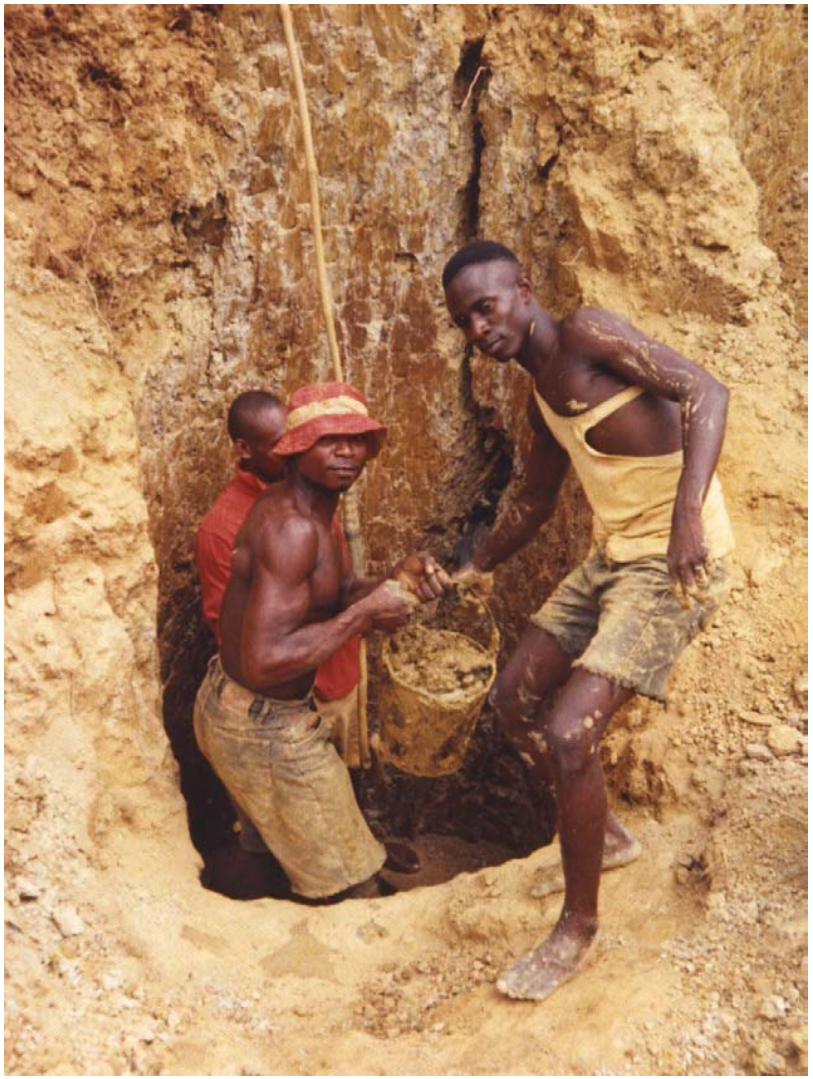
Global Mercury Project



Next Steps of the Global Mercury Project

Marcello M. Veiga

Chief Technical Advisor
Associate Professor
Dept. Mining Engineering
University of British Columbia, Canada

Gold ASM is Growing

This is the biggest gold rush the world has ever seen

More than 100 million people directly and indirectly involved and affected by mercury

Why Mercury is Used by ASM?

Main reasons by which Hg is widely used by ASM:

1. **easy to be used**
2. **cheap (1g Au = 1kg Hg)**
3. **very accessible**
4. **miners are not aware of risks**

Tanzania, 2003

Hg is Very Accessible to Miners

- In most countries, Hg is not allowed to be used in mining
- Hg enters legally the developing countries usually for DENTAL USE
- In many mining sites is sold for DENTAL USE

Probably this large amount of Hg is for animal dental treatment

Where This Mercury is Coming from?

- One dealer importing 20 tonnes/a of Hg from the Netherlands for selling to ASM in Zimbabwe and in Mozambique
- In 2000, the Netherlands shipped 245 tonnes Hg to 18 countries, most in Latin American/Caribbean region
- Spain shipped 774 tonnes
- UK 200 tonnes
- Germany 105 tonnes
- US (2004) 300 tonnes
- Since 1990, Canada exported 218 tonnes of Hg to US

Most of this Hg is of low quality…not useful for electronics but good for ASM

Veiga, Maxson, Hylander, 2004

Amalgamation Process Defines Hg losses *(and pathway for humans)*

Amalgamation of the Whole Ore → **Huge Hg losses, large environmental problem**

⇩

CH_3Hg in fish

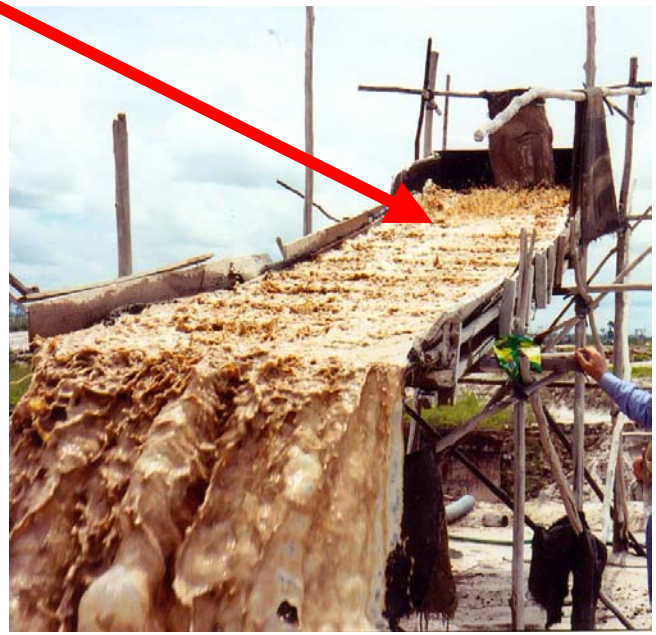
Burning Amalgams in Pans → **Health problem for miners, family, neighbors**

⇩

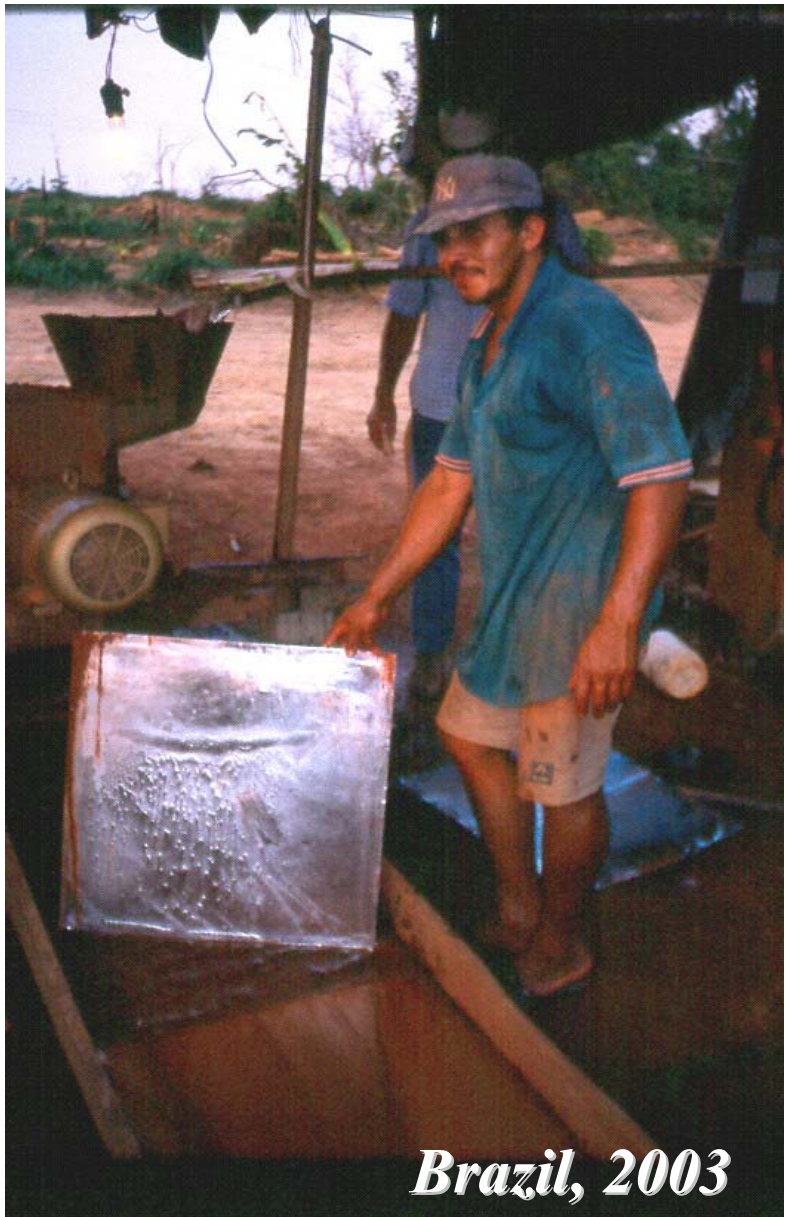
Hg vapor

Stop Amalgamating the Whole Ore

Hg



Indonesia, 2003



Brazil, 2003

What to Do with Amalgamation Tailing?

- Cyanidation of Hg-contaminated tailings oxidize and solubilize part of the Hg
- **DANGER**: Hg becomes soluble and can be methylated
- This is used in:
  - ✓ Brazil
  - ✓ China
  - ✓ Indonesia
  - ✓ Peru
  - ✓ Philippines
  - ✓ Venezuela
  - ✓ Zimbabwe

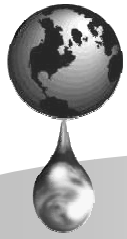
Zimbabwe, 2004

Global Mercury Project

Outline

SOLUTIONS

- ✓ First phase was devoted to environmental and health assessment
- Now it is time for INTERVENTIONS
  - ➢ Education of miners and communities
  - ➢ Higher efficiency gravity concentration
  - ➢ Reduction of Hg emissions and exposure



Global Mercury Project

Solutions for Hg Pollution in Mining

- ***Alternative Processes to Amalgamation***
- ***Hg Bioavailability Control***
- ***Reduction of Emissions***

UNIDO, 1997

Education is Everything

Sudan, 2004

Education/Training is not Trivial

- Miners cannot afford to stop their activities to "be educated"
- Miners learn by examples
- Miners must decide what is good or not for them…not us!!!
- Miners are moving from one site to another
- Traditional demonstration units stay in place while miners move on
- Suggestion: Transportable Demonstration Units

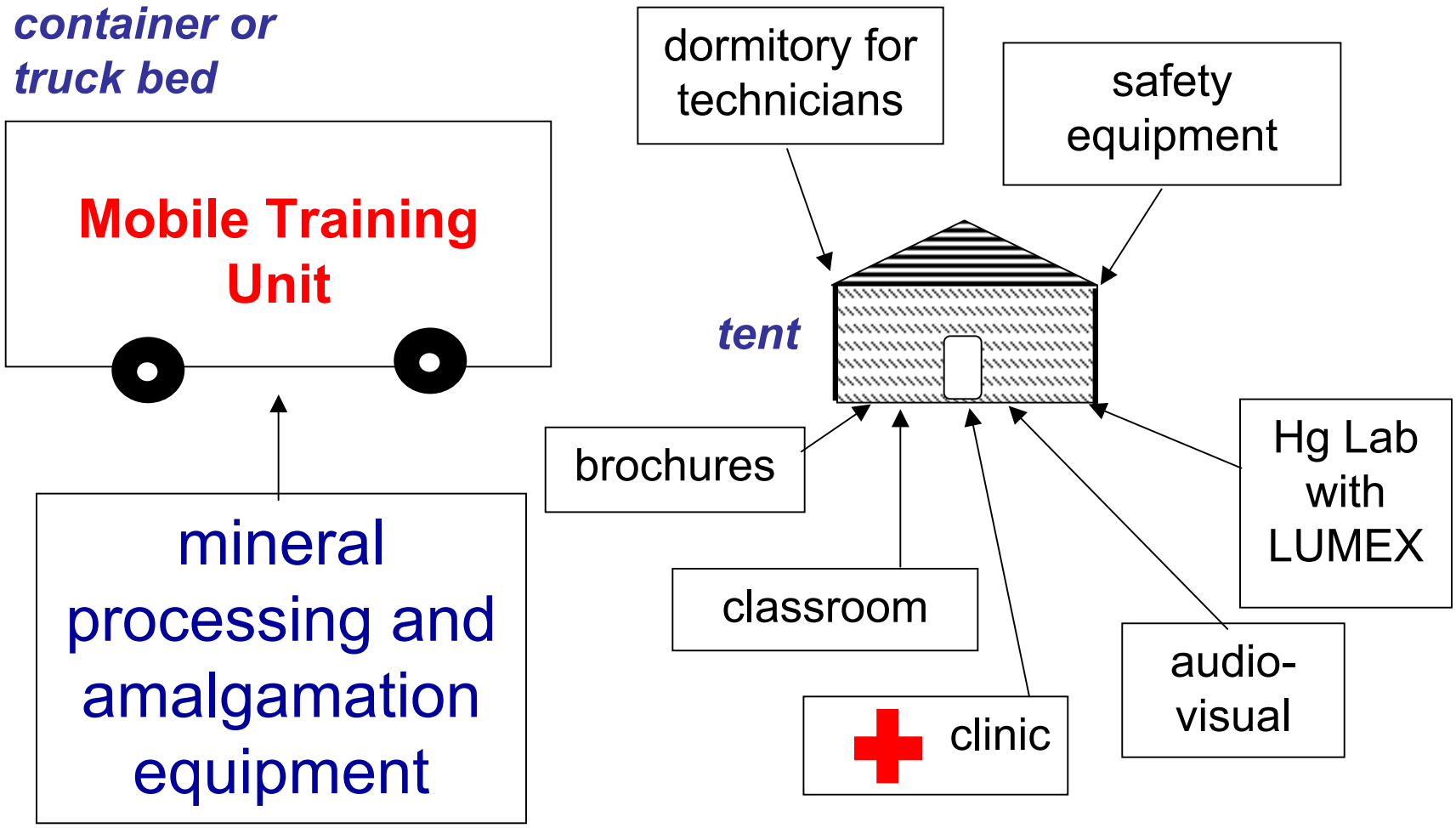
Transportable Demonstration Units (TDU)

1. cheaper to implement than fixed training centers
2. training units go after miners and not vice-versa
3. a variety of technical options demonstrated
4. easy to change and adapt new pieces of equipment
5. more miners and public can be outreached
6. the ownership is easy to decide; no land or mineral title issues or conflicts

Transportable Demonstration Units (TDU)

8. “peripheral” education: health & sanitation, bookkeeping, legal issues, etc) and awareness for non-miner communities
9. monitoring teams can make use of the units
10. the units can bring ideas to improve the livelihood of different mining communities such as suggesting economic diversification activities or value-adding techniques

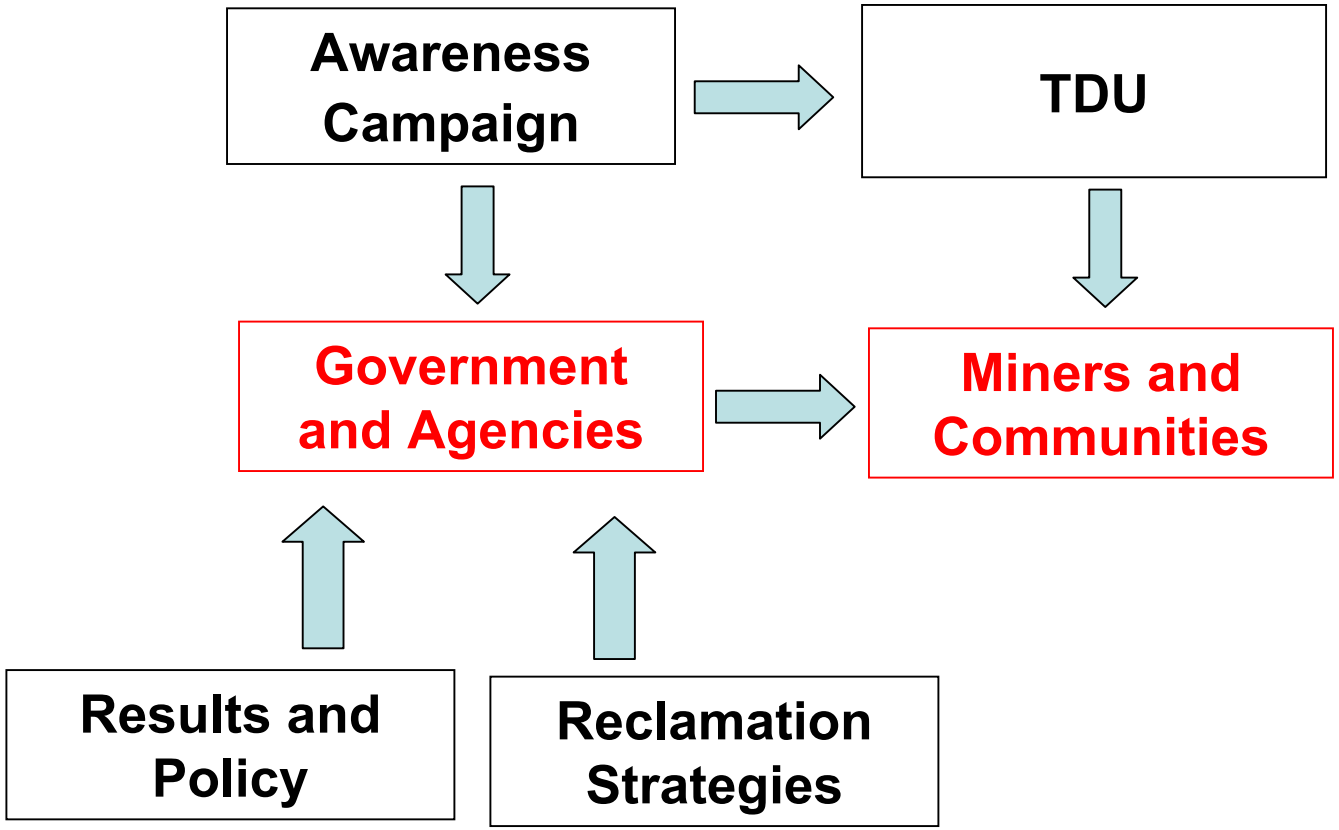
Transportable Demonstration Units (TDU)



Why Health Issues are Important

- HIV/AIDS is rampant in ASM regions; e.g. ¾ of miners in Kadoma are HIV positive
- The clinic will be multifunctional (HIV, malaria, Hg, diarrhea, parasites, hepatitis, etc.)
- This is also a way to attract miners and families to the TDUs

Global Mercury Project



Transportable Production Units

Ghana, 2003

Suggestion of Equipment to Be Demonstrated

- Comminution
- Gravity Concentration
- Amalgamation
- Retorting

Good Amalgamation Requires Comminution to Liberate Gold

- Gold liberation requires grinding
- Gold occluded in silicates or sulphides is not amalgamated
- Manual grinding ìs very inefficient

Tanzania, 2002

Comminution (Stamp Mill)

- Katanka = 1 man, 1 mill
- 1-stamp mill
- 0.3 tph
- 7.5 kW
- Weight ~ 1 tonne
- Not quite transportable

Katanka Stamp Mill

Comminution (Small Ball Mill)

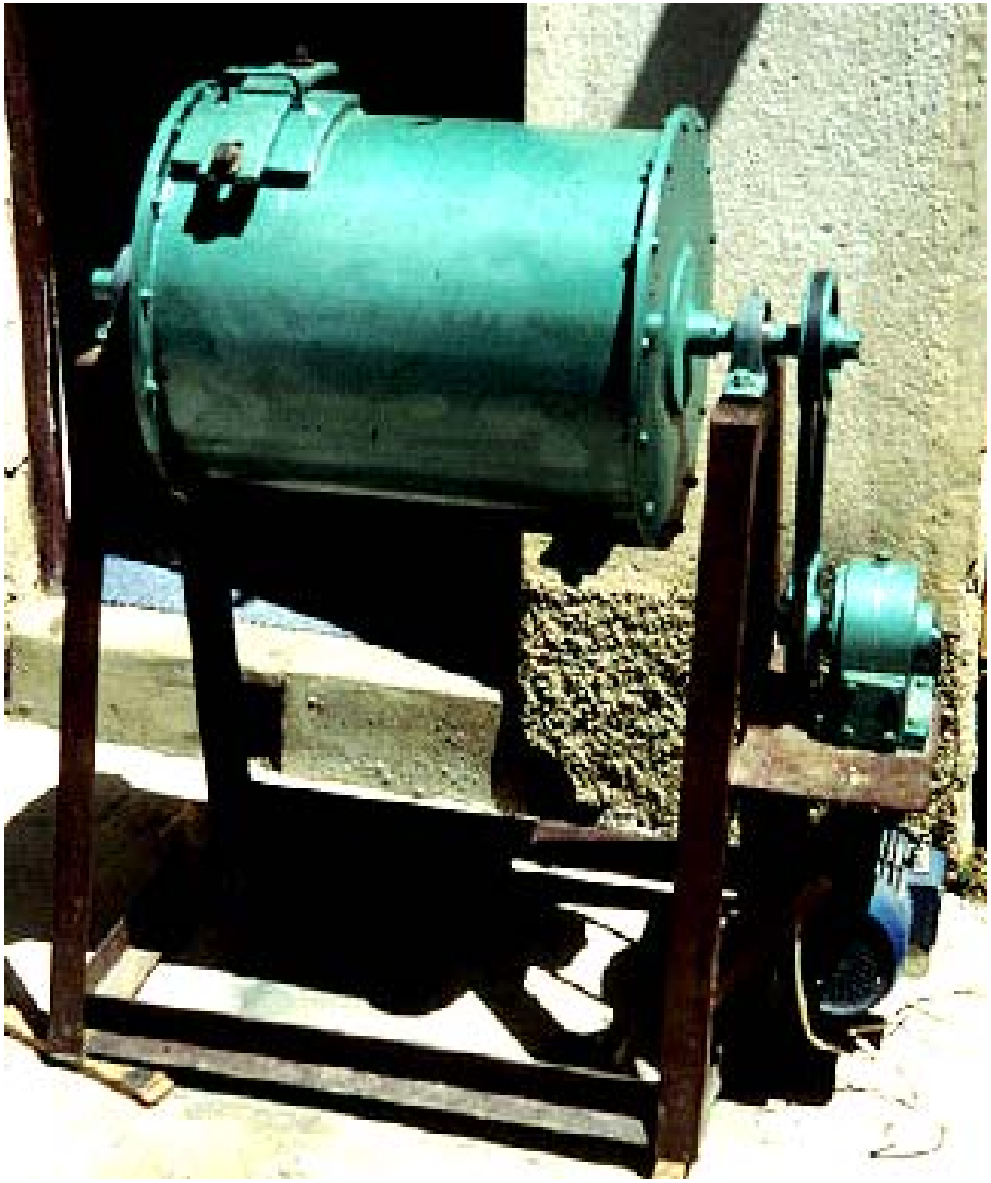
A series of small ball mills is an affordable idea

Indonesia, 2003

Comminution (Small Ball Mill)

Of course, Hg cannot be added into the mills

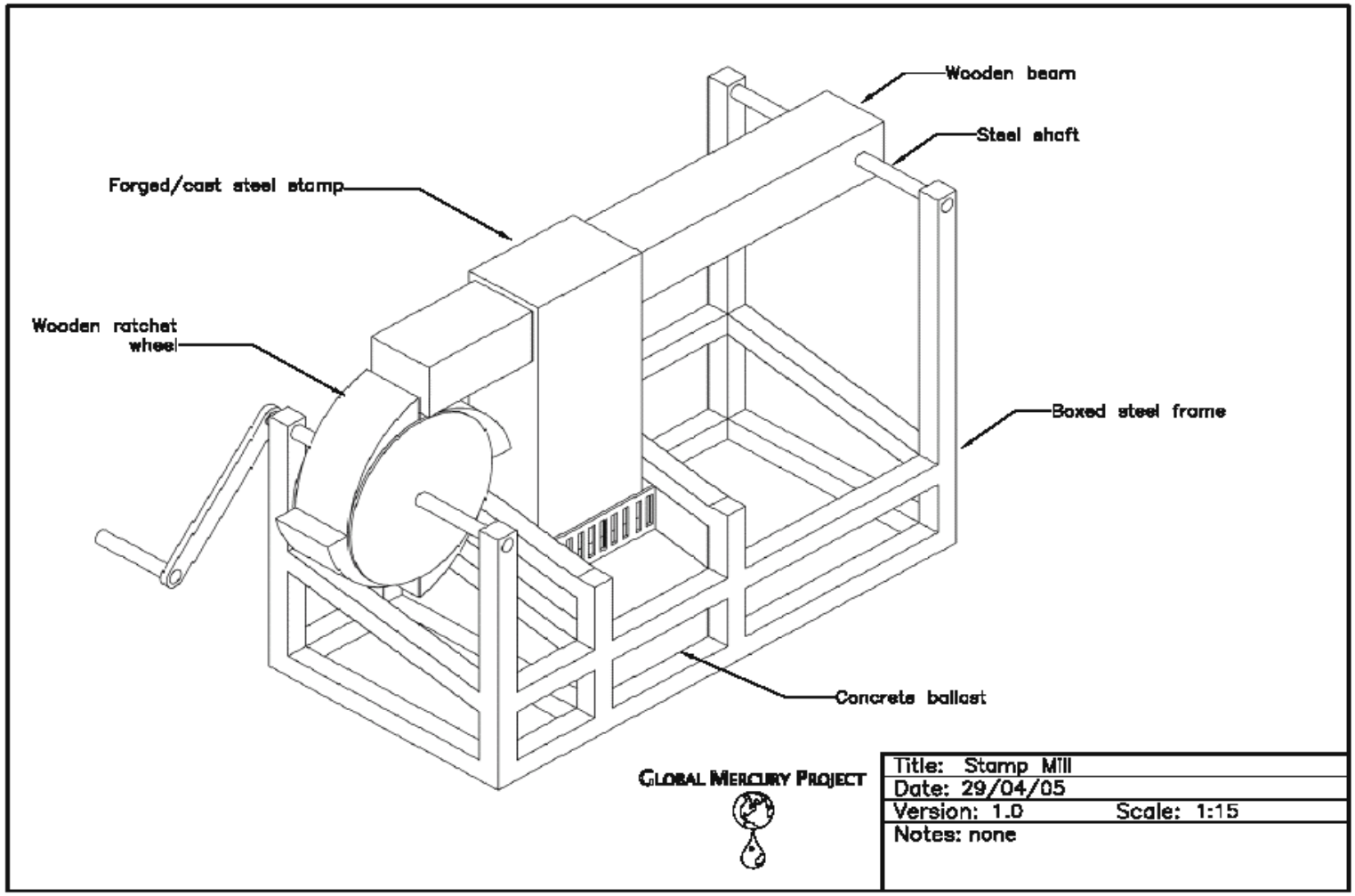
Indonesia, 2003



Small ball mill

Comminution (Manual Ball Mill)

Mozambique, 2005



Crusher-stamp Mill

Foot pump

Demonstrating Availability of Gold Concentrators

Concentrating Gold

Sluice boxes with right carpets work OK to concentrate fine gold…they don't need to be long

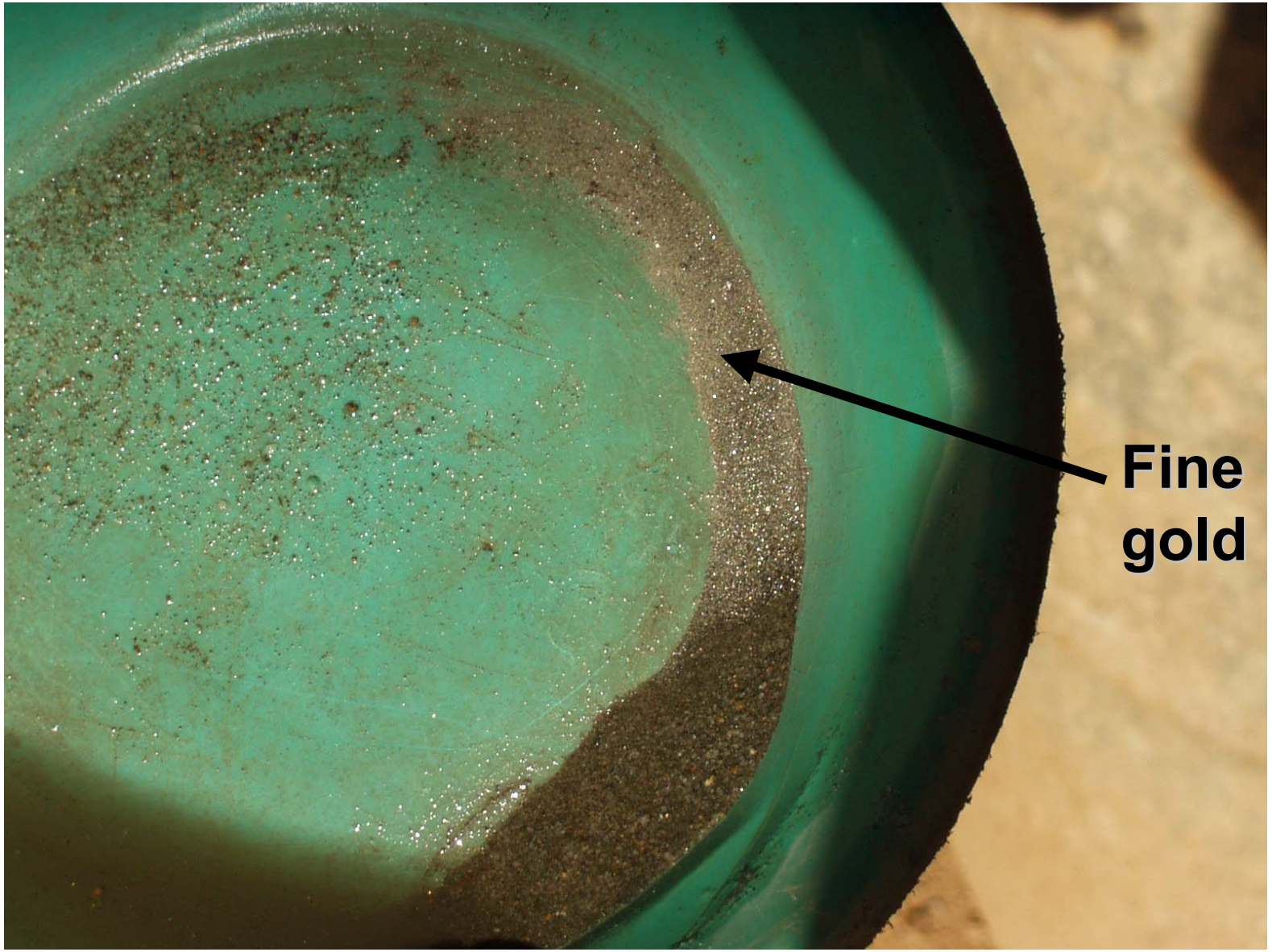
Concentrating Gold
(Cleangold® Sluice Box)

Fine gold is trapped on magnetic carpet

Cleangold Sluice Box to Reprocess Tailings

Venezuela, 2003

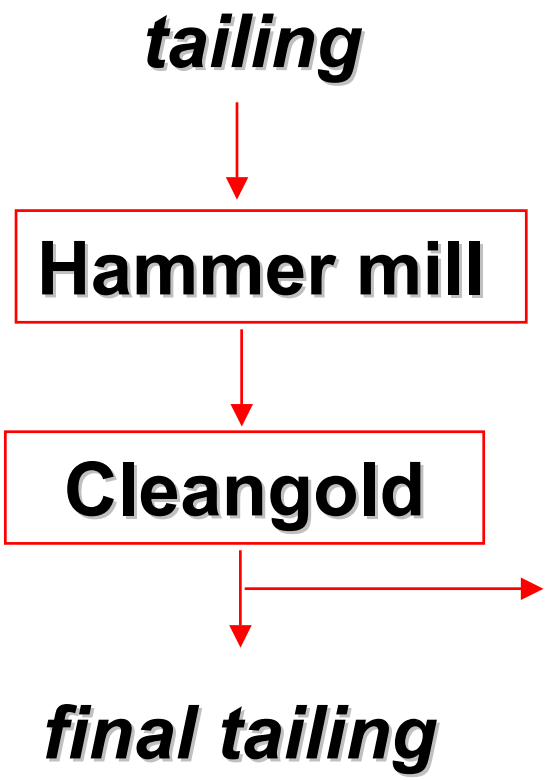
Reprocessing Tailing



Cleangold concentrate

Venezuela, 2003

Reprocessing Tailing



Clearly LACK of LIBERATION

Concentrate (2854 g/t Au, 11% Au)

Venezuela, 2003

Reprocessing Tailing

Sudan, 2004

Panning Tailings with Cleangold

Magnetic Sluice Made of Recycled Magnets

Magnetic Sluice Made of Recycled Magnets

Concentrating Gold (Magnetic Sluice Box)

Work sponsored by:
UNIDO and Blacksmith Institute

Mozambique, 2005

Filtering Amalgam

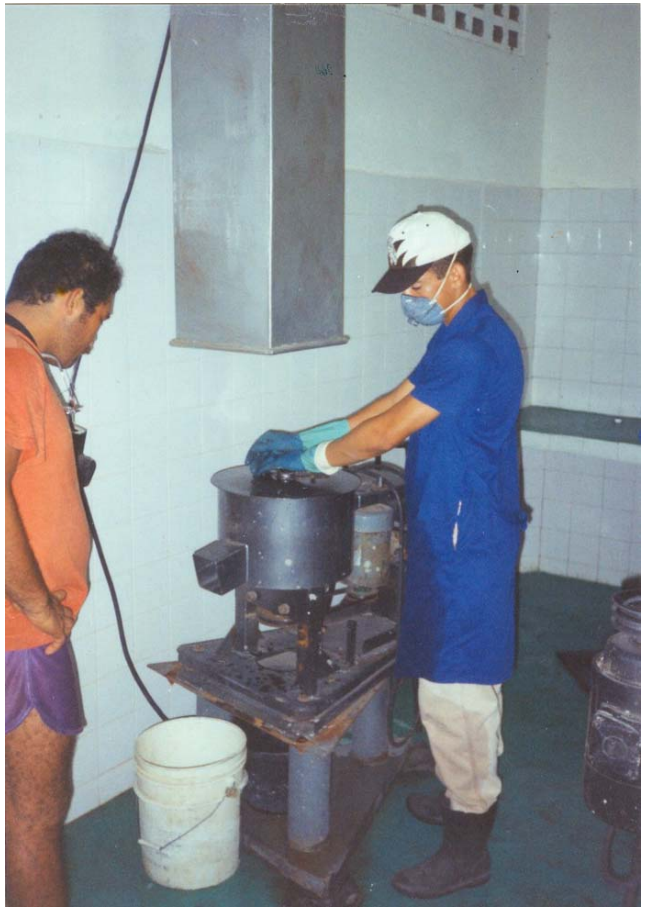
(removing excess Hg)

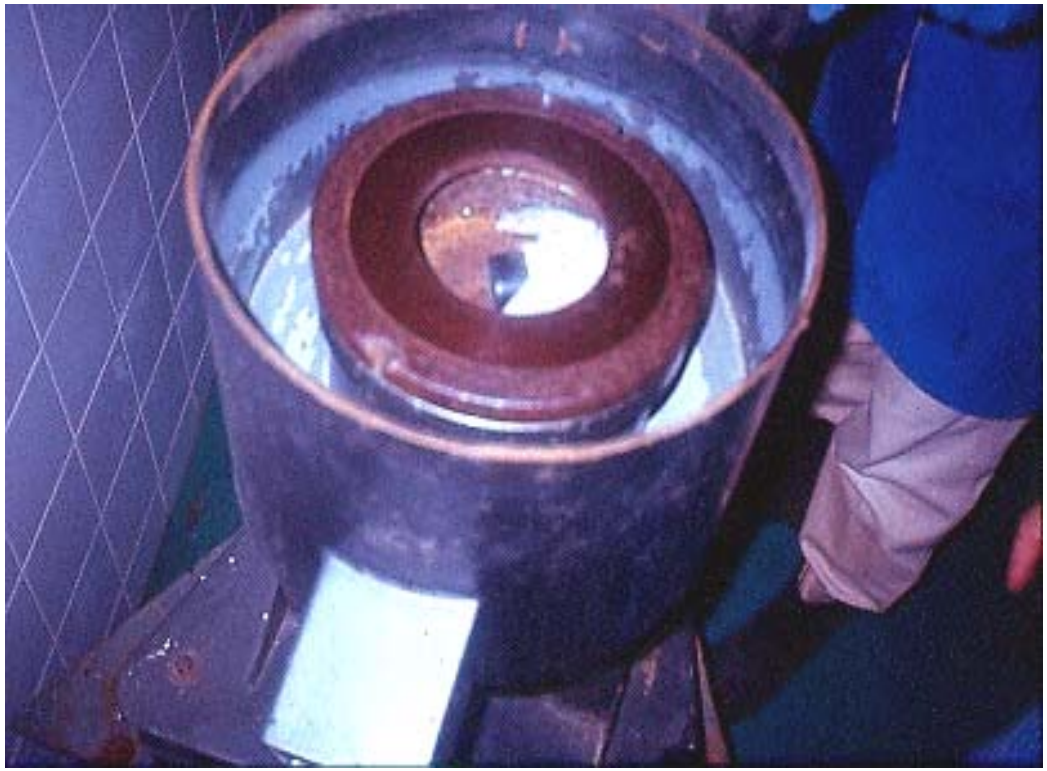
The amount of Hg in the amalgam depends how strong they squeeze (filtering process)

Manual Squeezing: 60% Au, 40% Hg

Indonesia, 2003

Filtering Amalgam





Venezuela, 1995

Using a centrifuge to filter amalgam:

80% Au, 20% Hg

(less Hg remains in the amalgam)

Filtering Amalgam

A small part of Hg can be absorbed through the skin

Excess Hg is squeezed off

Filtering Amalgam

A centrifuge can be made with PVC tubes attached to a bicycle wheel

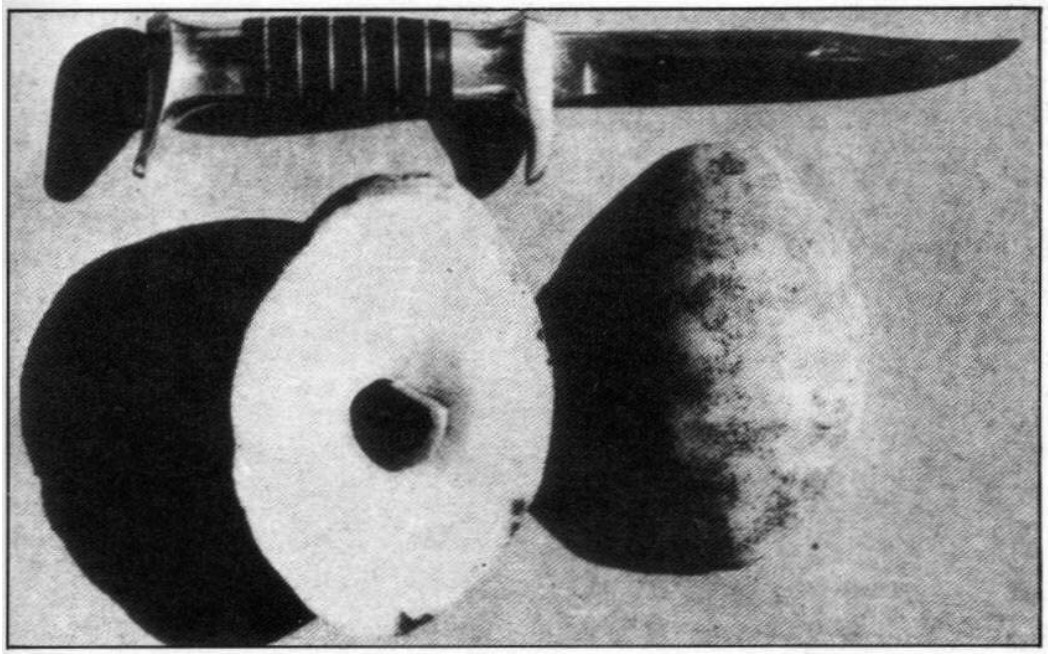
Burning Amalgam

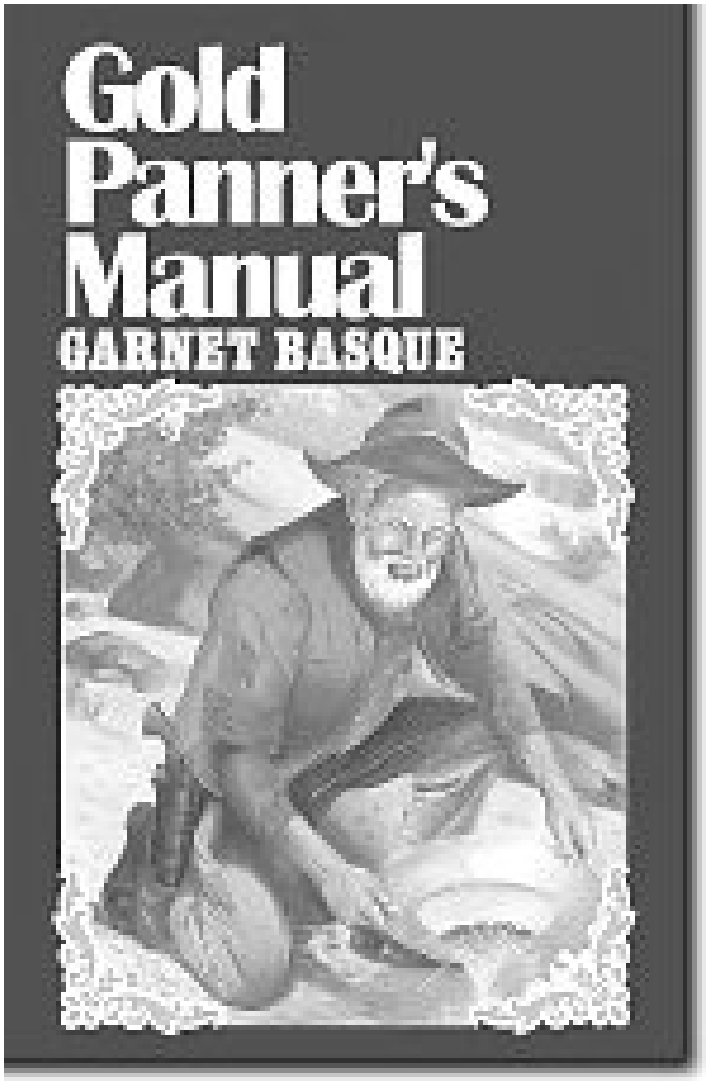
Sudan, 2001

Any solution is better than this

Potato Retort

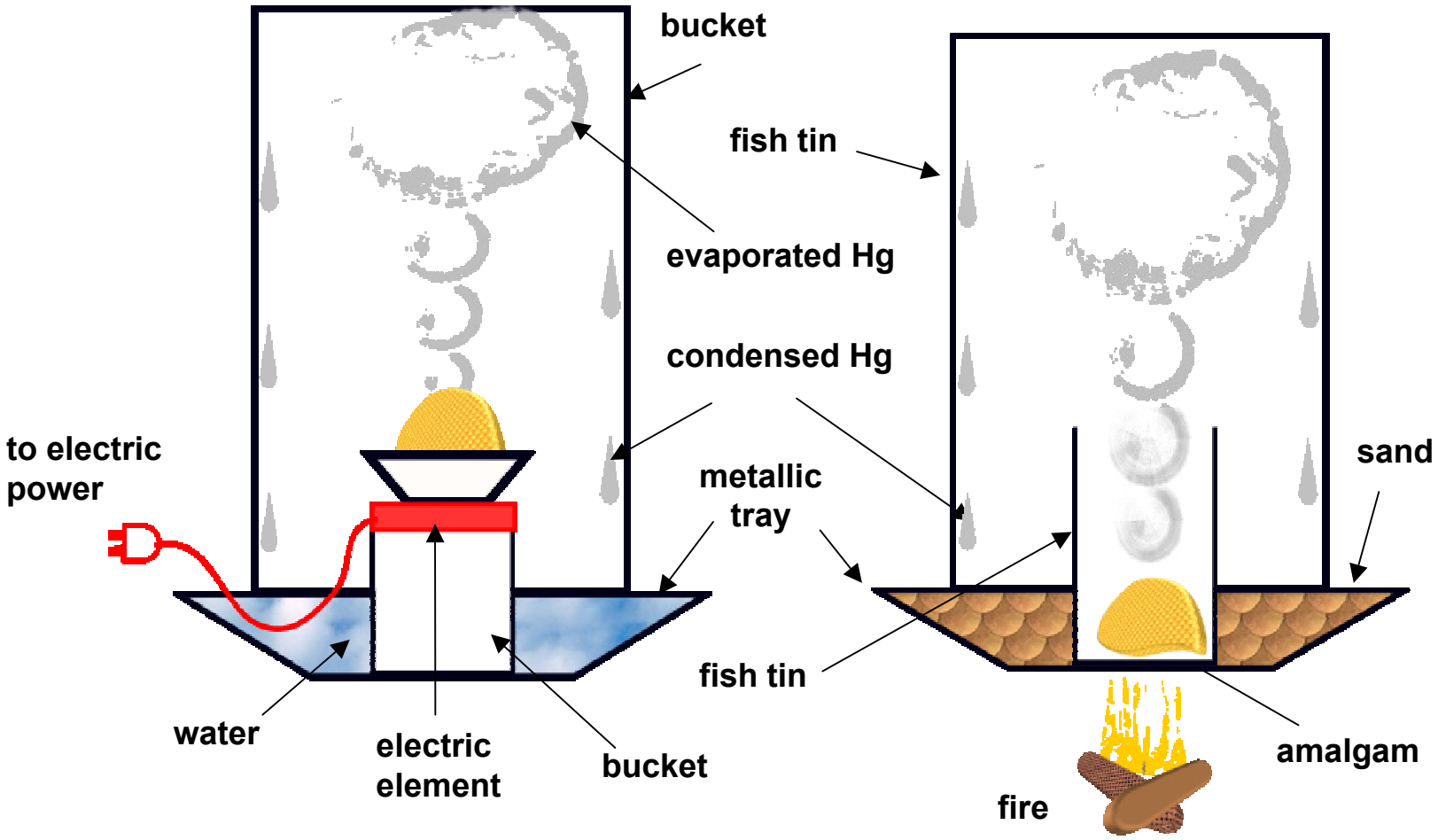
A Canadian booklet suggests that retorting amalgam in a scooped potato is also an option...





Bucket Retort (China)

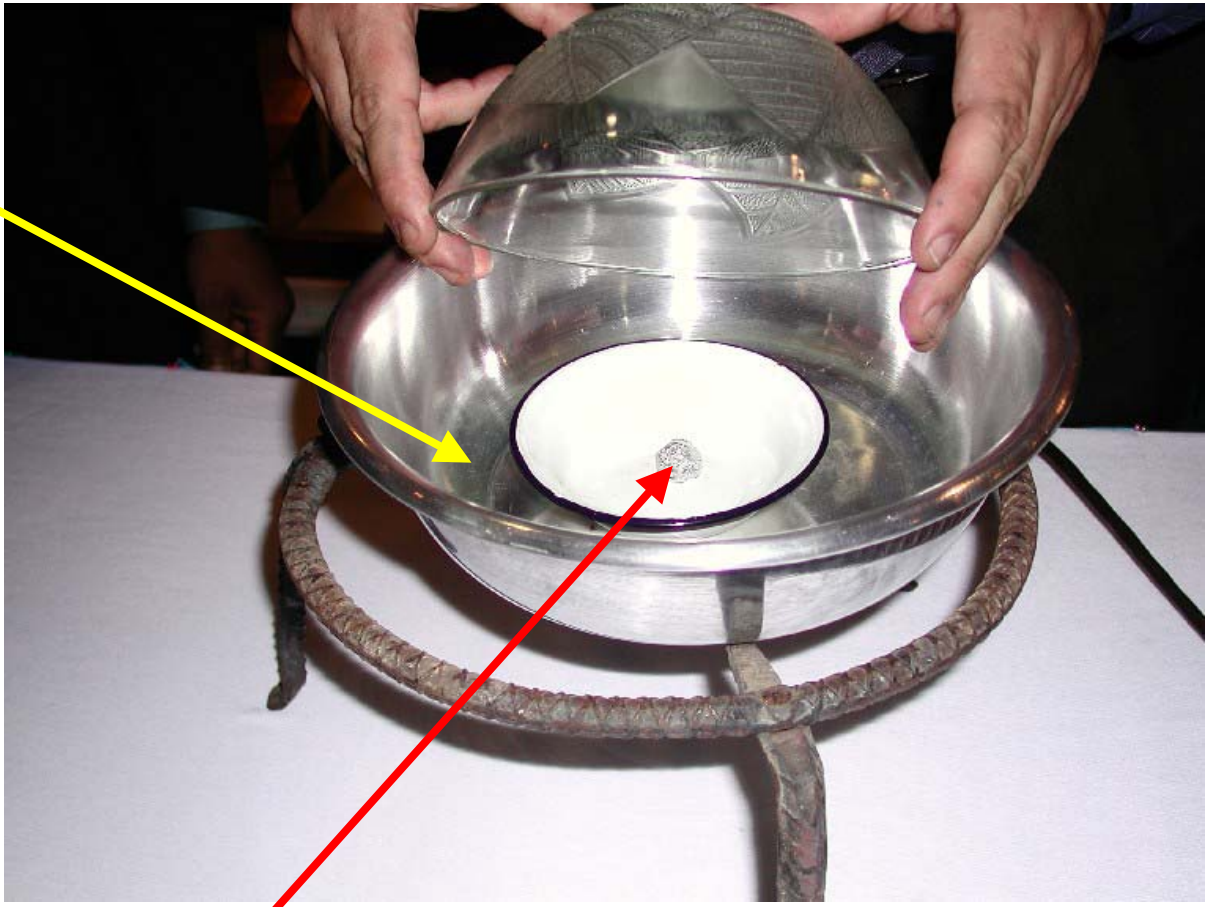
Fish-tin Retort (Papua New Guinea)



Veiga and Hinton (2002)

Home-made Retort Using Kitchen Bowls

sand is added to seal



Lao PDR, 2003

Gold comes yellow as àmalgam has contact with enameled dish

Retort Made of Kitchen Bowls

Sudan, 2004

Retort Made of Kitchen Bowls

Sudan, 2004

Kitchen-Bowl Retort

Ecuador, 2004

Kitchen-Bowl Retort

Ecuador, 2004

Using Kitchen Bowl Retorts

- **When miners burn amalgam in open pans: Hg in air = 50,000 µg/m^3**
- **In Mozambique, using the kitchen-bowl retorts, the levels at nose level decreased to 0.4 µg/m^3**
- **1 meter from the bowl = 3 µg/m^3**
- **0.1 m from the bowl = 35 µg/m^3**

Work sponsored by:
UNIDO and Blacksmith Institute

Hg in the Expired Air

- **Normal levels of Hg in the expired air depends on the number of Hg-dental fillings in the mouth**
- **Normal levels is usually between 0.03 and 0.3 µg/m^3**
- **In Manica, Mozambique levels in miners are between 1 and 60 µg/m^3 (average of 25 miners = 4 µg/m^3)**

Work sponsored by:
UNIDO and Blacksmith Institute

Hg in the Expired Air

Work sponsored by:
UNIDO and Blacksmith Institute

Mozambique, 2005

Hg in the Expired Air

Mozambique, 2005

Work sponsored by:
UNIDO and Blacksmith Institute

Using Kitchen Bowl Retorts

Mozambique, 2005

Work sponsored by:
UNIDO and Blacksmith Institute

Using Kitchen Bowl Retorts

Work sponsored by:
UNIDO and Blacksmith Institute

Mozambique, 2005

Using Kitchen Bowl Retorts

Mozambique, 2005

Work sponsored by:
UNIDO and Blacksmith Institute

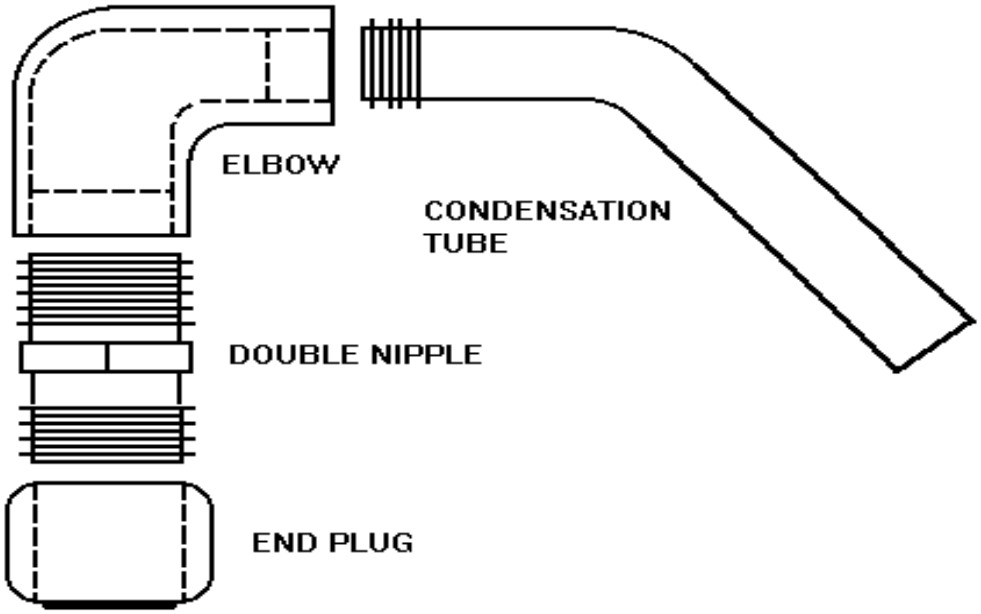
Using Kitchen Bowl Retorts

Sand is added to seal

Mozambique, 2005

Work sponsored by:
UNIDO and Blacksmith Institute

Home-made retort RHYP



- Devised by prof. Raphael Hypolito, Univ. São Paulo
- Made of water plumbing material (galvanized steel)
- Size: from ¾” to 4”
- Ideal size 1 ½” to burn 10 to 20 g of amalgam
- Cost: from US$ 5 to 10

RHYP retort

Indonesia, 2003

Home-made Retort – RHYP

Mozambique, 2005

Work sponsored by:
UNIDO and Blacksmith Institute

Levels of Hg escaping

0.1 m = 30 µg/m^3
1 m = 2 µg/m^3
Nose = 1.8 µg/m^3

Mozambique, 2005

Work sponsored by:
UNIDO and Blacksmith Institute

Recovering Hg coalescence

Fred Pantoja Method

Mozambique, 2005

Work sponsored by:
UNIDO and Blacksmith Institute

Retorts

Salad bowl

Venezuela, 2003

Retorts

Venezuela, 2003

Retorts

Venezuela, 2003

Awareness Campaign Strategy

- **Increase impact of awareness campaign by partnering with stakeholders**
  - **Miner organizations**
  - **Miller organizations**
  - **Women's organizations**
  - **Regional government (e.g. Departments of Health, Education, Mining, etc.)**
  - **NGOs**

Awareness Campaign Materials

- Communicate
  - Mercury hazards
  - Mineral processing solutions
- Promote
  - Health seeking behaviors
  - Community health solutions (Child and women's health, water and sanitation, etc.
- Master Documents but respecting differences in culture in all 6 countries
- Contain lots of pictures/illustrations
  - Very few words

Information Vehicles

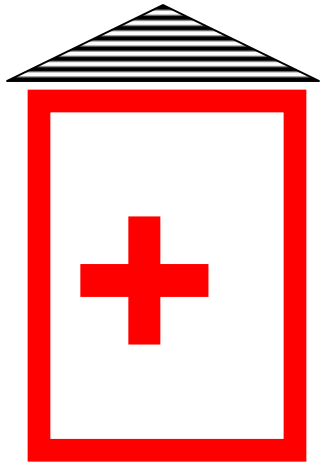
- Radio and TV
- Videos (Animations)
- Newspapers
- Brochures
- Posters
- Billboards
- PowerPoint presentations
- Speeches/lectures
- Songs (e.g., cordels)
- Community activities
- Comic books
- Hats, T-shirts, footballs
- Entertainment
  - Movies, soccer matches
  - Musicians and dancers
  - Theater and circus
- Involvement of celebrities: e.g. soccer players

Brochures and Posters
- technical -

- Overview of artisanal mining and mineral processing methods
- Gravity concentration
  - Sluices and centrifuges
- Grinding and crushing
- Mercury use
  - Amalgamation systems
  - Retorts

Brochures and Posters
- health -

- Mercury hazards and solutions
  - Why Hg is a hazard and what people can do
  - What happens to Hg when it goes into the air, water and ground.
  - How mercury makes you sick
- Maternal and baby health
- Occupational health
- HIV/Aids and other diseases
- Water and sanitation
- Nutrition



Brochures and Posters
- community -

- Business and Micro-credit
- Organization and division of labour
  - Options and processes for communities
- Development of employment alternatives
  - Jewelry making
  - Aquaculture
- Legal issues (country specific)
  - Mineral rights
  - Formalization

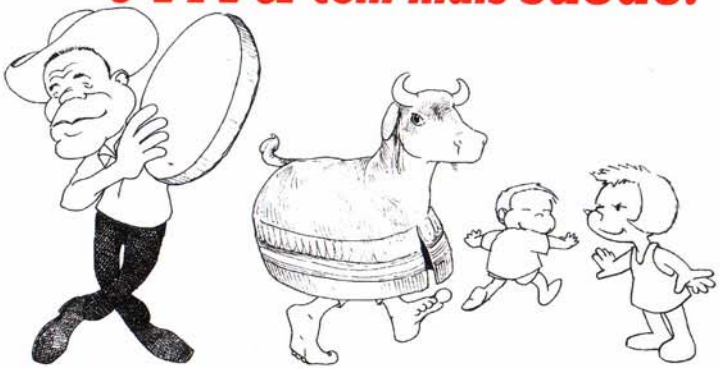
AS AVENTURAS DE Zé do Ouro e FAGÚIO

Nº 4

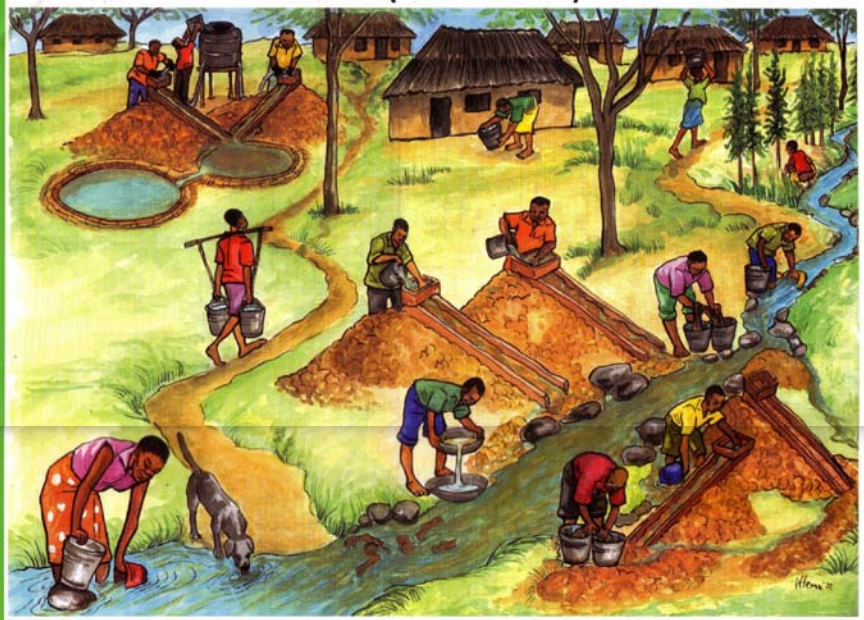
Queimar ouro não é errado,
mas o azougue vai disfarçado,
vira fumaça, o bicho é danado!
Põe veneno pra todo lado:
no rio, no peixe, nos filhos, na patroa.
O troço é ruim, não é a toa,
que toda essa gente boa
anda muito preocupada,
em mudar sua atitude.
Se usar máscara e retorta,
vai ter muito mais saúde!

Olha só o resultado,
mole, igual um melexete,
numa rede entrevado.
Se usasse o equipamento,
não teria esse sofrimento,
tudo seria evitado!

Trabalhe com mais cuidado,
e viva com mais saúde!



UCHENJUAJI MBALE (DHAHABU) NDANI YA MITO



HASARA

- Eneo kubwa la mto huathirika au huchafuka.
- Ni rahisi kupoteza dhahabu yako mtoni.
- Endapo zebaki inatumika madhara kwa watu na viumbe vingine yatakua makubwa.

Imetolewa na Wizara ya Nishati na Madini

Imefadhiliwa na USAID

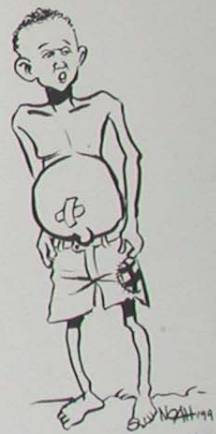
Imetayarishwa na IBI/TanDiscovery

AJIRA YA WATOTO MACHIMBONI

Watoto wasiajiriwe machimboni

Watoto wasiruhusiwe kwenye maeneo ya kukamatisha dhahabu

Haki za watoto



AJIRA MBAYA ZA WATOTO

Madhara ya ~~mercury~~ kwa afya ~~ya~~ ZAO ~~binadamu~~

Next Challenge: Sustainable Livelihoods

Discovery, Migration, and Relative Economic Prosperity

Depletion, Outmigration and Economic Destitution

Alternatives for sustainability after ASM:

- **Agriculture**
- **Brick making & Ceramics**
- **Small businesses**
- **Jewelry & Crafts**
- **Aquaculture and other creative alternatives...**

Alternatives for Mining Communities

Making jewels with recycled glasses in South Africa

Mintek, S. Africa, 2003

Alternatives for Mining Communities

Brickmaking

Mintek, S. Africa, 2003

Transforming Mining Pits into Fish Farms

Aquaculture in Alta Floresta

Photo R. Farias, 2000

500 fish farms in the region
900 people employed
100 tonnes fish/a produced

Aquaculture in Alta Floresta

Look the happy guys eating

Aquaculture in Alta Floresta

Hybrid species (more resistant) were developed

Critical Questions

- **What is good for artisanal miners is good for the surrounding communities?**
- **Should poverty alleviation policy be focused on miners or on rural communities?**

Conclusion

- Artisanal mining is a poverty-driven activity
- Hg emissions are increasing up to 1000 tonnes/a…and growing!
- Number of ASM is increasing with gold price and more women and kids are being involved
- GMP must focus this phase on INTERVENTIONS:
  - Awareness campaign
  - Transportable Demo Units

Conclusion

- **USEPA partnership is very timely and appropriate to implement solutions.**
- **The actions must be implemented in 2 fronts: policy and intervention in the field.**
- **Economic policies to create hurdles to the Hg flow to developing countries must be implemented.**
- **Simple and cost effective solutions to reduce Hg emissions and exposure must be immediately brought to the miners.**
- **A broader view of the problem is badly needed.**

"It's easier for a man to become an artisanal miner than for an artisanal miner to become a man"

(a miner in the Amazon)

Thanks