold about one ton of rock. Every now and then fluorspar dealers mainly from the commercial mining companies come and buy the fluorspar.

Figure 8. *Manual crushing of fluorspar ore by young boys*

Figure 9. *Bagged fluorspar stockpiled*

The license owner pays the small-scale miners about 3000 tugrug per ton. A group of miners may mine up to about 20 ton of fluorspar per month. Crushing and trucking the ore cost about 5000 tugrug per ton. This gives a total production cost of about 8000 tugrug per ton. The final bagged product is sold by the license holder to the buyers for about 25.000 tugrug (~25 US$) per ton.

Men mainly carry out the mining of fluorspar, whereas children mostly do the breaking of fluorspar ore into small pieces and women often do the bagging.

Needs assessment

The main problem in small-scale fluorspar mining is the lack of cash flow. Fluorspar is mined throughout the year and stock piled until a buyer shows up (Fig. 9). This can easily take several months during which period no cash is available for the license holder to employ workers.

Figure 10. *Stock piled fluorspar in Gobi Desert*

If the Government could provide microcredits to the licence owners this would ensure a stable cashflow which would benefit the small-scale fluorspar miners.

A safety problem is that the tunnels dug by fluorspar small-scale miners are not secured. Therefore the roofs frequently cave in causing injuries and causalities. Training of safe tunnelling and supply of supporting timber or metal would solve some of these problems.

Small-scale mercury miners

This is a very special type of small-scale miners, which probably are unique to Mongolia. Few other places, if any on Earth can small-scale miners recover mercury by small-scale mining. This, however, is unfortunately the case in the Boroo river area North of Ulaan Baator.

Early in the previous century a Chinese company started mining gold from the Boroo River area. They used mercury to extract gold. The mercury was stored in a big tank. Eventually the company stopped and pulled out. In 1956 the tank exploded and the mercury ran out in the Boroo river area. An estimated 10 tons of mercury was thereby discarded to the environment. The mercury content of the area is so high so droplets of metallic mercury can be seen on the surface.

Such high amounts of mercury are of course attractive to the gold small-scale miners and some of them specialise in mining mercury form the Boroo River and sell the mercury to small-scale gold miners. The amounts of mercury extracted by small-scale miners do not meet the demand of mercury from small-scale miners in Mongolia. It is only a small extra

source. Most of the mercury used by small-scale gold miners in Mongolia is smuggled into the country mainly from China.

The high amounts of mercury in the Boroo river area pose a serious threat to the local population. The investigation[7] carried out in 2003 showed that the mercury has travelled at least 40 km downstream Boroo River towards several towns. The mercury continues travelling down stream and will eventually reach Lake Baikal in Siberia. The river water and the sediments in the river have mercury contents much higher than the recommended maximum values. Urine samples from the local population also show alarmingly high contents of mercury. However, the investigation also demonstrated that most of the mercury is still at the spill site.

This problem has been discussed with officials from Ministry of Nature and Environment, Ministry of Trade and Industry, Ministry of Health, Ministry of Labour and Social Welfare and with UNDP. The problem has also been discussed with several NGO groups. All involved parties agreed that it is a serious problem and if an efficient clean up of the mercury spill is not carried out in the near future the consequences will be serious. It has been considered to move groups of people away from the polluted area unless the mercury spill is removed.

A pilot project has therefore been designed with the purpose of cleaning a limited area and if the techniques applied works then a large clean-up project can be initiated. In the pilot project a mercury extracting method will be used which has been designed in South America and has been tested in Brazil and Venezuela[8] The pilot project has been negotiated with the Ministry of Nature and Environment in Ulaan Baator. See section below on suggested pilot project of clean up of mercury in the Boroo river area.

[7] Action research on mercury pollution in Boroo area Mongolia. Compiled by B. Tumenbayar for Japan International Cooperation Agency Mongolia Office (2003)

[8] Equipment Specification for the Demonstration Units in Tanzania by Marcello Veiga. UNDP Global Mercury Project. Project EG/GLO/01/G34: Removal of Barriers to Introduction of Cleaner Artisanal Gold Mining and Extraction Technologies.

Gender issues

Small-scale hard rock gold mining

Previous investigations as well as investigations carried out during the present project indicate that many children are active in small-scale gold mining. During the summertime fifty percent of the small-scale gold miners are men and another fifty percent are women and children. The percentage of children can not be discovered. When the schools start most of the children are sent to school in villages and towns. They are looked after by relatives. In hard rock gold mining men mainly carry out the mining whereas women and children break the rocks, make gold concentrates and do the amalgamation.

Working with mercury in amalgamation is mainly done by women and children. Some of the women appreciate that mercury as highly toxic, but nevertheless they touch it frequently with their bare hands. During this project a teaching and training course was held in a small town North of Ulaan Baator (see Annex 2 and separate chapter in this report). The course mainly dealt with health and safety problems in small-scale mining for gold.

Working with mercury is dangerous to men and women. However, it is especially critical if pregnant women work with mercury. The foetus upconcentrate the mercury. Thus if the pregnant woman has so and so much mercury in her body the foetus will have ten times as much. This means that pregnant women may show no or weak symptoms of mercury poisoning and yet the foetus may become permanently brain damaged.

Small-scale placer gold mining

This type of gold mining is carried out on a family basis, where father, mother and children participate (Fig. 9). Thus the proportion of men is generally lower than fifty percent. However, during the winter season most children are sent to school and some of the women follow the children back to the villages.

Figure 11. *Child (11 years old) working as small-scale placer gold miner*

Small-scale miners on gold placers claim that they do not use mercury. It is probably true that the majority do not use mercury, but it is highly probable that some of them use mercury and this number may very well increase when the small-scale miners realise that they can extract more gold per ton of rock by using mercury. In Kyrgyz Republic almost all small-scale placer gold miners use mercury.

Small-scale coal mining

In this type of small-scale mining no female small-scale miners were observed or reported. Some children ‘steal’ coal from the small-scale miners, but this can hardly be termed child labour.

Small-scale fluorspar mining

All fluorspar mining is reportedly carried out by men, whereas children and women break and bag the fluorspar ore.

Needs assessment

An obvious problem for women and children is the use of mercury. Especially for pregnant women it is dangerous since the foetus concentrates the mercury relative to the mother. It is thus important to explain the women about the danger of using mercury and teach them re-cycle mercury. Children should be kept from handling mercury. The Ministry of Health in Ulaan Baator pointed out that medical doctors in towns and villages do not know the symptoms of mercury poisoning. The Ministry thus suggested establishing training courses for these medical doctors in order to assure good health conditions among the small-scale miners and the general population.

Proposed mining law for small-scale mining

During the first in-country visit in May 2004 none of the officials in any of the visited Ministries wanted to discuss the proposed mining law. The reason was the upcoming general election for a new parliament in July 2004. During the second in country visit September-October 2004 the general election had taken place and the new parliament had been established. However, the cabinet had not been established. This means that not all ministers have been elected and many of the officials in the Ministries do not know whether they have their job tomorrow. Therefor the are all reluctant to discuss the proposed mining law for small-scale miners.

Needs assessment

A small project to evaluate and discuss the draft mining law when the cabinet has been established is urgently called for. Robin Grayson, compiler of the Canadian funded baseline study of small-scale mining in Mongolia 2003 has made a big effort together with some NGO groups making comments and suggestions to the draft mining law for small-scale miners.

Teaching and training course for small-scale miners and owners of gold extraction plants

October 4th a teaching and training course was carried out for small-scale miners and owners of gold extraction plants in the Bornuur area about 150 Km North of Ulaan Baator in co-operation with ILO and the NGO group Mongolian Employers federation (see Annex 2). Prior to the course visits were paid to two gold extraction plants in the area. These plants used slightly different techniques. At both plants the ore was delivered in small rock bits not larger then a few centimetres. At one plant the ore was ground to less than one millimetre. During the grinding about 5 kg of mercury was added per three to four ton of rock. The overflow, which contains an estimated 30%, of the added mercury was deposited without any security. The ground ore from the first mill was then delivered to the miners who concentrated the heavies and then burned off the mercury thereby recovering the gold. The second plant only ground the gold ore. The small-scale miners received the ground ore. They carried the ground ore to a nearby river. There they added mercury to the ground ore and then concentrated the amalgam. Later they burned off the mercury and recovered the gold.

20 small-scale miners turned up at the teaching and training course, which was held in a school in the town of Bornuur. The small-scale miners were informed about the health and environmental risks by using mercury. They were also told that investigations of urine samples from inhabitants of Bornur town showed alarmingly high contents of mercury. They were thus very interested in learning how to recycle mercury by using a retort (see Annex 2).

After the teaching program the small-scale miners received a number of questions regarding their working conditions. The questions were discussed in groups and a representative from each group subsequently explained the opinion of the group. The questions can be seen in Annex 3 as well as their answers and a list of participants in the training course.

Needs assessment

The outcome of the group working on the questionnaires was as follows.

The small-scale miners are not particularly interested in obtaining licenses. They fear it will be too expensive.
They know that mercury is dangerous, but the have no knowledge on how to minimise the risks. They would also like to have cheap access to ropes, safety helmets etc.

1. Transportation costs are a heavy burden on the budget of small-scale miners. Maybe the local authorities could organise a form of collective transportation.
2. The small-scale miners suggested that the Mongol Bank had branches where they could sell their gold.
3. The small-scale miners are deeply worried about the lack of social security for them. In case of accidents or casualties they are have serious problems surviving.

Workshop for government officials and parliament members held at World Bank Ulaan Baator 7th October 2004

Agenda

14.30-14.45	Opening	Mr.Peter Appel, Consultant, World Bank
14.45-15.00	Baseline survey of small-scale mining in Mongolia	Mr. Robin Grayson, Eco-minex International Co.Ltd
15.00-15.15	Role of mercury in small-scale mining and how to minimize the health and environmental problems	Mr. Peter Appel, Consultant, World Bank
15.15-15.30	Discussion	
15.30-15.45	Coffee break	
15.45-16.00	Introduction of a future project: Training courses fo rmedical doctors and small-scale miners	Mr. Peter Appel, Consultant, World Bank and Ms. Enkhsetseq, Ministry of Health.
16.00-16.30	Introduction of a future project: Pilot project on cleaning the Boroo river for mercury	Mr. Peter Appel Consultant World Bank, and Mr. B. Tumanbayar, Sans Frontiere Progress Mongolia
16.30-17.30	Discussion	
17.30	Closing	Mr. Peter Appel, Consultant, World Bank

The workshop was well attended, see Annex 4 for list of participants. The results of the present project were described and the details of the two new projects were described and discussed in much detail.

Brief summary of needs assessment

1. Fluorspar small-scale miners need microcredits to obtain an even cash flow.

2. Coal small-scale miners need methane detectors, equipment and help from mining engineers to prevent caving in of their tunnels

3. Small-scale gold miners need teaching and training courses in recycling mercury and help from mining engineers to prevent caving in of their tunnels.

4. Medical doctors need teaching and training courses for diagnosing symptoms of and cope with cases of mercury poisoning.

5. Legalising small-scale miners activities by a new mining law for small-scale mining

6. A major mercury spill in the Boroo River area North of Ulaan Baator needs a serious clean up project.

Comments to the follow-up proposals

During meetings with parliament members and government officials from Ministry of Nature and Environment, Ministry of Industry, Ministry of Labour and Social Welfare and Ministry of Health it was obvious that the Government of Mongolia is deeply concerned with the problems of small-scale mining. A few regard small-scale mining as a passing phenomenon, which will disappear in the near future. Another few are inclined to enforce the banning of small-scale mining. However, the majority of government officials and parliament members seem to agree that small-scale mining will not stop tomorrow, but may go on for decades or even during most of this century. They therefor welcome the initiative of World Bank and other international groups to teach the small-scale miners of Mongolia better working methods which will ensure that land degradation is minimised and the negative impact of small-scale mining on the environment is reduced as much as possible.

Of special concern to the Government officials from all the involved ministries is the widespread use of mercury by small-scale miners and the resulting release of large amounts of the metal to the environment. The report on mercury pollution from small-scale mining in the Bornuur area North of Ulaan Baator by the Japanese group[9] has caused much concern to the Government. All the Ministries have thus reacted very positive to the suggestions of teaching and training small-scale miners in how to recycle mercury. One of the Ministries was so enthusiastic so it arranged for manufacturing of a number of retorts for recycling mercury. The manufactured retorts were then handed out during a training course held during the mission in Bornuur town North of Ulaan Baator. The small-scale miners participating in the training course were very eager to use retorts. Bornuur town was a particular good place to start the teaching and training program because the Japanese survey has shown that the inhabitants of this town has very high contents of mercury in their urine and that the mercury stems from amalgamation by small-scale miners.
The Ministry of Health in Ulaan Baator suggested to include a training program for medical doctors in diagnosing mercury poisoning and to teach medical doctors how to treat mercury poisoning. The Ministry also suggested to collect and analyse human tissue for mercury and to establish a database on the results. The database would over time cover most of Mongolia and help the Health authorities to establish a road map on how to reduce the growing mercury pollution of the environment and the population of Mongolia.

The proposed teaching and training project for medical doctors and small-scale miners has been discussed with the UNDP office and the Asian Development Bank office in Ulaan Baator. Both organisations were very positive. UNIDO in Vienna were likewise interested in incorporating teaching and training of medical doctors and small-scale miners in Mongolia in future teaching programs.

[9] Action research on mercury pollution in Boroo area Mongolia. Compiled by B. Tumenbayar for Japan International Cooperation Agency Mongolia Office (2003)

The Boroo river mercury spill is of deep concern to the involved Ministries. One attempt to clean the area has been carried out, but with no success. This failed attempt actually caused more harm than good in stirring up a lot of mercury-rich river sediments. The Ministry of Nature and Environment has placed the proposed pilot clean-up project of the mercury spill of the Boroo River high on their priority list. The project proposal on a pilot clean-up project of the Boroo river mercury spill has been discussed with the UNDP office in Ulaan Baator and with the Asian Development Bank office in Ulaan Baator. Both groups were very positive towards the project. A similar positive attitude came from UNIDO office in Vienna.

Short description of a Training program for medical doctors and small-scale miners in handling problems with mercury in Mongolia

Background

The most serious health and environmental problem caused by small-scale mining of gold is the widespread release of mercury during the extraction of gold. Mercury is used by small-scale miners themselves but also by owners of gold extraction centers in villages. Inquiries at gold extraction centers in villages in the Gobi desert revealed that for each 3 to 4 ton of gold ore to be processed 5 kg of mercury were added in the milling process. The owners of the gold extraction centers estimated that about 30% of this mercury were lost with the tailings. The remaining mercury evaporated during the refining of gold. It is difficult to estimate how much mercury is released to the environment in Mongolia each year. A recent survey[10] showed that in the Bornuur area north of Ulaan Baatar about 500 kg of metallic mercury was released to the environment every year. There is no indication that the amount will decrease in the future. The mercury enters the drainage pattern and the food chain. Alarmingly high amounts of mercury were found in soil, river water and river sediments. Mercury cause considerable irreparable damage to humans. The Japanese survey showed that the population in the investigated area had high contents of mercury in their urine. In one investigated area the mercury pollution stems from an industrial source, but in other areas the mercury pollution can definitely be ascribed to release of mercury by small-scale miners.

It is suggested to initiate a teaching and training project not only for small-scale miners but also for medical doctors who are not trained in symptoms of mercury poisoning. The project is suggested to comprise the following items.

1. Teaching and training of medical doctors in soum and aimag centers outside the major cities of Mongolia. The teaching will focus on the symptoms of mercury poisoning and what precautions can be taken.
2. Teaching and training of small-scale miners and owners of gold extraction centers in villages, soum and aimag centers. The teaching will focus on methods to recycle mercury during amalgamation and on alternative methods, which do not involve mercury.
3. Teaching and training by international consultants of Mongolian counterparts (trainers)
4. Collection and analyzing blood and urine samples and establish a database for mercury levels in the population of Mongolia.
5. Establish local information centers where the local population can seek information and advice on problems related to small-scale mining. Produce hand out which people can fetch at the information centers.
6. Discussing the problems of small-scale miners with local authorities in villages, soum and aimag centers in order to create a more positive and cooperative attitude from local authorities towards the small-scale miners.

[10] Action research on mercury pollution in Boroo area Mongolia. Compiled by B. Tumenbayar for Japan International Cooperation Agency Mongolia Office (2003)

Scope of Work

Task 1):

Teaching and training of medical doctors and local trainers

The program is suggested to consist of lectures, discussions on mercury toxicology and risk assessment and management. In addition there shall be demonstrations of sampling techniques for environmental and biological monitoring. The scope shall be to provide an elementary but scientifically up to date introduction to mercury toxicity, risk assessment and risk management.

The following components shall be included in the program:

1. General mercury toxicology
    - Physical and chemical properties of various mercury species
    - Human exposure routes, air, food, skin contact, and placental transfer
    - Distribution in the body and biochemical reactions
    - Excretion
2. Diagnostic criteria for acute and chronic mercury poisoning
3. Treatment and prevention
4. Consequences of long-time low-dose exposure
5. Risk assessment and risk management
6. International guidelines for safe exposure
7. Demonstration of sampling techniques for environmental monitoring (air) and biological monitoring (blood and urine)

Before the start of the courses a handout containing a summary of the most important information shall be prepared and distributed to the participants.

Task 2):

Teaching and training of small-scale miners, owners of gold extraction centers and trainers

The program shall consist of lectures and group working where the small-scale miners will discuss and specify the particular problems they are facing. The group workings shall also comprise discussions on how to improve the working conditions for small-scale mines.

The following components shall be included in the program:

1. Demonstration of methods for recycling of mercury
2. Explanation of alternative methods for gold extraction
3. Improvement of sluices and sieving techniques
4. Basic geology course to facilitate the discovery of gold
5. Methods to recover gold from the mercury-rich tailings left from previous (?) gold extraction

Outcome
The expected outcome of the project after two years can be summarized as:

1. Medical doctors and small-scale miners have been taught and trained in recognizing the effects of mercury poisoning and recycling mercury or using alternative methods in extracting gold
2. The mercury consumption by small-scale miners has decreased
3. Mongolian trainers are fully capable to continue teaching and training courses for medical doctors and small-scale miners
4. Training centers are established in soum centers and handouts will be printed
5. Database with information on mercury levels in the population of Mongolia established

Deliverables
During the project the following deliverables should be produced:

1. Handouts for participants of the teaching and training courses
2. PowerPoint presentations for the courses for medical doctors, small-scale mines and owners of gold extraction centers
3. Compilation of the results from the group workings of the small-scale miners and owners of gold extraction centers
4. Database for mercury contents in human tissue

Short description of a suggested Pilot Project: Cleaning of a major mercury spill in Boroo River area, Mongolia

Introduction

In 1913 a Chinese mining company started gold mining from river gravel in the Boroo area about 60 km north of Ulaan Baatar. The company used mercury to extract gold. They stored the mercury in a tank. In 1956, long after the company had ceased mining and could be held accountable, the tank broke and released about 10 tons of mercury into the Boroo River area. The mercury is slowly travelling downstream and dangerously high levels of mercury in river sediments and river water have been detected more than 40 km from the spill site. The population in the villages and towns downstream from the site use the polluted river water for drinking, for watering cattle and for irrigation. High contents of mercury in human tissue and urine have been detected in the people in villages and towns downstream from the spill site. The mercury spill will eventually reach Lake Baikal.

It is suggested to carry out a pilot project of cleaning a small area at the Boroo River for mercury. The techniques employed have been developed in South America, where they have proved very successful at a number of cases. If a pilot project at Boroo proves successful, a full scale cleaning project should be carried out. The mercury spill is a serious threat to the human population in the Boroo area and further North to Lake Baikal even if the areal extent of the polluted soil and gravels is limited to 0.9 km^2. It is not a major, long lasting task to remove all of the mercury from the limited area are of the polluted site, but it will have a positive impact on a very large area. If a pilot project proves successful then a total clean up of the area can probably be carried out over a period of no more than a few years.

Action

It is estimated that the technical part a pilot project can be carried out over a period of two to three months. Prior to that will be a period of purchasing equipment and have the equipment shipped to Mongolia.

A pilot project can be divided into five tasks.

Task 1):
Purchase of equipment, internationally and locally. The type of equipment must have been tested and found efficient. Such equipment can be purchased from various places in South America.

Task 2):
Sampling soil and analyzing its mercury contents.

Task 3):
Processing of an estimated 800 m^3 of soil mixed with appropriate amounts of water through the mercury extraction unit.

Task 4):
An environmental assessment analyses should be carried out prior to and after completion of the pilot project.

Task 5):
Reclaiming the test area and collect and analyze soil samples for mercury content.

Annex 1. People met

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Annex 2. Technical description of recycling of mercury

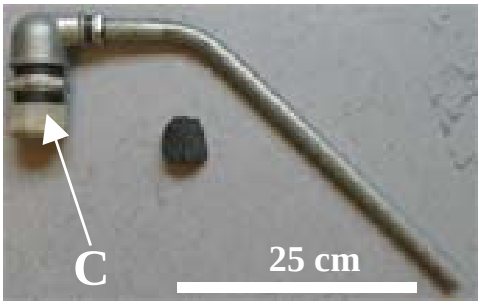
Mercury has been used for more than half a century in South America for extracting gold by small-scale miners in the so-called amalgamation process. Amalgam is gold partly dissolved in mercury. The amalgamation process has spread to Africa and South-East Asia. Recently amalgamation is also used in Central Asia e.g. Kyrgyz Republic, Mongolia and China.

The process of amalgamation is very simple. Gold ore, either crushed hard rock, or placer sand and gravel is first concentrated by various methods. This process discards the light minerals and keeps the heavy minerals. The final product of this process is a concentrate consisting of several different heavy minerals including gold. Next step is to discard all other heavy minerals except gold. This is often done by amalgamation. Mercury is added to the concentrate and is thoroughly mixed and stirred repeatedly. Gold in the concentrate forms an amalgam with mercury. The amalgam is separated from the heavy minerals. The amalgam is then put in a small spoon or iron cup and placed in a fire. The mercury burns of and the gold is left. The gold is not completely pure. There is always a little mercury left in the gold. Gold buyers deduct the estimated amount of mercury from the gold price.

The mercury, which has been burned off fall back on the ground and gradually, enters the drainage system. There it is either directly introduced into the food chain as metallic mercury or it is transferred by bacteria to the even more toxic methylated mercury. The amounts of mercury released to the environment in Mongolia are alarmingly high exceeding several tons.

A very simple devise has been invented in South America decades ago is used for recycling mercury. It is called a retort (see box). It has been produced in numerous versions, but the one described below is one of the cheapest and most robust types[11] It consists of a few pieces of plumbing tubes and can be manufactured all over the Earth at minimal costs. The amalgam is placed in the small cup (marked c). The long tube ends in a glass or tin with water. When the cup is heated mercury evaporates and gradually condenses in the container with water. 95% of the mercury can be recycled in this way. The retort is used extensively in South America, Africa and South East Asia.

[11] Equipment Specification for the Demonstration Units in Tanzania by Marcello Veiga. UNDP Global Mercury Project. Project EG/GLO/01/G34: Removal of Barriers to Introduction of Cleaner Artisanal Gold Mining and Extraction Technologies



Retort

An alternative method of gold extraction is acid treatment. This is a fairly new method seen in operation in Kyrgyzstan and elsewhere. The concentrate mentioned above consisting of heavy minerals including gold is dried and treated by a hand magnet. This removes more than 90 % of the concentrate. The remaining 10 % consist of non-magnetic minerals and gold. Concentrated nitric acid is added and heated. This dissolves what is left in the concentrate apart from gold. The process develops highly toxic nitrogen dioxide and it must be carried out outdoors or in very well ventilated areas. The brown fumes of nitrogen dioxide disintegrate rapidly to non-toxic components. The gold extracted by this process is very pure without any contents of mercury. This gold therefor fetches a high price.

The method is used in different countries, but it has correctly been stated that there are severe safety problems with the method. It is correctly pointed out that the nitrogen oxides are highly toxic and can cause death if inhaled. It does thus require considerable technical knowledge and skills to use the method. However, since the method is already in use in Kyrgyzstan it may very well spread to Mongolia. Small-scale miners should thus be warned against the risks involved when using the method. During a small-scale mining mission for WB in Kyrgyzstan a hand out was prepared explaining the dangers of using acid treatment. The hand out was printed and distributed by the Swiss Red Cross to village nurses in a large part of Kyrgyzstan. The nurses could then contact local users of nitric acid.

Annex 3. Teaching and training course for small-scale miners and owners of gold extraction plant in Bornuur town, North of Ulaan Baator 4th October 2004.

List of participants

№	Name	Location	Number of years, worked in small scale mining	Using mercury for amalgama-tion
1	Badamtsetseg	Ogoomor bag	2-3 years	Yes
2	Dolzodmaa	Ogoomor bag	1-2 years	Yes
3	Sarantsetseg	Ogoomor bag	2-3 years	Yes
4	Mongontsetseg	Mandal bag	3-4 years	Yes
5	Damdinbazar	Mandal bag	3-4 years	Yes
6	Tserenpil	Mandal bag	3-4 years	Yes
7	Ugtahbayar	Mandal bag	3-4 years	Yes
8	Ganbold	Ogoomor bag	5 years	Yes
9	Dulamsuren	Bichigt bag	3-4 years	Yes
10	Beejin	Bichigt bag	2-3 years	Yes
11	Otgonsuren	Bichigt bag	1-3 years	Yes
12	Jargal	Ogoomor bag	1-2 years	Yes
13	Bolormaa	Bichigt bag	3-4 years	Yes
14	Tsetsegdulam	Bichigt bag	4-5 years	Yes
15	Uranchimeg	Bichigt bag	4 years	Yes
16	Altanhuyag	Ogoomor bag	4 years	Yes
17	Tumenbayar	Ogoomor bag	3 years	Yes
18	Monhtulga	Ogoomor bag	3 years	Yes
19	Monh	Ogoomor bag	3 years	Yes
20	Batzorig	Ogoomor bag	3-4 years	Yes
21	Monhtsetseg	Ogoomor bag	4-5 years	Yes
22	Ariunzaya	Ogoomor bag	4-5 years	Yes
23	Purevsuren	Ogoomor bag	4-5 years	Yes

A questionnaire was distributed to the participants. They were divided into small groups. They discussed the questions and each group selected one person to present the result of their discussions.

Questionnaire was held among 20 small-scale miners. 40% of participants were 36-45 years old, 25% of participants were 26-35 years old, 25% of participants were 16-25 years old, 10% of participants were 45-55 years old and 15% of them were men. As for the education, all participants, except 1% percent, have secondary and primary education.

Participants were divided into 3 groups and each group has summarised their members' answers into one presentation. Following are the summarised result of the questionnaire:

- First question: Problems in obtaining license and your opinion on how to solve this problem. They answered that they don't want to obtain license because of its complicated process and expected high costs.
- Second question: How is your knowledge on safety measures? Most participants answered that they have general knowledge on safety measures. For example: it's dangerous to use mercury, they should have proper lightning, water proof clothes, safety helmet, rope, proper equipment for mining. But their knowledge was very low compared to knowledge, which they should obtain and also they almost don't take any safety measures.
- Third question: Do you face lack of proper clothes? Answers were there's always lack of safety clothes, but they couldn't afford to buy proper clothes.
- Fourths question: How are the transportation cost for small-scale miners from sum and bags to mining sites? Answers were, transportation cost to mining site is: 2.500 tugrug for each person (5.000 tugrug for 2 way), 1.500-2.000 tugrug for one sack of rock and totally it would be 8.000-10.000 tugrug. It's too much for them.
- Fifths question: Do small-scale miners have opportunity to sell gold legally and for a fair price? Answers were, it would be good if Mongol bank branches opened in their province or movable bank collect gold from them and pay them fair price for the gold. When they want to sell gold in banks in UB, they face many problems such as measuring gold carat, purifying the gold and high transportation cost to city etc. At the present time they are selling gold to individuals illegally and they pay very low price for the gold.
- Sixths question: How is your knowledge about laws and regulations on small-scale mining? Answers were: It is necessary to adopt law by the parliament to make them legal. At least it would give them opportunity to have social insurance.
- Seventh question: Is there any social guarantee for small-scale miners? Answers were there are no social guarantee for small-scale miners. Government has to take measures to provide them social guarantee.

Annex 4. List of participants in a workshop on small-scale mining for government officials and parliament members held at the World Bank, Ulaan Baator 7th October 2004

List of Participants

No	Name	Organization
1	Ms. Oyun	Vice speaker
2	Mr.Radnaa, Member	Parliament of Mongolia
3	Mr.Sukhbaatar, Member	Parliament of Mongolia
4	Mr. Damariran	Head Economic Standing committee
5	Ms.Sh.Enkhtsetseg, Specialist	Ministry of Health
6	Mr.Bat-Ochir, Specialist	Ministry of Industry and Trade
7	Ms. Navaan-Yunden Oyundar	Ministry of Natur and Environment
8	Ms.Erdenechimeg, Specialist	Ministry of Social Welfare and Labor
9	Mr.Tsedenbaljir, Specialist	Ministry of Nature and Environment
10	Mr.Damdin, Specialist	Ministry of Nature and Environment
11	Mr.Jargalsaikhan, Director	Mineral Resources Authority of Mongolia
12	Mr. Jargalsaikhan	National Security Council
13	Mr. Saijaa	Academy of Health
14	Ms. Oyunbileg	ILO
15	Mr. Algaa, Executive director	Mongolian National Mining Association
16	Mr. Enkhbaatar	Ministry of Justice and Internal Affairs
17	Mr.Davaatsedev, Former Member	Parliament of Mongolia
18	Ms. Shurentsetseg	Academy of Health
19	Mr. Robin Grayson	Eco-Minex International Co.Ltd
20	Mr.Tumanbayar	Sans Frontiere Progress Mongolia
21	Ms. Tsetsegmaa	Economics officer, ADB
22	Mr.Peter Appel	Consultant of World Bank
23	Mr. Kh.Ganbaatar, Exec. Director	Mongolian Employers' Federation
24	Ms. Oyundadi	Mongolian Employers' Federation
25	Ms. Enkhtuya	Mineral Resources Authority of Mongolia
26	Ms. Tsevel Delgaetsoo	Mongolian Business Development Agency
27	Mr. Erdenesaikhan	UNDP
28	Mr.S.Battulga,	Mineral Resources Authority of Mongolia
29	Mr. B. Magvanjav	Mineral Resources Authority of Mongolia
30	Mr. P. Zorigt	Mongolian National Mining Association
31	Mr. Tamir	Ministry of Nature and Environment
32	Mr. Janchiv	Security department of Nalaikh town

It is sometimes hard to find your way in the Gobi Desert, then you must ask the locals which way to drive.