Module 3

Mercury Use in Artisanal and Small Scale Gold Mining

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KEY MESSAGES

- Artisanal and small scale gold mining (ASGM) provides an important source of income for miners, particularly in rural communities and regions where economic alternatives are extremely limited. With gold rising from $260 US/oz in March 2001 to over $1000 US/oz in March 2008, a gold rush involving poverty-driven miners is currently being observed in many countries.

- Artisanal and small scale-gold mining involves an estimated 10-15 million miners, including 4.5 million women and 1 million children. With the recent surge in gold prices, the number of miners using mercury may increase in the coming years.

- It is the single largest intentional-release of mercury in the world, one that:
  - Results in severe exposure to workers, releases to the environment and poses risks to those in the nearby community who eat fish contaminated with mercury. Women of child-bearing age and children are most vulnerable;
  - Results in extensive environmental degradation and ecosystem contamination, which may go on for decades after mining activities have ceased.

- Mercury exposure for miners and their communities can be reduced in simple and cost-effective ways.

- Cyanide, the only chemical extraction alternative, also presents risks to human health and the environment.

WHY IS THIS IMPORTANT TO YOU?

Artisanal or small-scale gold miners who use mercury are often unaware of its dangers.

Miners, their families and communities, and those downstream are at risk of mercury poisoning.

Serious long-term environmental health hazards exist in populations living in, near or downstream/wind of mining operations.

Storage, transport and handling of mercury introduces opportunities for spills and exposure to mercury vapour.

WHAT CAN YOU DO?

For Citizens

- Be aware that mercury use is dangerous for miners, their families and the surrounding community. Do not consume fish from areas downstream of artisanal gold mining.
- Never use mercury and cyanide in the same area.
- Make sure mercury is stored and used far away from families and children.

For Health Care Workers

- Recognize the symptoms of mercury poisoning (see Introduction Booklet).
- Educate people in mining communities about the dangers of mercury.
- Inform authorities when mercury poisoning is found, so that other people in the area can be examined and the source of the mercury contamination identified.

For Governments

- Take measures to formalize ASGM at the national level.
- However, evidence from various developing countries and countries with economies in transition indicates that most imported mercury ends up being used in ASGM.
- Identify where mercury is being used and take steps to educate miners and communities.
- Work with miners to find ways to reduce mercury use and to reduce releases, for example through use of retorts.
- Identify areas with low mercury level fish. Advise people to reduce consumption of large predatory or carnivorous fish that are likely to have higher mercury levels.
- Take steps to limit mercury supply.
- Build community capacity to market cleaner gold.
- The UNEP Global Mercury Partnership is open to new partners. Joining the partnership can be an excellent opportunity to network with experts and build capacity. To take part in the UNEP Global Mercury Partnership go to: www.chem.unep.ch/mercury/partnerships/new_partnership.htm.

Mercury Use in Artisanal and Small Scale Gold Mining

What is artisanal and small-scale gold mining?

Artisanal and small-scale gold mining (ASGM) is the extraction of minerals, most commonly gold, by miners working in small or medium sized operations, using rudimentary techniques. Simple practices with little economic investment are often used. Mercury is often used to separate the metal from the ore and is generally handled by people with little or no awareness of its risks, training to minimize risks or safety equipment.

ASGM provides an important source of income for miners, particularly in rural communities and regions where economic alternatives are extremely limited. At least 100 million people in over 55 countries depend on ASGM for their income. It is believed that ASGM produces 20-30% of the world's gold, or approximately 500-800 tonnes per annum.

ASGM usually involves the use of substantial amounts of mercury in mineral processing, often in highly unsafe and environmentally hazardous conditions. In many countries the use of mercury is discouraged or even prohibited for use in gold mining. Nevertheless, mercury demand in ASGM continues to increase, particularly due to the rise in the price of gold. Furthermore, mercury use is generally prevalent and is the preferred method of extraction employed in ASGM - it is considered rather simple to use and inexpensive.

In general, large-scale gold mine operations have phased out mercury use by adopting alternative technologies. However, mercury is often generated as a by-product in large scale mines (see Module 2).

How is mercury used in ASGM?

Mercury is used to separate and collect the gold from the rocks in which it is found. Mercury binds to the gold to form an amalgam which helps it to separate from rock, sand or other material. The amalgam is then heated to vaporize the mercury leaving the gold behind. A number of different techniques are used which result in varying degrees of mercury release:

Whole Ore Amalgamation

In this process mercury is added to all of the ore being processed during crushing, grinding or sluicing. This is the most polluting way to use mercury. In many cases only 10% of the mercury added to an amalgamating barrel or pan (in the case of manual amalgamation) combines with gold to produce the amalgam. The rest (90%) is excess and must be removed and recycled or is released into the environment.

Whole ore amalgamation leads to widespread elevated mercury levels in the local environment and the most severe health exposure problems for both miners and non-miners. Studies conducted in locations where whole ore amalgamation is practiced show the highest levels of mercury in soil, sediments and fish.

Gravity Concentration or "Panning"

Panning (gravity concentration) of gold-bearing materials is a common process. This concentrates the gold with the heavier particles in the pan, while lighter particles are sluiced away. Mercury is then added to the concentrates in order to amalgamate or gather the fine gold particles. This process is an improvement over whole ore amalgamation. About 10-15% of mercury losses from ASGM are a result of this process.

Burning Amalgam

Miners also heat amalgam to recover the gold. Amalgam is burned in a shovel or metal pan over an open fire. When this is done without the use of a retort, mercury vapours are released to the air and are inhaled by the miners, their families and others nearby. This practice produces atmospheric mercury emissions of around 300 metric tonnes per year worldwide (GMP, 2006). Retorts can collect the mercury vapour, preventing release to the atmosphere and reducing the human health risk to the miners, their families and communities. Retorts are a relatively simple technology which can recover much of the mercury vaporized from the amalgam.

What is a retort?

A retort is essentially a bowl or other vessel inverted over the burning amalgam in which the mercury vapour is trapped and condensed. The United Nations Industrial Development Organization's (UNIDO) Global Mercury Project field assessments found that effective retorts could be made cheaply (for as little as $3.20 US, in some cases) and that they could retain mercury vapour so that over 95% of the mercury is recycled and can be re-used. This practice reduces exposure hazards and saves money. There are many types of retorts. Some are made of stainless steel, while others are made of inexpensive galvanized steel. The retorting efficiency depends on the type of connections or clamps used. Homemade retorts can also be made of steel tins or kitchen bowls (stainless steel or enamel bowls).

How are people exposed to mercury in ASGM?

The major pathway of concern for the miner is through the inhalation of mercury vapour from burning mercury amalgam. Some mercury is also absorbed directly through the skin when amalgamation is done by hand. Typically, amalgamation and burning are done with no protective measures (such as retorts or gloves) and often in the presence of children or even in the home.

Mercury vapour also settles in homes, onto food preparation areas, soil and into local bodies of water. Mercury vapour is a danger not only to the local population, but can be carried long distances in the atmosphere. Mercury deposited in water is eventually taken up in bacteria in aquatic environments bioaccumulates in the food chain and is the primary source of mercury in our food (see Introductory Booklet).

Even in low doses, methylmercury poisoning causes neurological problems and is especially dangerous for women of child-bearing age (see the Introductory Booklet). With extremely high mercury concentrations found in breast-milk of nursing mothers in ASGM communities, infants are especially at risk.

Mercury dust is also carried on the clothing of miners and brought back to their homes in this manner.

Health surveys across ASGM sites worldwide show high levels of mercury in miners. Some miners are being exposed to levels of mercury that exceed more than 50 times the World Health Organization (WHO) public exposure limit. At one project site almost 50 percent of miners experienced unintentional tremors, which is a typical symptom of mercury-induced damage of the central nervous system.

How does mercury use in ASGM affect the environment?

Sites identified with high concentrations of metallic mercury, usually in or near flowing water, are called mining “hotspots.” Hotspots can have dimensions of a few square meters to hundreds of square meters. They are major sources of mercury dispersion into aquatic systems, resulting in methylmercury contamination of fish and wildlife and impacting the lives of thousands of people involved with, or living in general proximity to, mining activities. Typically mercury-containing tailings are dumped into or beside bodies of water, and as a result soil, rivers, streams, ponds and lakes are contaminated for very long periods of time. There are thousands of polluted sites that will be affected for decades to come, and their impacts extend beyond the local area, often presenting serious, long-term environmental health hazards to populations living downstream of mining regions. One particular danger comes with the disintegration of tailing dams due to floods or severe weather. This results in high quantities of mercury-laden sediment being washed downstream. A related danger comes from the combined use of mercury with cyanidation - this is a very hazardous combination as it promotes the methylation of mercury.

How can mining communities minimize mercury use and exposure?

Although the use of mercury is generally an easy and inexpensive way to extract gold in ASGM, cost-effective alternative methods exist that can eliminate or greatly reduce the quantity of mercury used, thus reducing health and environment risks and saving the additional expense of using excess mercury.

Alternatives to whole ore amalgamation

Amalgamation of the whole ore leads to widespread exposure, but it is frequently used because it is an easy and inexpensive way to extract gold quickly for miners. The most important measure a mining community can take to reduce its mercury use is to concentrate the gold-containing portion of the ore before adding mercury. This can be done by crushing and grinding the ore to a finer particle size and then using carpeted or magnetic sluice boxes or gravity concentration techniques such as panning or centrifuges. In this way, more gold will be captured, less mercury will be required and residual mercury can be more completely captured.

Protective measures

Protective measures include the use of retorts when burning amalgam (which not only conserves mercury and makes it available for reuse, but protects workers and their communities) and the use of gloves by those handling mercury or amalgam.

Alternatives to mercury use

A complete phase-out of mercury use in mining may be a viable option for many miners. This might require a higher order of economic investment, organization and technical expertise. Primary ores must be ground to promote gold particle liberation. Free or partially free gold particles can be concentrated. Miners need to know how finely to grind the ore, and whether another treatment, like oxidation, is needed.

Gravity separation or concentration methods (e.g., carpet sluices, magnet-based methods and centrifuges) have great potential to reduce and, in some specific situations, to eliminate the use of mercury. In approximately 10% of current ASGM cases, gold sources are alluvial ore (free gold), and completely mercury-free-alternatives could be locally available at a very low cost.

The most promising technology to replace totally the use of mercury in any type of gold ore is cyanidation, but this method may not be affordable or technically available to all artisanal miners. Also, cyanidation methods must be used with care and carefully introduced due to its significant risks to human health and the environment. It is important to note that that cyanide and mercury should not be used in any way together, because that can greatly exacerbate pollution and health risks.

What can governments and health care workers do?

- Governments should provide ways to legalize the artisanal and small-scale miners, including educating miners on environmental management;
- Support (education, training, health care) should be provided to miners, their families and communities on the dangers of mercury and options for alternatives;
- Gain an understanding of the situation in your country/region and implement an environmental management strategy to monitor, regulate, etc;
- Subsidize equipment designed to reduce mercury release. This may additionally produce benefits such as reduced health care burden and costs as well as reduced environmental impacts;
- Encourage and assist communities to organize themselves to produce and market higher valued 'clean gold' to the market (see Case Study 10).

What are the barriers to the adoption of safer practices?

ASGM is an important source of income in many rural communities and regions where economic alternatives are limited, particularly when gold prices are high. In addition, when there is a ready mercury supply and mercury prices remain low, market forces can work against the development of alternatives to mercury use.

Convincing miners to use less mercury because of health or environmental considerations is difficult. Programmes directed at reducing health risks from mercury need to be placed in the broader context of the overall living conditions of subsistence miners, their families and communities. Successful efforts to introduce alternative technologies are often those that demonstrate their economic benefits to miners.

Individuals will not be easily convinced of new practices introduced by outsiders. It is much better if the message is delivered by community leaders who are convinced of the benefits. For instance, such leaders can act as trainers and demonstrate cases where sluice boxes that capture more of the fine gold particles, retorts that allow mercury to be recycled or the promotion of higher valued "clean" gold to the fair trade market segment.

Where does the mercury come from?

In most countries mercury is imported legally for use in dental amalgams or the chlor-alkali industry. However, evidence from various developing countries and countries with economies in transition indicates that most imported mercury ends up being used in ASGM. The unregulated trading of mercury from industrialized countries to developing countries and countries with economies in transition makes mercury easily available at the mine sites. In some cases mercury is provided free of charge, provided that the gold is sold to the mercury provider. Stockpiling of mercury by gold dealers is an additional health and environment concern/risk.

What efforts are being made on a global scale?

The UNEP Global Mercury Partnership

The small scale gold mining partnership area was initiated in 2005. It operates under the framework of the UNEP Global Mercury Partnership whose overall goal is to protect human health and the global environment from the release of mercury and its compounds by minimizing and, where feasible, ultimately eliminating global, anthropogenic mercury releases to air, water and land. The following web address provides further information on the ASGM partnership: www.chem.unep.ch/mercury/partnerships/new_partnership.htm.

The Global Mercury Project

The Global Mercury Project (GMP) is a joint initiative led by UNIDO with governments to demonstrate ways of overcoming barriers to the adoption of best practices in ASGM, including waste minimization strategies and pollution prevention measures that limit contamination of international waters.

Pilot project activities focused on six countries – Brazil, Laos, Indonesia, Sudan, Tanzania and Zimbabwe. At sites in these countries the GMP has been focusing on capacity-building programmes to remove barriers to the adoption of cleaner technologies. These programmes involve mobile training units that can reach miners in rural areas to create local priorities. This community assistance model is receiving widespread support, and the GMP has already certified teams of local trainers. Yet, the regions benefiting from the GMP constitute only a fraction of the global population impacted by ASGM. Further commitment and resources are needed in these and other regions and are being pursued in a second phase of the GMP (see: www.globalmercuryproject.org).

The Association for Responsible Mining and Green Gold

"Fair Trade Artisanal Gold" is a label given to gold produced by artisanal and small-scale miners who respect a pre-defined set of social, economic, labor and environmental development standards in certain countries and regions that are participating in the programme. This is a process intended to help miners' organizations to minimize the use of mercury and cyanide over an agreed period of time, through implementation of responsible practices and technologies to mitigate impact on the environment and human health.

The Association for Responsible Mining (ARM) has proposed standards that include two "levels" of certification. The first level forbids the use of whole ore amalgamation, and requires the use of retorts and proper storage and handling of hazardous materials. The second "premium" level forbids the use of mercury or cyanide in production. When the ASGM operator achieves this second level, their certified "Green Gold" is sold on local and international fair trade and green

markets, and miners receive a bonus above the market value of gold that recognizes the benefits of a sustainable activity. More information on the program may be found in Case Study 10.

Communities and Small Scale Mining

Communities and Small-Scale Mining (for everyone) provides a coordinated network of shared information, a set of complete resources for use at the local level and a clearinghouse to distribute information to regional clean production centres.

CASGM is developing good practice toolkits and guidance notes to improve the design and implementation of policies and programmes. It also supports and organizes workshops and conferences on artisanal and small-scale mining to bring together stakeholders to develop and transfer strategies for dealing constructively with the social, environmental and technical challenges posed by ASGM and for maximizing the potential of these strategies where they are being practiced.

CASGM awards small grants to community leaders, organizers, miners' groups, NGOs and others whose proposed projects will foster communication, information sharing, and good working relationships between miners and communities (whether their own or other communities impacted by their activities); between small miners and big miners; and among various stakeholders involved in one way or another in the production process, such as mineworkers, small mine owners, mill mine owners, minerals traders, minerals transporters, creditors, land owners and governments.

CASE STUDY 10:
'GREEN GOLD' AND THE ASSOCIATION FOR RESPONSIBLE MINING

Certified 'Green Gold', also known as Fair Trade Artisanal Gold, is produced through a sustainable, socially and environmentally responsible, small-scale mining programme that is based on fair trade practices and the observance of ten mining certification criteria. 'Green Gold' is a registered trademark and is produced by artisanal and small-scale miners in participating countries and regions who agree to respect a pre-defined set of social, economic, labor and environmental development standards. The program was developed by the Association for Responsible Mining (ARM), which began its activities in Colombia, and is now working to develop Fair Trade Standards for minerals and gemstones worldwide.

The 'Green Gold' program is intended to support miners' organizations that are minimizing their use of mercury and cyanide over an agreed period of time through implementation of responsible practices and technologies to mitigate impact on the environment and human health.

The Certified 'Green Gold' criteria were developed using the traditional knowledge of the Afro and Indigenous communities of the Choco, the experience of local miners in their daily work, scientific knowledge contributed by the Institute of Environmental Research of the Pacific (IIAP) personnel, academic and technical orientation from mining experts, and the scientific knowledge and advice of Dr. Ranil Senanayake, who has undertaken "analog forestry" programs in Sri Lanka. The certifying body, IIAP, monitors bio-indicators to verify the rehabilitation of areas where the Green Gold program is implemented.

The proposed ARM standards for gold include two "levels" of certification. The first level forbids the use of whole ore amalgamation, and requires the use of retorts and proper storage and handling of hazardous materials. The second "premium" level forbids the use of mercury or cyanide in production. When the ASGM operator achieves this second level, certified "Green Gold" is sold on local and international fair trade and green markets, and miners receive a bonus above the market value of gold that recognizes the benefits of a sustainable activity. The agreed-upon certification criteria are actually compatible with the community's ancestral mining techniques, in which chemicals such as cyanide or mercury were not used.

Land reclamation through the application of "analog forestry" techniques plays a central role in the scheme. Analog Forestry is an innovative technique that enhances the recovery of ecosystems and their biodiversity with a methodology that accelerates the processes of forest succession. The project is focused on replanting with food species. This produces cash crops that provide a source of

income based on the marketing of rare and highly appreciated forest products, namely fruit, aromatic and medicinal plants, wood and fibers, among others.

The 'Green Gold' program has enjoyed a wide acceptance by beneficiary communities and by traditional miners in its pilot region. This is partially due to its bottom-up approach, which is consistent with the local Choco culture in Colombia, and to community participation in decision-making through Community Councils. The programme also strengthens community organizations, empowers communities and improves their capabilities and increases food security and livelihood in mining communities. Certified 'Green Gold' is now sold in Colombia, the United States, the Netherlands, the United Kingdom and Germany, thereby creating a new market sector whose existence will encourage other sustainable mining projects.

For more information on the Green Gold Program and for links to participating and associated organizations, see the ARM website at
http://www.communitymining.org/pilotoeng.htm.

ARM invites membership requests to be made through a formal letter directed to the ARM Board of Directors, in which the interested party explains the work undertaken by the organization and the reasons why they want to form part of ARM. All requests must be sent to: arm@communitymining.org.

United Nations Industrial Development Organization (UNIDO) - Global Mercury Project:
www.unites.uqam.ca/gmf/intranet/gmp/index_gmp.htm

In the Documents section, find many valuable documents, including:
'Manual for Training Artisanal and Small-Scale Gold Miners,' Authors: Veiga MM, Metcalf SM, Baker RF, Klein B, Davis G, Bamber A, Siegel S, Singo P. (2006)

Communities and Small-Scale Mining website:
www.artisanalmining.org/
Standard Zero for Artisanal Gold:
www.infomine.com/publications/docs/AssocResponsibleMining2007.pdf

'Technical measures for incorporation into the U.N. International guidelines on mercury management in artisanal and small-scale gold mining, UNIDO, Draft, June 2007'
www.chem.unep.ch/mercury/Sector-Specific-Information/Artisanal-small-scale-mining.htm

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GMP, 2006. Global Impacts of Mercury Supply and Demand in Small-Scale Gold Mining. GMP Report to the UNEP Governing Council Meeting, February, 2007. Dated October, 2006.

International Labour Organization (ILO) (1999) *Social and Labour Issues in Small-scale Mines*. Report for discussion at the Tripartite Meeting on Social and Labour Issues in Small-scale Mines, ILO, Geneva

Veiga, M. M, P. Maxson, and L.D. Hylander (2006). Origin of mercury in artisanal and small-scale gold mining. *J. of Cleaner Production*. 14: 436-447.

Veiga, M.M. and Baker, R. (2004). Protocols for Environmental and Health Assessment of Mercury Released by Artisanal and Small-scale Gold Miners. Published by GEF/UNDP/UNIDO Global Mercury Project. Vienna.

Veiga MM, Metcalf SM, Baker RF, Klein B, Davis G, Bamber A, Siegel S, Singo P. *(2006)*. 'Manual for Training Artisanal and Small-Scale Gold Miners'.

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