Processing Centers in Artisanal and Small-scale Gold Mining: Evolution or More Pollution?

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Artisanal Mining

The term *artisanal mining* encompasses all small, medium, informal, legal and illegal miners who use **rudimentary** processes to extract gold and other minerals from secondary and primary ores.

*Brazil*

*Ghana*
Artisanal Mining

About 30 million artisanal miners extracting more than 30 minerals in virtually all developing countries

Venezuela

Zimbabwe
Gold price increasing = More people involved
This is the biggest gold rush the world has ever seen

- 10 to 15 million artisanal miners producing around 350 tonnes Au/a in more than 70 countries
- About 50-100 million people directly and indirectly involved in artisanal gold mining

Guinea
In the world as many as 9 million women (50% involved in gold mining)
Sudan
Children in Artisanal Mining

ILO (2004) estimated 2 million children working in artisanal mining

*Mozambique*

*Laos*
Children in Artisanal Mining

*Suriname*

*Guinea*

*Photo: Rukimini*
Causes of Poor Artisanal Mining Practice

- Disorganization & Transience
- No technical assistance
- Lack of education of miners
- Inadequate regulations
- Financial barriers
- Lack of support from mainstreams of Society
- **POVERTY**

*Tanzania*
Environmental, Health & Social Problems Caused by Artisanal Gold Mining

- Water siltation
- Landscape degradation
- Prostitution, Drugs & Crimes
- Money laundering
- Deforestation
- TB, malaria, tropical diseases, HIV/AIDS
- Mercury & Cyanide pollution

Indonesia
Galangan, Kalimantan, Indonesia

- 10,000 illegal artisanal miners invaded area
- 200 km² of forest (Orangutans habitat) destroyed
- 2 tonnes/a Hg lost
Burning Amalgam

Indonesia

Photo K. Telmer
What Are the Solutions?

• Monitoring, monitoring and more monitoring (preferred by the MAJORITY of researchers)

• Legalization (preferred by MOST Governments) … but NO enforcement

• Processing Centers (being adopted in MANY artisanal mining regions)

• Education and technical assistance (ignored by ALL Governments)
Number of samples analyzed for Hg in the Amazon: 8333 samples

Source: Alberto Rogerio B. Silva
Monitoring in Artisanal Mining

No fair balance!!!

Solutions for the Problem

Monitoring and Studies
Examples of Ineffective Laws: Brazilian Approach

- **Law 97.507/89** – Hg and CN prohibition

  “No artisanal mining site is allowed to use Hg or CN without previous permit issued by the environmental authority. Environmental crimes are punishable with fines and jail”

- **Reality:**

  Survey showed 99.3% of artisanal miners in Tapajós, Brazil using Hg and CN without any license
PROCESSING CENTERS: Miners Take Their Ores to Be Processed by Trained Operators
Processing Centers in Indonesia

- They use the most rudimentary process
- 25 to 40% of Au recovered (LOW)
- Adding Hg into the Grinding Circuit
- About 40-50% of Hg added is lost
- P.C. owners keep the tailings with Hg & Au as a payment
Processing Centers in Indonesia

Hg-contaminated Tailings Are Submitted to Cyanidation
Processing Centers in Indonesia

Tailings with Hg & cyanide reach the streams
Processing Centers in Colombia

Owners of the Processing Centers Use NaCN to Extract Residual Gold from Hg-Tailings
Processing Centers in Zimbabwe

- Cu-Hg Plates amalgamate the whole ore
- Hg-contaminated tailings are submitted to cyanidation in Processing Centers
Processing Centers in Ecuador

- Poor extraction of gold from the ore brought by miners to one of the 110 Centers in Portovelo
- P.C. owners retain the tailings
Processing Centers in Ecuador

92 cyanidation tanks in the town of Portovelo leaching Hg-contaminated tailings
Processing Centers in Ecuador

Tailings with Hg and cyanide are dumped into the Amarillo River
Miners use Cu-amalgamating plates to recover the “easy” more accessible gold.
Processing Centers in Brazil

- Hg-tailings are leached with NaCN
- Hg-cyanide in tailings reach the rivers
- 60% of fish >0.5 ppm Hg
- WHO max guideline for edible fish = 0.5 ppm Hg
- One fish sample = 22 ppm Hg

Brazil, São Chico, Amazon
<table>
<thead>
<tr>
<th>Sites</th>
<th>Mean Hg in fish (ppm or mg/kg)</th>
<th>Number of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>São Chico</td>
<td>2.53</td>
<td>73</td>
</tr>
<tr>
<td>Creporizinho</td>
<td>0.36</td>
<td>161</td>
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<tr>
<td>Indonesia</td>
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<tr>
<td>Galangan</td>
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<td>Talawaan</td>
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<td>Laos</td>
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<tr>
<td>Blue Nile</td>
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<tr>
<td>Rwamagasa</td>
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<td>Zimbabwe</td>
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<tr>
<td>Kadoma</td>
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<td>52</td>
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</tbody>
</table>
Mercury Forms Soluble Complexes with Cyanide

- \([\text{Hg(CN)}_4]^{2-}\) which is stable at pHs above 8.5 and \(\text{Hg(CN)}_2\) (aq), stable at pH below 7.8

- These complexes can be either methylated in the sediments or directly bioaccumulated

Education: Demonstration of Cleaner Techniques

- The pieces of equipment were discussed and designed with miners.
- The majority of the equipment is locally manufactured.

Indonesia
Demonstrating Cleaner Techniques

Laos

Sudan
Demonstrating Cleaner Techniques

Tanzania
Demonstrating Cleaner Techniques

Brazil

Zimbabwe
Demonstrating Availability of Gold Concentrators and How to Improve Efficiency
Zig-zag Sluice

Indonesia

Zig-zag sluices increase chances of gold being capture by carpet

Laos
Demonstration of Simple Solutions to Reduce Hg Vapor Exposure

Miner burning amalgam in an open pan
Hg vapor exposure of the whole family

Cambodia
Photo: Tom Murphy
Home-made Retort Using Kitchen Bowls

- Wet sand is added to seal.
- Mercury is condensed on the glass bowl and recovered.
- Amalgam in a small cup.
Retort Made of Kitchen Bowls

Using a enameled steel bowl

Adding a small stainless steel salad cup
Retort Made of Kitchen Bowls

Zimbabwe

Laos
Retort Made of Kitchen Bowls

Sudan
Sealed with wet sand

Kitchen-Bowl Retort

Ecuador
Kitchen-Bowl Retort

Colombia
Kitchen-Bowl Retort

Chile
Replacing Hg with Cyanide
Intensive Cyanidation of Concentrates
(Field Tests in Ecuador)

- 95% of gold extracted from gravity concentrate in 8 h of intensive cyanidation in a small ball-mill
- Use of activated carbon
- Cyanide was destroyed with bleach

Ecuador

Training the Trainers

Indonesia

Brazil

Sudan

Laos
Training Material

"Take care of your Treasure"

Despesca na piscina

Faça a piscina quando fizer a despesca na piscina, lembra você recuperar o mercúrio, o peixe agradece e você não adoece.

Como você vê no desenho acima fazer uma piscina não dará muito trabalho, e o material também não é muito caro e fácil de agiarr.

Brazil
Training Material

Laos

เป้าหมายด้วยตัวอย่าง

- สำนักงานต่างประเทศใน
  ทางวิจัยและพัฒนา
  แม่นยำและมี
  แนวโน้มในผล
  และ ที่มันจะ

- ใช้ประโยชน์และภัย
  บวกกับผู้ที่
  ทำลายผลกระทบ
  และ ที่มันจะ

- สำนักงานการท่องเที่ยว
  การท่องเที่ยวแม่น
  รายละเอียดในสิ่ง
  และ ที่มันจะ
Training Material

Indonesia
Training Material

Global Mercury Project

Sudan
There is Light at the End of the Tunnel

- Artisanal miners are becoming small-scale miners
- More responsible and cleaner gold production
- No mercury being used
- Cyanide is destroyed after use

Ecuador
Conclusion

- Legal approach to introduce cleaner production in artisanal gold mining areas is ineffective
- Monitoring is important but not enough
- Processing Centers are concentrating wealth in the hands of owners and creating Hg & CN pollution
- Hg-cyanide environmental effects are still unknown
- Solution is education and permanent technical assistance to miners
- Solution is evolution of artisanal miners to become responsible small miner
We need to change this perception:

“It’s easier for a man to become an artisanal miner than for a miner to become a man”

A Brazilian artisanal gold miner

Thank you