Global Mercury Project

Project EG/GLO/01/G34:
Removal of Barriers to Introduction of Cleaner Artisanal Gold Mining and Extraction Technologies

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Removal of Barriers to the Introduction of Cleaner Artisanal Gold Mining and Extraction Technologies

GMP IN SUDAN

FINAL SUMMARY REPORT

BLUE NILE STATE – SUDAN
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Global Mercury Project in Sudan

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TABLE OF CONTENTS

INTRODUCTION

Artisanal and small-scale gold mining (ASM) is a poverty-driven activity that provides an important source of livelihood for perhaps 10 – 15 million people, but is also one of the major global sources of mercury contamination. It is estimated that artisanal gold miners produce up to 800 tonnes of gold annually, but releasing as much as 800-1000 tonnes of mercury to the environment in the process. These activities are frequently accompanied by extensive environmental degradation and deplorable socio-economic conditions.

The use of mercury to recover gold, a process known as amalgamation, is a common and simple gold extraction process that has been used for centuries. However, it is only relatively recently that the hazards of mercury have been understood and how ASM activities can contaminate air, soil, rivers, lakes and their fish communities with mercury, both locally, and ultimately, on a global scale. The health of the miners and other people living within the area is adversely affected primarily through inhalation of mercury vapour, and the consumption of mercury contaminated fish. Environmental and health impacts of amalgamation by the artisanal gold miners and their effects on international water bodies are similar in nature in most developing countries and solutions to these problems require concerted and coordinated global responses. The Global Mercury Project (GMP) was initiated to begin this global response to address environmental impacts resulting from mercury released by the artisanal mining sector. This report addresses the GMP's efforts to introduce technology, educate miners and reduce mercury use and loss to the environment in The Sudan.

Objectives of the Global Mercury Project

The ultimate goals of the GMP are (1) to reduce mercury pollution caused by artisanal miners, thereby protecting human health and local water bodies; (2) to introduce cleaner technologies for gold extraction and develop mechanisms to allow this technology to be supplied locally; and (3) to train local miners and develop community awareness about all environmental impacts derived from artisanal mining. Besides the environmental issues, this program also aims to train miners in procedures related to the formalization / legalization of their activities and good practices to both improve their health and quality of life.

Background – Gold Mining in Sudan

Gold mining and processing in the Red Sea Hills and Nubian Desert has been in process for at least 3,000 years. At that time providing gold to the Pharoanic Dynasties. Post-pharoanic gold production was continued by Arabs, Beja tribes and Turks in the desert of north and north-east Sudan. In what is now Southeastern Sudan, gold was discovered by the Turkish during the time of the Ottoman Empire in the mid 19th Century. Gold processing did not include amalgamation with mercury until the last couple of decades with the arrival of foreigners. Artisanal and small scale mining has been a traditional sub-sector. Its contribution to the national economy is underestimated, partly because the banking system does not have a mechanism to include gold. Despite the large number of the population being involved in artisanal gold production for centuries, few efforts have been made to improve technical abilities. At present, Ariab gold Mining Co. is the only gold producer on industrial scale. Annual production is in the 3-5 mT range.

Project Area – Blue Nile State, south-eastern Sudan

The area selected for the Global Mercury Project implementation site lies in the Ingessana Hills, Bau Locality (province) ~80 km to the southwest of Edamazin town, the capital of Blue Nile state. This area is characterized by a range of hills expanding in a semi-circular form from north to south with a diameter ~40 kilometers (figure). Chromite, asbestos and magnesite (in 1960s) and later gold (in late 1990s) were discovered in commercial quantities in these hills.

Bau, the central town in Ingessana Hills district lies ~80 kilometers southwest of El Damazin, the capital of the Blue Nile State. Other smaller towns and villages scattered around the hills are Soda, Gabanit, Gam, Dairang, Taga, Kumrik, Fadamia, Salbal, and Gugub. The Ingessana Hills are home to more than 20 artisanal gold mining sites. The gold production activities started in the late 1990s. In the neighboring localities of Queissan, Kurmuk and Belguwa gold mining practices have taken place for centuries. All these sites lie within the Blue Nile river system. Seasonal streams flow into the Blue Nile River above the Roseries Dam. The Blue Nile contributes 80% of the Nile water budget.

See Appendix 1

History of Gold Mining Processing Methods and Mercury in Ingessana Hills

Up until the present time, traditional gold panning has been the main method of gold separation in the different ASM sites in Sudan. Estimated panning efficiency in extracting gold from ore is 50% at best. During the last decade, artisanal gold production became increasingly dependant on amalgamation as a cheap method of gold extraction from ore. Mercury as a medium for gold separation was introduced in the 1990s by the Dwalla people displaced by fighting. Prior to that time, amalgamation was mainly confined to goldsmith shops. Goldsmiths also act as mercury suppliers, which are in contact with importers. No official record of Hg imports is available, and it is believed that mercury is smuggled in from the neighboring countries. Artisanal gold miners use mercury in a largely uncontrolled manner for amalgamating gold. Mercury is often mixed excessively with gold concentrate where spillage often takes place. Miners often mistakenly think that more mercury will mean more gold and are unaware of the toxicity of inhaled mercury. The most dangerous part of the process is the amalgam heating to evaporate mercury leaving behind gold dore' with partly not evaporated mercury. Up to %20 of this gold associating Hg ends up in goldsmith shops in town. 80% of mercury inhaled can not be excreted by the body and thus causes a gradual increase in concentration. The amount of mercury emitted by burning into the air in Khor Gidad area has been estimated at around 0.3 – 0.4 tonnes/annum. Estimates at the ratio of Hg lost: Au produced varies from 1:1.5 to 1:4.

Artisanal gold miners in the Ingessana Hills are spread over approximately 100 gold mining sites in Belguwa, Qeissan, Kurmuk and Bau districts. Gugub and Khor Gidad villages (~7 km apart) along with Taga (~5km away) are major centers as the main mining site. This was chosen as the project site. Both alluvial and primary ores are excavated and processed in 23 pit sites. Rudimentary ore comminution, concentration and amalgamation are thought to recover up to 50% of the gold. Work is mostly conducted by women in the rainy season (up to 90%) as most of the men attend to agriculture at that time. Primary ore is mined with hammers and picks up to 20 meters deep. These quartz veins have high grade of up to 30g Au/tonne, and an average miner can extract 0.3 g Au/day. Alluvial workings are more productive and it is estimated that each miner produces 0.5 – 1.0 g Au/day. This gives about 150-300 kg Au/annum production.

Since the 1980s efforts to develop and regulate ASM gold mining have been attempted by Geological Research Authority of the Sudan (GRAS), Ministry of Energy and Mining and local governments in different parts of the country. Most notably efforts in regulating activities in Belguwa, Qeissan, and Ingessana Hills, Blue Nile State were made in collaboration with Intermediate Technology Development Group, now Practical Action, NGO. During the 1990's there were surveys made to assess the ASM situation in the Blue Nile State. The undertaking culminated in the creation of approximately 30, 1-2Km sq, permitted gold mining concessions (see S. Khaleel Legal report,2004). At that time dry hammer mills were unsuccessfully introduced. Due to adverse conditions and deteriorating security in the district efforts were postponed. Now after the Comprehensive Peace Agreement signed in 2005 between central Government and Sudanese People Liberation Army (SPLA), few permit holders returned back to the region and resumed semi-rudimentary gold extraction.

The recent demobilization of armed men from the southern states has initiated a government effort to train and employ thousands of ex-combatants. News of large nuggets of gold being found in the Blue Nile State recently has attracted prospectors to the area. The arrival of outsiders once again threatens the social peace of indigenous Ingessana people. Until late 2006, inter-ethnic relations between indigenous Ingessana and war-displaced Dwalla were good. Over time conflicts between the two groups over gold-rich pits and cultural differences increased to the point that in January of 2007 the Dawalla returned to Kurmuk.

The Blue Nile State is not considered part of South Sudan, nor does it function as part of North Sudan. According to the Comprehensive Peace Agreement CPA signed at the formal end of the twenty year civil war (2005) Blue Nile State is one of three "States with special status". It remains marginalized and underdeveloped and therefore its people are vulnerable to external influences unless real development programmes are immediately introduced. At the present time 600 ex-combatants from the recent civil war are returning to Bau Locality. These returnees represent those loyal to the government as well as to the South. The local price of gold has risen from $13/gram in 2005 to $15/gram in 2007 in Damazin.

MAIN ACTIVITIES

Socio-economic assessment

The indigenous Ingessana community of >25,000 makes up the majority of Bau locality residents. However, during the 1990s the war displaced the Dawalla community from Kurmuk (100km south) to the Ingessana Hills. They introduced the mercury processing to the area, in addition to some Islamic values and primary school education for all children. Previously the Ingessana people had pursued a variety of livelihoods including cattle-raising, sorghum cultivation, charcoal making and recently gold mining using traditional panning methods. With the arrival of the Dawalla and mercury, gold production increased to 200kg gold per annum from panning alluvium and primary ore extraction. Socio-economic study of Ingessana Hills' targeted ASM community revealed social patterns, economic relations, and general attributes of the area. During 2004, ~1000 artisanal gold miners practiced panning in more than 20 sites in the Ingessan Hills. 80% of miners were from Dwalla ethnic group of Kurmuk. Ingessana ethnic miners made <%10 of the **total. Women and children participation was amazingly high (up to 90%). Illiteracy rate is high in Ingessana Hills (~90%) and is highest among women**

(~95%). Miners tend to work in family groups rather than form cooperative bodies. Tools for work were acquired through self-financing and are rudimentary.

Health and Environmental Assessments

These assessments were valuable in revealing the situation of the ASM communities. Because mercury has only been recently introduced to the area, it is an excellent baseline study for exposure for 5 – 10 years. The hazards of indoor burning of mercury and of mercury in tailings were evident. Evident also is the direct relationship between individual behavior and mercury contamination. Amalgamation and burning is often done in the privacy of the single room home in the only pan. Considered 'women's work' young girls are frequently the burners. Mercury vapor is the most toxic form as it enters into human body via inhalation. Mercury is a neurotoxin that concentrates in the body, it especially affects growing fetus, and therefore it is extremely important that women and girls of child bearing age keep away from or less avoid it. Because of increasing poverty and adverse situation in the rural areas, more desperate women go into ASM activities. In the Ingessana Hills during 2004-5, it was noticed that women and children make 90% of work force at gold pits. All recommendations made emphasize the necessity of keeping women and children away from amalgamation and amalgam burning. Acute health problems include malaria, diarrheal diseases, malnutrition and lack of obstetrical care. UNICEF provides an immunization program for children; otherwise there is little health care. (see Casalas C., Fenet H., Lamot M-O., ElBashier H., Medani K. BRGM report, 2005).

Gugub and Khor Gidad are among the heavily mercury contaminated sites. In a similar manner to the River Nile in the north, artisanal gold production has created many mercury hot spots. Gold amalgamation and burning are performed haphazardly; inside houses, in yards and around the shops. Liquid mercury is frequently found in the village soil. Evidence of burning in the kitchen using cooking pots is seen on the walls and ceilings of homes. Due to the high annual rain fall and proximity of ASM activities to river banks along with increasing use of mercury makes the Nile contamination eminent. The fish were so far not affected by mercury and considering the size of the watershed and the amount of ASM therein, it becomes urgent to prevent future methylation and bioaccumulation. Acute environmental concerns are headed by lack of clean water and sanitation methods as well as rapid deforestation (see G. Récoché, JP. Ghestem, I. M. Suleiman, R. Maury-Brachet, V. Roques-Duflo and A. Boudo, BRGM report 2005).

Micro-credit assessment

Micro-credit study made on ASM community reveals many opportunities for the miners/small investors to access financing institutions. The approach to micro-financing small gold production necessitates first organization the miners into associations, cooperatives or any community based organizations (CBOs). The experience of micro-crediting has been successful in a number of projects led by non-governmental agencies especially in the field of micro-agriculture. Among those NGOs, Practical Action (PA) Group (formerly Intermediate Technology Group, UK) has a good in country experience in the areas of community organization and promotion of micro-credit opportunities. With their new office in Edamazin, the chances are bigger for ASM community in southern Blue Nile to pursue acquiring small scale gold mining and processing equipment through the different micro-crediting options (see B. Elnaeim Microfinance options report, **2006). PA has already expressed interest in going into collaboration with GMP activities in Blue Nile State.**

Another option to organize ASM activities in the country is to adopt the gold milling centres, which is widely performing successfully in Zimbabwe and elsewhere. The setting there is the community deals directly with custom milling and processing point for a small fee or a share on gold produced. In either case, the mill owner keeps the tailing for a further treatment to extract the remaining gold in ore. Usually that is where the owner makes the profit. By this undertaking, the artisanal gold miners get organized because their activities are mostly tied with the mill. In this way the environment is also protected because all processing activities are contained in a small area, which minimizes mercury and tailings/waste contamination.

The Savings Bank and Industrial Development Bank in Edmazin and other State capitals offer opportunities for micro-crediting small scale enterprises, which likely suits the needs of ASM community to acquire equipment.

Design and Manufacture of equipment for transportable demonstration unit (TDU)
In order to design and produce appropriate, affordable, transportable gold mining equipment in Sudan the project relied heavily on transfer of technical knowledge from Patience Singo, a mining engineer and experienced miner from Zimbabwe. Along with consultation from Prof. Hermann Wotruba from Germany and a Iyass El Bashier, a Sudanese manufacturing engineer in private business, a whole line of suitable affordable, locally made gold mining equipment was successfully manufactured. This equipment was designed in order that individual components are affordable in Blue Nile State. Iyass El Bashier has offered to train workshop owners in Damazin how to manufacture the same equipment, which would make the cost event lower. In addition to the Sudan manufactured equipment, a hammer mill was imported from Brazil. A Keene dryblower sluice was also added to the TDU. Imitation NOMAD carpet and green Astroturf were purchased locally for use in the sluices. The locally produced equipment was been tested and shown to process ore efficiently with better mercury recovery; saving time and human toil, as well as preventing loss of gold. Various retorts and a Mvuto blower were also purchased for the TDU.

In addition EPA designed technology for mercury emission reductions in small scale gold refining facilities are being constructed and installed in gold shops in two sites, Damazin and Khartoum. Results as far as effectiveness and efficiency are not available to date.

See Appendix 2

Training of the trainers (TOT)
Training of the trainers occurred in two phases; the first at the end of 2005 with the emphasis on small mining equipment; and health and behavior change concepts. The second at the beginning of 2007 concentrated on the locally manufactured and imported equipment along with techniques in minimizing the use of, maximizing the recycling of, and avoidance of environmental contamination with mercury. A total of five trainers completed the training, two nurses and three technicians and several interested parties. Global Mercury experts Gillian Davis, GMP coordinator for Sudan, University of British Columbia, Canada; Professor Hermain Wotruba, University of Aachen, Germany, and Patience Singo, mining consultant form Bulawyo, Zimbabwe completed the TOT. The trainers received a thorough course on the different elements of gold mining and processing along with classes on environmental, health, legalization and micro-credit issues pertaining to ASM activities. They went through the

training manuals supplied by GMP. As part of TOT, the team along with ACFP visited GRAS pilot gold production site in Bayuda Desert, River Nile State in the north. Practical demonstrations on gold extraction and technologies use were performed. Trainers had chances to practice hands-on training on ore handling, sluicing (wet and dry), ore concentration, amalgamation and retorting. Nurse trainers also found a good chance to get acquainted with gold mining and processing settings, and the inherent environmental and health risks entailed. As first part of the technical training, a wet sluice was demonstrated. It was equipped with a 10mm grizzly screen to eliminate coarse oversize. No riffles were applied. As carpet, a copy of Nomad carpet was used. To demonstrate a mercury-free process to separate the gold, the pan concentrate was dried and then the gold was separated by the blowing-tapping technique. A clean gold concentrate could be obtained. This technique is well suited for small amounts of concentrate, like the ones obtained by gold panners. It is too slow to process larger amounts of concentrates. In some cases, magnetic minerals can be separated by using a hand magnet (old loudspeaker). This was not possible in this here, as the black minerals are mostly ilmenite. After completing the concentration tests, all concentrates were mixed and amalgamated in a gold pan. The recovered amalgam was then burned in a retort on a campfire. Even using the Mvutu blower, this is a very slow process. After more than half an hour, the burning still was not finished. If accessible for the miners, it should be considered to use gasoline torches as heating device. After the demonstration of the wet sluice, the Keene Dryblower was set up and operated. It is the mechanical type, using a fan driven by a small gasoline motor. The performance apart from the output of dust- was apparently very good. Even fine gold could be recovered into the concentrate, which was then later upgraded by using a pan. This is definitely the type of concentration equipment for eluvial and alluvial deposits in desert areas. The manual version was recommended for artisanal mining by Professor Wotruba.

See Appendix 3

TDU Trainings

The period of training extended from early March to end of May 2007. More than 300 individuals were registered for training. As mentioned earlier this area is extremely remote and at the time of the TDU had recently been the subject of forced repatriation of a high percentage of the actively mining Dwala group out of the area. Tribal hostilities remain high as land rights between groups are very fragile at this time of Sudanese history. The result was that the Khartoum based trainers were not totally trusted by those mining gold in Bau district last spring. Hostilities between different local groups resulted in the trainings ended early.

However despite these difficulties the trainers were able to provide training on: basics of gold ore geology; prospecting and testing; ore communition; ore concentration basics; different sluicing techniques; other gravity concentration techniques; size reduction; screening; amalgamation; mercury handling; hazards; retorting techniques; environmental protection; health and sanitation; organization and legalization of ASM activities and micro-financing options.

Training included both theoretical and practical sessions. Different types of alluvial and primary gold ores were used for hands on training. All attendees expressed satisfaction with equipment performance and many showed real interest in acquiring them and follow procedures they learned. We believe this is a positive signal for behaviour change. A follow up programme to consolidate technology transfer to those marginal communities is strongly recommended.

When comparing all manual labour vs introduced appropriate equipment it took one hour for three people to process half a ton of alluvial ore instead of ten hours for four or five people. Miners experienced the difference between hand crushing ore to <2mm at 2-3kg/hr/miner vs using quimbelete at 40-50kg/hr/two miners vs using hammermill at 1-2 ton/hr/two miners. Gold recovery increased using the two meter sluice and red nomad carpet from 50 to 80%. When local finer carpet also added recovery increased to 90 – 100% as fine gold also recovered. 100% of gold was recovered with the hammermill and two meter suice. Retorts were tried and it was agreed that the gas retorts were preferred for time usage.

Awareness Campaign

In November 2005 the Awareness Campaign was kicked off with a "Lightening Strike" event. This was an all community event with people travelling up to one hundred kilometers to attend. It was televised locally throughout the Blue Nile State, as well as broadcast nationally. Based on the previous socio-economic study and later survey during training, it is evident that over 80% of ASM miner trainees are illiterate. Therefore the attempts to teach via music and group discussions were very important both at the initial event and henceforth as the trainings became more formal during the spring of 2007.

Those participants who can read are mainly 10-15 years old students from Taga and Bau schools. All were offered both theoretical and practical demonstrations on TDU equipment and hands on operation. In addition, sessions on health, environment, sanitation, legalization and economics matters were integral part of training. Visual teaching aid like posters, booklets and board drawing helped very much and proved effective in bridging illiteracy gaps.

During training, more than 30 sets of GMP theme Booklets (sets of 4) and 10 sets of posters (set of 10) depicting all aspects of artisanal/small-scale gold mining and processing along with health, sanitation and environmental issues were distributed to community chiefs, schools, Gam mine engineers, and others who can read. A set of posters glued to a board was made available to Taga elementary school to teach students further on proper ASM mining. Also during training, about seven retorts were donated to community chiefs and most active artisanal miners in the area to share with others.

Media participation during the formal TDU training was more limited. TDU activities coverage, lightening strike event, and the BBC's Price of Gold shows were run at the camp and at Taga school yard. However, during training, 4 tapes covering day to day TDU training were shot. The wrap up event was covered by Sudan News agency SUNA, and Edamazin radio & TV came to the TDU site for half day coverage. Radio, SUNA, and TV Interviews with ACFP, Ibrahim, Tajelsir, Nurse Asfa and Dr Buthaina Elnaeim, mcrocredit expert covered all aspects of the training conducted and GMP objectives as well. All interviews were aired on Edamazin radio & TV, which were well received by audience. Both Edamazin radio & TV manager and SUNA reporter promised to extend broadcasting to the national radio & TV in Umdurman. All are welcoming more GMP interviews and footages. At the end of wrap up, an invited singer's band performed in front artisanal gold miners and chiefs for more than two hours. At break times, ACFP and Dr Buthaina addressed the audience on ASM issues and how activities can be boosted by collaboration and commitment of all for the benefit of the community and for a better life for all.

See Appendix 5

Legal issues:
GMP recommendations in the development of policies for gold mining include standards for safety, amalgamation and use of mercury as well as for the legalization of miners. The Mining and Mineral Resources Development ACT - 2007 was ratified by the National Council and signed by the President of the Republic. The Geological Research Authority of the Sudan (GRAS) is placed in charge of all prospecting, exploring and organization of mining, including the provision of licenses. The law addresses the issue of legalization of miners and for the first time creates a process towards legalization. However, the costs may be prohibitive for many miners. In addition lack of awareness at the local level about the possibility of legal licenses will require attention. In addition to the provision of licenses the law also introduces penalties for mining without a license. These penalties include confiscation of mining equipment and finished product and imprisonment up to two years with a fine for extraction.

This law is a first step towards gold miners entering the legal world. Presently the banking system has no ability to account for and absorb newly mined gold. Therefore all trade in gold is illegal and untaxed. The recent currency change in Sudan has created the first consistent currency since prior to the civil war. In addition development oriented banks are opening up in rural areas of Sudan, these are familiar with small lines of credit for start up projects. In Damazin, Blue Nile State microcredit is now available for individual people, families and communities.

MAIN ACHIEVEMENTS:

Diagnostic Analyses
The socio-economic, health and environmental studies in the project area provided significant information vital for the design of the project.

Health results individually returned
Approximately 90% of individuals tested were educated on their results. As a consequence of these discussions it became apparent that in the time between being tested and receiving the results the majority of people had changed their mercury related behavior for the better.

Local design and manufacture of appropriate gold mining equipment
The equipment was manufactured in Khartoum. There is now provision to manufacture future equipment in Damazin where suitable factories have been identified by the GMP team.

Better Practices of Small-scale Gold Extraction
Efficient small-scale gold extraction must depend on suitable processing technologies like those introduced by Global Mercury Project. The ultimate goal is to transfer gold processing intermediate technology to those impoverished and marginal communities and the teaching of mining families how to efficiently operate equipment for increased productivity.

Gold Mining Education
In addition to the successful Awareness Campaign and Trainings; the Geological Research Authority of the Sudan GRAS set up a pilot gold processing centre in the Bayuda desert, River Nile State in the north with the aim of producing alluvial gold on small-scale. Equipment in use now includes 2-4 long steel sluices, concentrators fed by an elevated hopper with 10m long chute. Ore haulage is by a 15 tons dumper truck, a back hoe and a loader. Two technicians and 8 support personnel operate the equipment. GMP experts offered valuable advice on equipment adjustment and efficient gold processing techniques. Advice made has paid off as we learned later that gold production in the north is doubled. Nowadays, the pilot project produces up to 5 ounces/day from alluvium. In addition this site is well placed as an education center as it is in a developing area where licenses are being acquired for small scale mining.

See Appendix 4

Reduction of Mercury Contamination in Gold Shops
Recent recordings of Hg in several gold shops in Damazin revealed that behavior has changed since the first intervention in 2005. Several shop keepers stated that they had stopped burning inside when they learned of the health risks during the awareness campaign. Indeed the only area where there was very high level of mercury in the air was outside where active burning was underway. Many of the gold shop owners volunteered to have the EPA ventilation system in their shop.

Health Education
Local nurses trained in health aspects of gold mining provided excellent outreach to community members, particularly women and children as they involved groups of women in discussion. Gender issues, water and sanitation issues, community decision making and related topics were discussed.

Successful collaboration with Khartoum Office of Practical Action
Involvement of an NGO body familiar with field implementation of development project facilitates more interaction with community and local politics. Practical Action provided appropriate educational materials for the Awareness and Educational campaigns. In addition to providing critical local community organization experience Practical Action is critical to ongoing efforts in the region.

Negotiations with the Directorate of Demilitarization and Rehabilitation
The Directorate of Demilitarization and Rehabilitation has both a National office in Khartoum and a local office in Damazin. The mandate is to provide appropriate training to help stabilize the many thousands of transient ex-combatants in Sudan. GMP team met with leaders at both the National and State level encouraging transfer of information and training equipment. Communication between GRAS and DDR had already been established and was encouraged by the team. As the DDR has a significant UN budget it was acknowledged that any difficulty in continuing the project would be due to difficulties between the National Government and local State governments of transitional states in relation to transfer of funds. Commitment of local and central authorities is of prime importance to a sustainable development achievement in rural areas.

The transience nature of many ASM communities must be put into consideration when implementing similar projects in rural areas. Significant to the Ingessana Hills is the continued movement of communities related to post-civil war tensions. The project area has had approximately 600 people return to the area this year, many of whom mined for gold prior to the civil war. At the same time people who

were displaced north, due to fighting further south near Kurmuk, have been forcibly returned to their former home. Damazin has seen an increase of 300,000 people since the civil war which has almost doubled the population.

Legalization/formalization Process
The process for legalization of miners has been commenced. The process is under the control of GRAS and due to the GRAS expertise in gold mining it is expected that the process will be implemented in order to allow miners to gain legal status prior to fines being introduced.

Development of Access to Microcredit
Empowering desperate artisanal gold miners through seeking avenues to accessible to micro-finance institutions is critical so that miners are able to purchase the equipment. Micro-credit is now available in Damazin.

CONCLUSIONS:

Although the Global Mercury Project and partners Geological Research Authority of the Sudan faced many challenges throughout this project, Sudan now has a fully educated team of experienced technical trainers available to travel to the many far flung gold mining sites emerging in the recent gold rush. The suite of appropriate gold mining equipment is reproducible at reasonable cost to miners as micro-credit becomes available in remote areas of Sudan. One educational site is proving to be successful and would be easily reproducible in Blue Nile State and elsewhere. The ability and willingness of gold miners to change their behavior, once health related knowledge is received, has proven to be an excellent indicator that once micro-credit is available miners will change their mining practices. Miners were very impressed with the increase in gold recovery and savings of time and labour. The demobilization of thousands of former combatants and the resulting transient nature of many people presents a potentially volatile situation as claims to land, water and natural resources are challenged. At this time it is clear that the continuation and expansion of the work achieved by the GMP is essential in order to provide appropriate mining education and organization of mining communities. This will prevent environmental havoc and the continuation of labour intensive competitive family based gold mining which leaves individual mining families dependant on the gold smugglers. GMP Sudan met the objectives of the project. Having said that, the work is just beginning in terms of need.

Health results explained to 90% of those studied; and here discussed with the Chief. Village meetings run by the Chiefs supported individual behavior change and facilitated support for amalgamation work being removed from homes and done by men instead of women.

RECOMMENDATIONS FOR FOLLOW UP ACTIVITIES:

Mechanism of Sale of Gold
Support changes in banking system to accept gold. Acknowledge present market system including black-market and smuggling of gold out of the country and mercury into the country. Support for community education in preparation for group microcredit as appropriate for individual communities. This is the next crucial step towards improving gold pricing and fairness of the gold trade.

Support of Regulating Mercury Trade
The GMP policy recommendations provide standards for amalgamation, the use of retorts and for the reduction of mercury loss in tailings. The formal acknowledgement and regulation of the mercury trade is a crucial next step and would support the process of legalization and formalization of miners.

Legalization/Formalization Process
Avoidance of monopolies and ability of government to tax without legalization may be a challenge.

Gender Issues
Women and children are increasingly involved with ASM activities for the last decade in Sudan as a result of political instability and increasing poverty. As men in rural areas e.g. in southern Blue Nile, are involved in conflicts, migrated to other parts of the country or participating in other low-income activities, women find themselves in positions of major family supporters in addition to the traditional roles they are playing in those marginal communities.

Child Labour Issues
Minimization of contamination and injury during gold mining is realistic as Blue Nile State recovers from decades of isolation and civil war.

Community Dialogues
Acknowledge the value of community dialogues in 'crisis countries'. Organization of ASM miners into community-based organizations (CBOs) could serve far better in getting targeted groups benefit from training offered and options suggested for them to access decision makers, legalization, and micro-credit avenues for equipment/operation financing. In rural communities like the Ingessana, it seems better to adopt bottom-up approach in order to furnish fruitful implementation of a development project. In current circumstances in Blue Nile state, the voice of those marginal groups is often unheard. Authorities are more involved with or occupied by national/regional politics rather than with rural interests.

Technical Assistance
Continued assistance will be required as related to outcomes of community dialogues.

Voice for Advocacy
Implication of general social and development programs to support social infrastructure in communities with large numbers of transient mobile people within traditional structures and poverty alleviation and equitable wealth creation.

Continuation of Trainings in Blue Nile State with support of DDR
It was initially aimed to also mobilize TDU to at least a couple more ASM sites in Qeissan and Bulang within southern Blue Nile region as soon as finish training in Ingessana Hills. Ibrahim Toum, training leader and ACFP made a reconnaissance visit to Qeissan in early May and met with local chiefs for coordinating training. Unfortunately, at that time no one was practicing artisanal gold mining due to water shortage. An educational 'milling center' center in the southern Blue Nile State with gold ore milling and concentration education is recommended by GMP. This is an ideal way to continue to introduce efficient technology, training and awareness along with organization and legalization instrument for regulating ASM activities in an area of great need. The GMP TDU equipment can be stored at the site. Translation of educational materials into more languages is essential.

Continuation of Manufacture and testing of EPA equipment
At present plans for EPA equipment is with GRAS and Iyass El Bashir for manufacture prior to installation and testing in gold shops in Khartoum and Damazin.

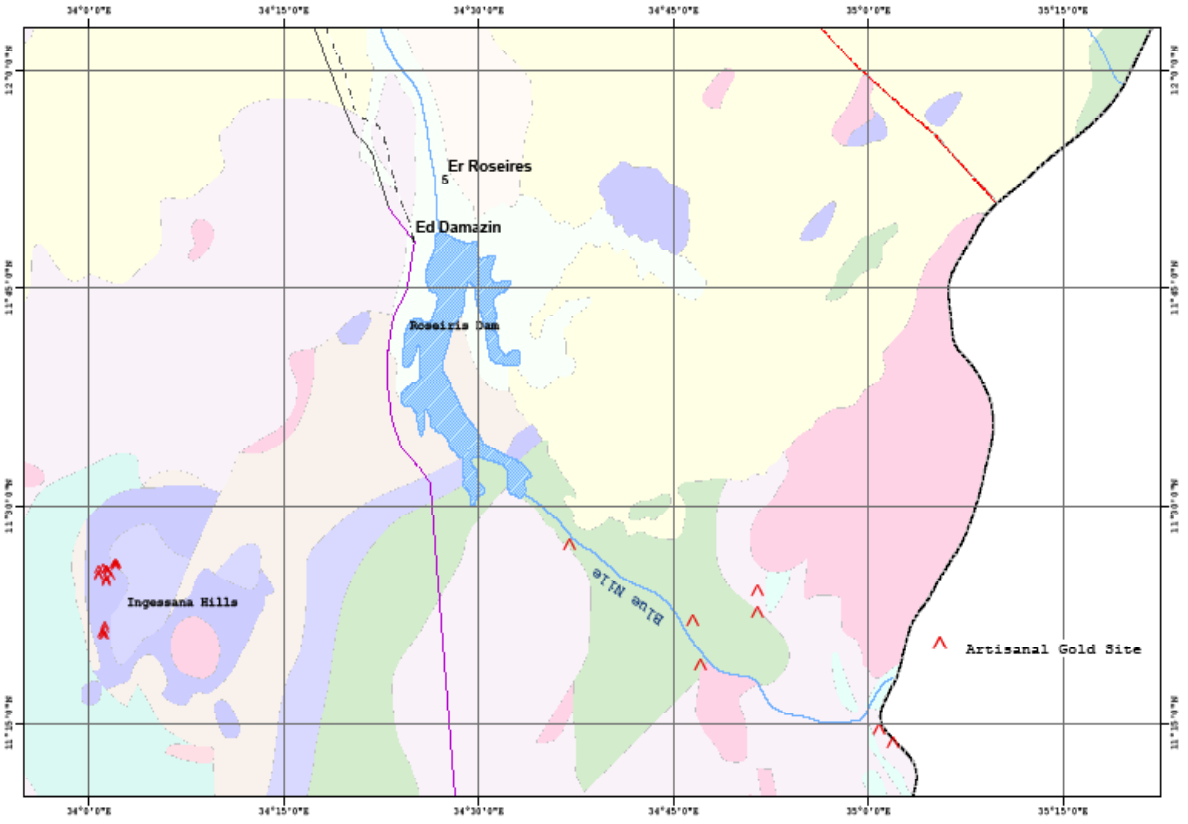
Complete transfer of knowledge and design of TDU equipment
Presently design and manufacture of suitable affordable gold mining equipment has been completed in Khartoum. Local factories in Damazin have been identified as capable of manufacturing the equipment in Blue Nile State. Manufacturer in Khartoum is eager to teach local manufacturers in Damazin. Local DDR office already has agreements with local bank to facilitate micro-credit as needed related to employment training.

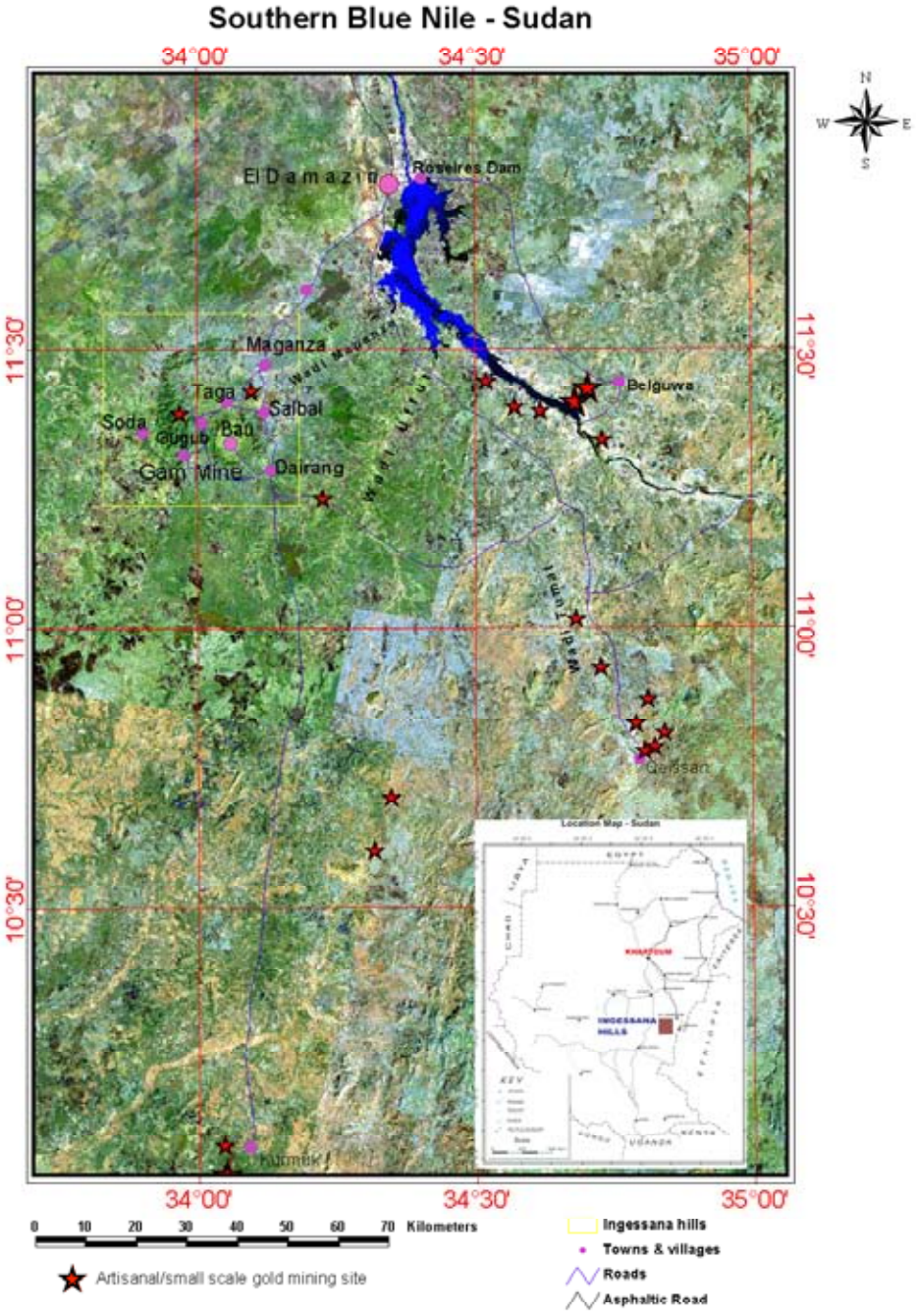
Continuation of Training of Trainers
Presently Sudan has a dearth of young educated mining engineers and technicians and very few appropriate jobs. As gold mining becomes an established small scale business the training of these mining engineers in the appropriate techniques will make a vast difference. In addition the training of women mining engineers will be a great support to the women gold miners in the field, especially in the southern states.

Involvement of UNIDO and Practical Action
The authors strongly recommend that the momentum gained in this project is not lost, and that provision be made to support a staff person at the UNIDO office to continue with the next steps. In addition the formal involvement of Practical Action is the best choice to organize the communities, build the capacity of CBOs, assist in assessment of market, include environmental policy, ensure cross cutting issues are carefully considered (livelihoods, environment, gender, sustainability, HIV), develop complementary activities that address overall health issues (sanitation, water, food security etc), and monitor progress and impact on the ground.

APPENDIX 1: *Maps and Project Site*

Southern Blue Nile Artisanal Gold Mining Sites




Southern Blue Nile - Sudan
34°00'
34°30'
35°00'
11°30'
11°00'
10°30'
N
W
E
S
El Damazin
Roseires Dam
Maganza
Wadi Maganza
Taga
Salbal
Soda
Bau
Gam Mine
Dairang
Wadi Tumat
Belguwa
Qeissan
Location Map - Sudan
EGYPT
LIBYA
CHAD
KHARTOUM
INGESSANA HILLS
KENYA
UGANDA
0 10 20 30 40 50 60 70 Kilometers
Artisanal/small scale gold mining site
Ingessana hills
Towns & villages
Roads
Asphaltic Road

Project site - Blue Nile State

Khor Gidad, prominent alluvial mining site.

Local village.

Women do 90% of the mining in this area. Men work with the primary ore, but this is a small percent of the goldmining.

Women and children in typical mining scene.

Young miners.

Aftermath of mining extends over a large area.

APPENDIX 2 Design and manufacture of appropriate affordable equipment

Designs are discussed by manufacturing engineer and foreman.

Initial designs were improved using local materials.

Technicians adapted to making small equipment.

Some equipment was hand made.

Small ball mill being examined.

Factory donated worker time and experience to the project to ensure success.

Sluices under construction.

Equipment tested for leaks.

Imported equipment examined by factory owners.

APPENDIX 3

Train the Trainer workshops

Learning to use the Lumex.

Examining efficiency of local systems.

Tuning equipment for more success.

Practicing using new hammer mill.

Setting up and running concentrator.

Locally manufactured ball mill tested.

Setting up locally made sluices in the field for testing.

Team of trainers running sluices.

Imported dry sluice tested out.

Training the Trainers in the field

Panning.

Amalgam.

Using carpets to concentrate.

Tapping and blowing technique requires no mercury and is appropriate when yield is small.

APPENDIX 4

Trainers in the GMP site area

New equipment for examination by miners.

Classroom lessons emphasise step by step of use of new technologies.

Classes on health problems caused by exposure to mercury and other health issues.

Discussions in groups of men.

The nurses worked with the women in gourps.

Miners pratice using the new equipment.

Hands on learning is the most effective.

Seeing gold on microscopic level improves even experienced miners skills.

Practicing running the sluices requires teamwork.

The ball mill reduces physical labour.

Hammer mill and concentrator used together.

Learning how to run the hammer mill.

Local miners appreciate time to examine the equipment hands on.

Panning and testing to see how much improved the results are.

Learning how to use a retort.

TDU Training-Ingessana Hills, March-May 2007

Group/class	Theoretical	Practical	Women attend.	Total illiteracy%
1	18	14	7	60
2	25	25	3	96
3	17	14	2	82
4	20	16	7	40
5	21	18	0	10
6	16	16	1	80
7	8	8	1	85
8	10	10	0	13
9 (Chrome mine	7	7	0	0 (engineers)
10	10	6	0	100
11	12	11	0	90
12	10	10	0	50
13	3	2	0	0 (engineers)
14	30	30	0	0
Total	**220**	**199**	**21**	

APPENDIX 5

Awareness Campaign

"Protect Myself, Protect My Children" curriculum used by the nurses to promote positive behavior change in regards to mercury exposure.

This poster demonstrates the "More gold, Better Health, Less Mercury" message.

Formal classroom discussion and lessons for miners were taken very seriously.

Posters and brochures promote discussion.

Community discussions are an important aspect of sustainable change.

Community events provided education and entertainment, as well as an opportunity to see the new technologies being introduced.

Media exposure supports the training

Local and national TV crews record the project.

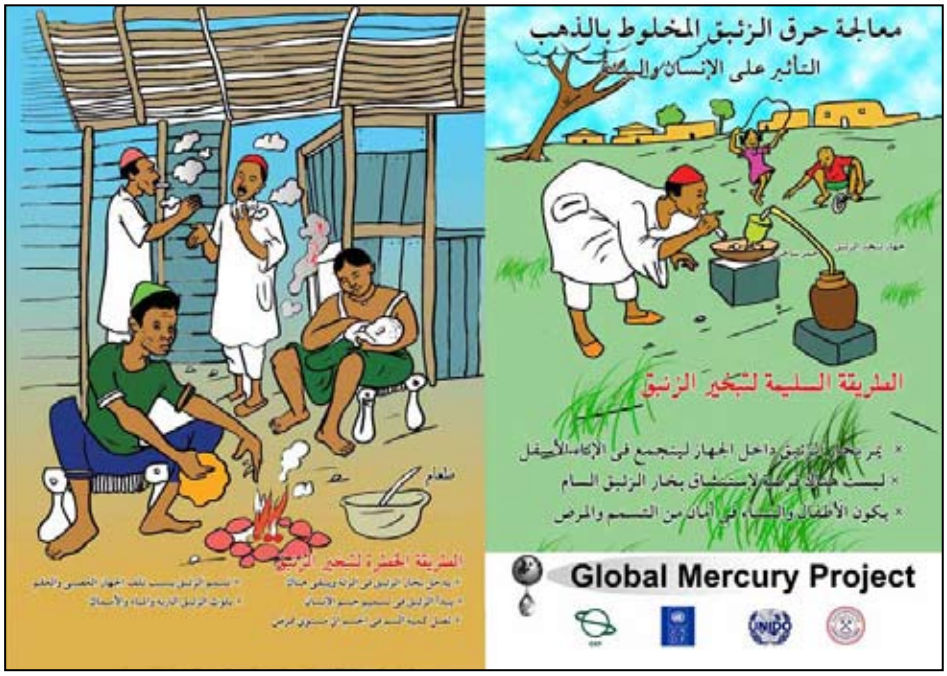
The changing role of local women is addressed in the video.

Micro-credit expert is interviewed about how miners will be able to afford equipment by investing in groups.

Parties and celebrations in villages

EDUCATIONAL MATERIALS

Reduction of Contamination with Mercury



Here the dangers of enhaling droplets of mercury and of smoking cigarettes are explained. Second hand smoke and burning amalgam inside are also addressed. The alternative choice of using a retort far from the village is illustrated in contrast.

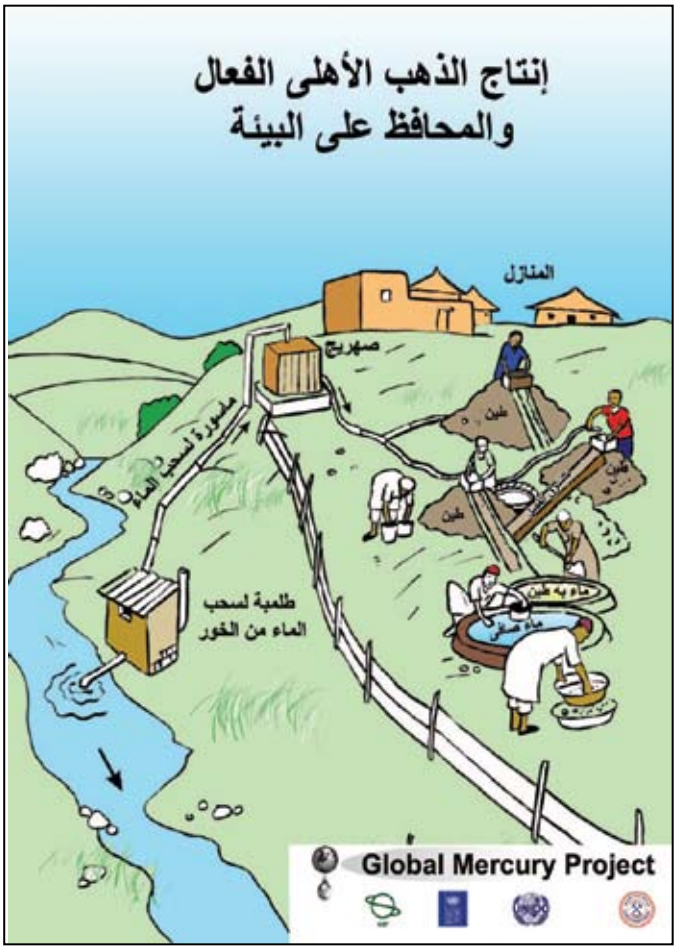
Recycling Water

Here recycling of water is illustrated. This avoids wasting water and avoids contamination of surrounding area.

Protecting the water

The previous closed cycle is seem in the bacground as a positive contrast to areas where goldprocessing is contaminating the river upstream from where water is collected for human and farming use.

Simple pump supports protection of the water

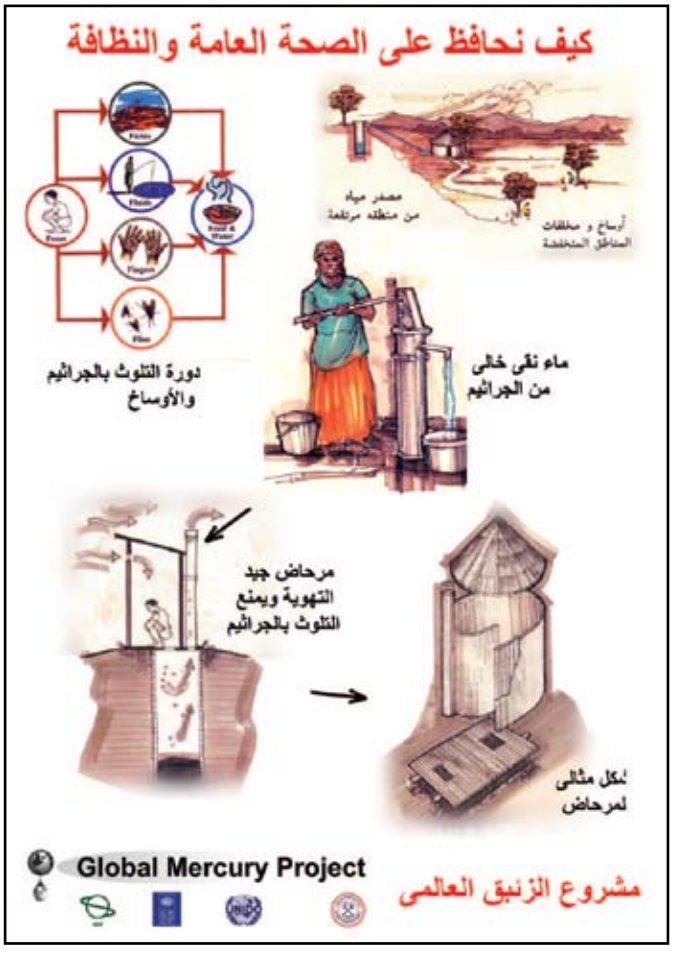


Use of a pump makes protecting the river easier

Less physical work by using simple tools

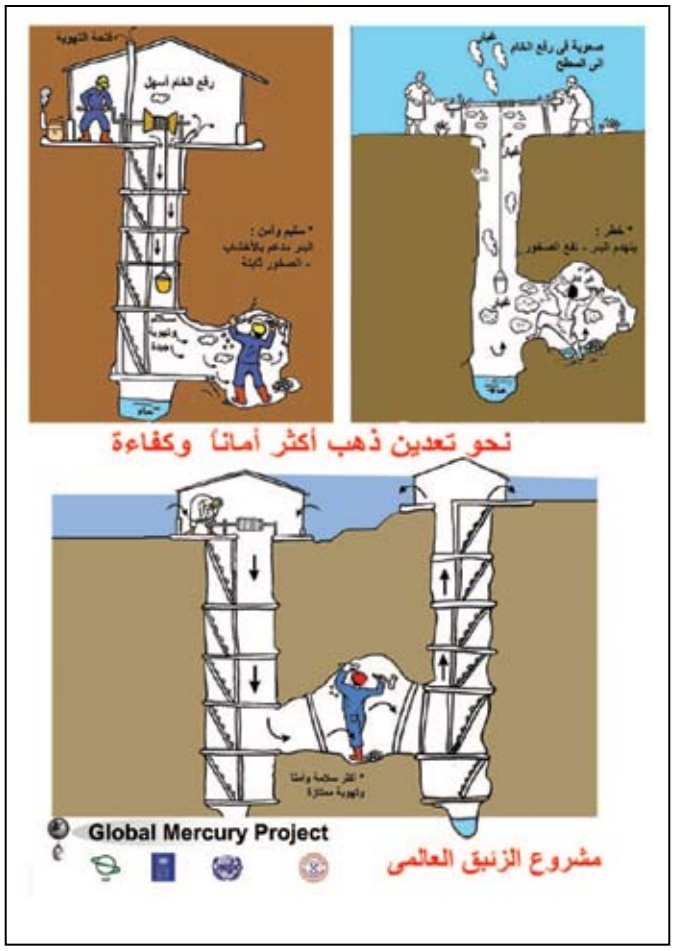
Simple tools make crushing and grinding ore much easier and more productive.

Healthy miners



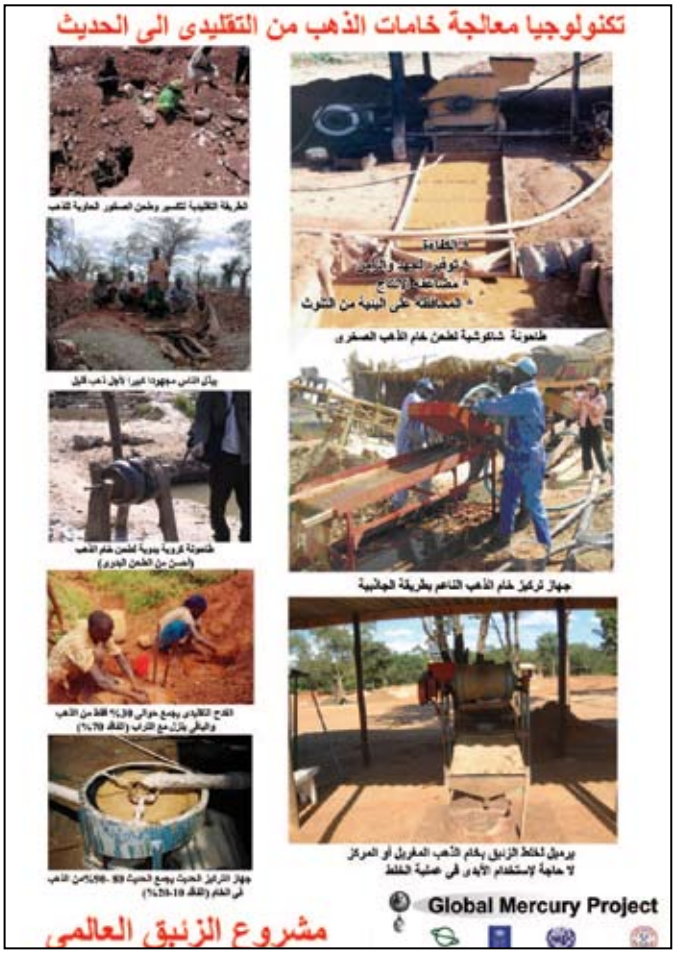
Prevention of diseases transmitted by contaminated water is made easy in a few critical steps. Many ASM communities lack basic technologies supporting access to clean water.

Underground safety



Underground accidents account for many of the dealths of miners. Improving knowledge of airflow, shoring and winching techniques is important to the project.

Improved technology



Introduction of next-step technologies requires demonstration.

APPENDIX 6

Dr. Buthaina, Micro-credit expert; Gillian Davis, GMP National coordinator; , Graphic Designer

Dr. Obeid Ahmed, Country Focal Point; Dr. Hermann Wotruba, International expert; Patience Singo, International expert; Mohamed Soliman Ibrahim, Assistant Country Focal Point

Primary gold - Gugub, **Blue Nile State**