

# Mineral Processing techniques in ASM

## PanAfGeo WP3 Conference

Prof Richard K Amankwah  
University of Mines and Technology, Tarkwa

September 2017

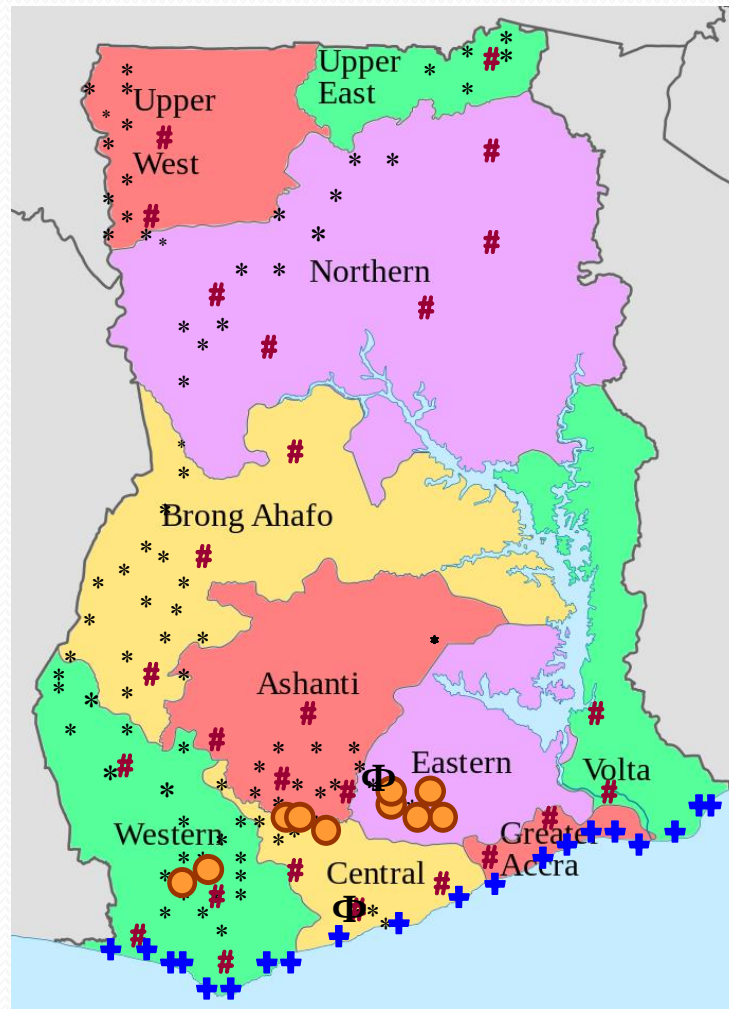
# Introduction

- Safe and Environmentally Sustainable Gold Mining for ASMs can be applied in several areas
  - Prospecting/exploration
  - Mining
  - Mineral Extraction
  - Tailings disposal
  - Land reclamation

# This discussion

- Mineralogy
- Size reduction
- Size of gold relative to grind size
- Particle shape and concentration
- Sluice mats
- Mercury use
- Tailings disposal

# Map of Ghana showing ASM areas

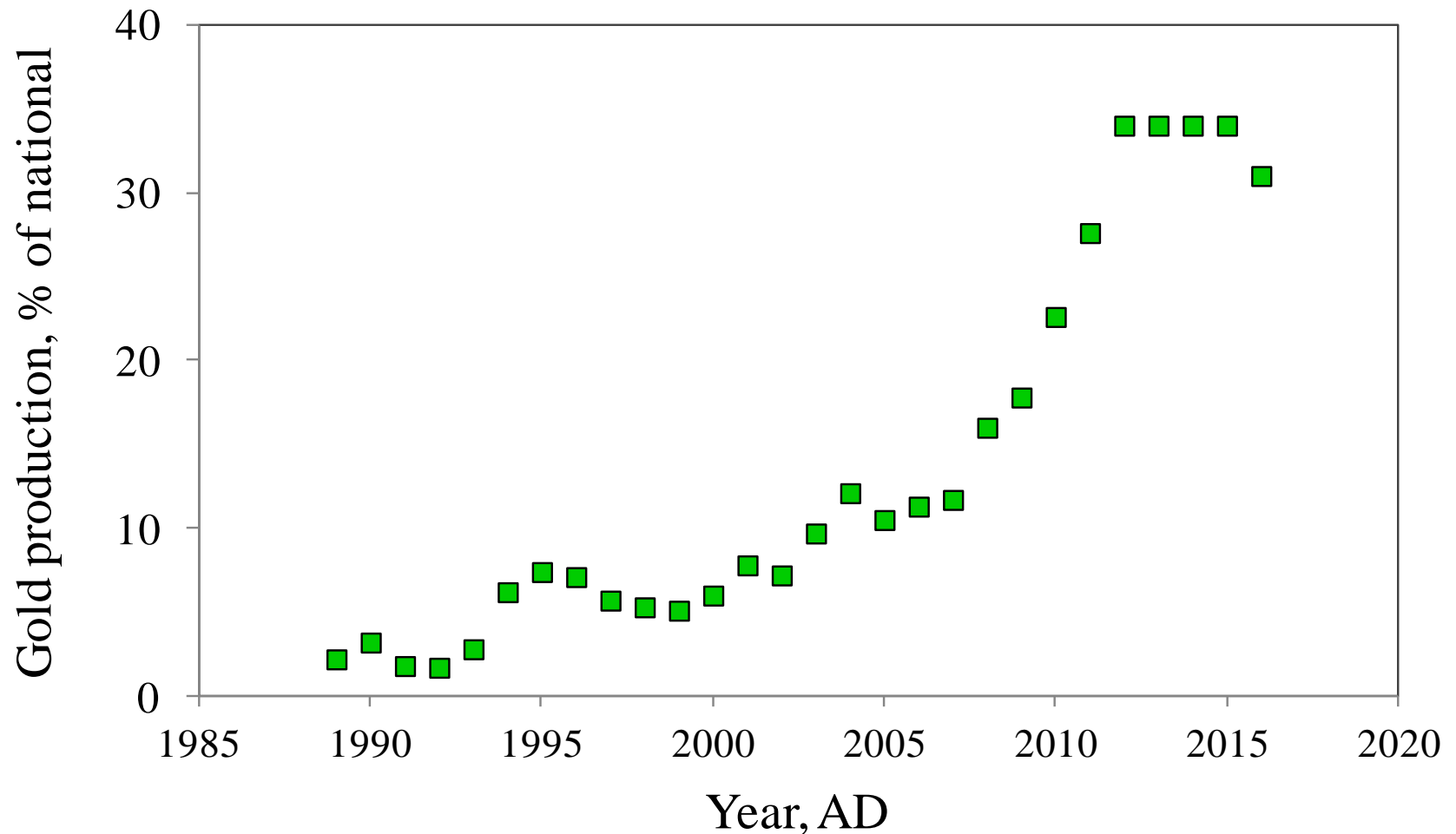


*	Gold
#	Construction materials
○	Diamonds
+	Salt

# Size of the sector

- Registered small scale mines
  - 800 – 2012
  - 1,500 – 2017
- Estimated 1 million people employed by the ASM sector
- Produced 1.15 million ounces of gold in 2016. This is 31% of total gold produced in Ghana

# Trend of gold production in ASM





# **Some Mining Methods**



# Rock fragmentation and excavation



- Chiseling
- Thermal stress cracking



# DANGEROUS MINING ACTIVITIES





# PIT WITH STEEP SLOPES





# DESTRUCTION OF FORESTS BY ILLEGAL MINERS





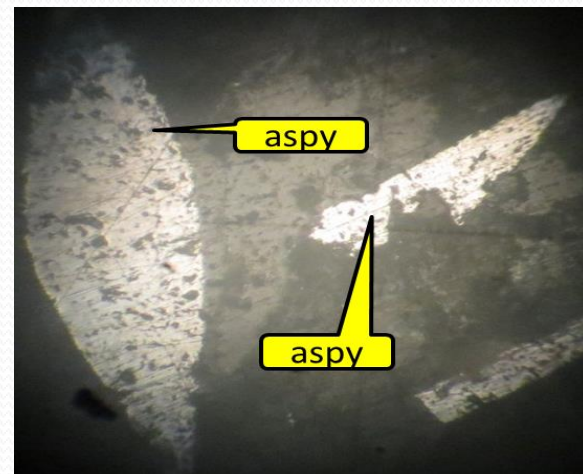
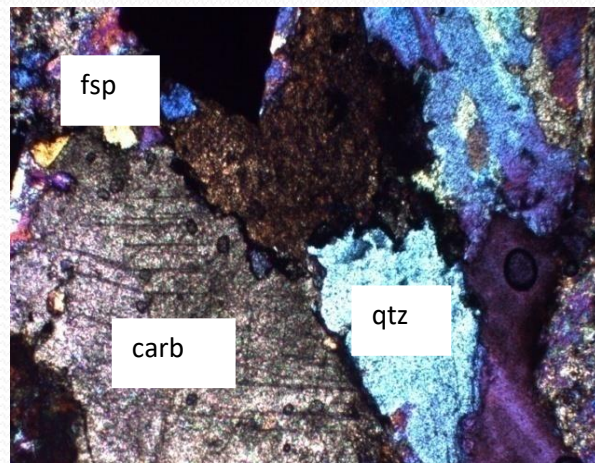
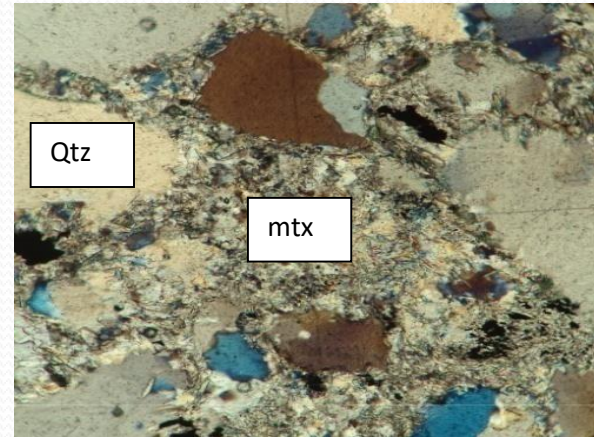
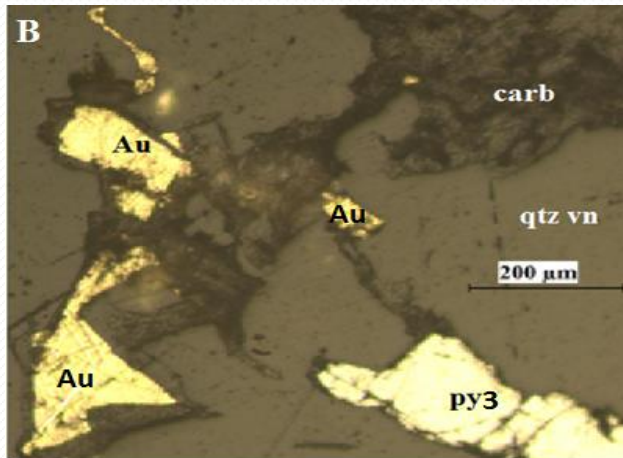
# ILLEGAL DREDGING ACTIVITIES



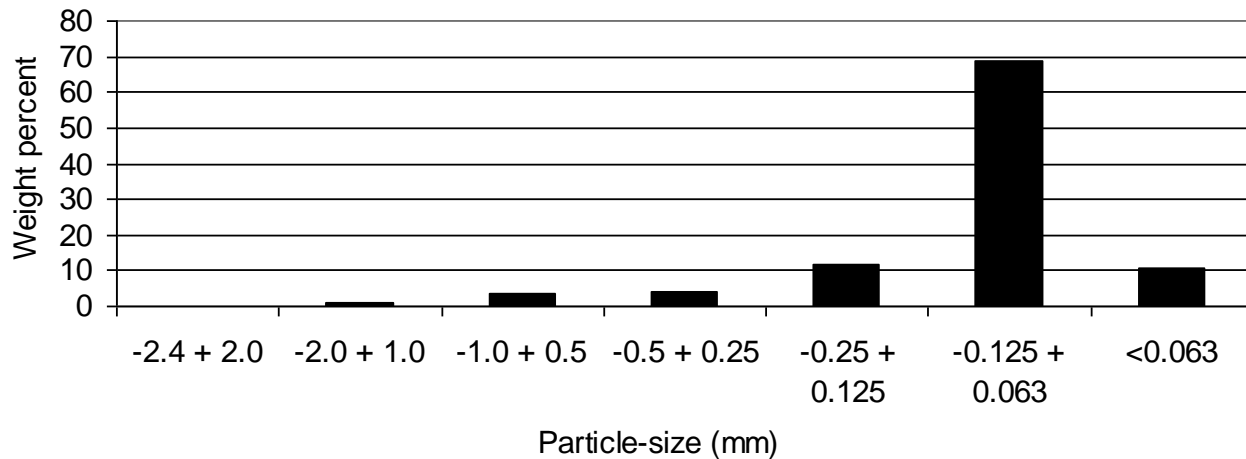
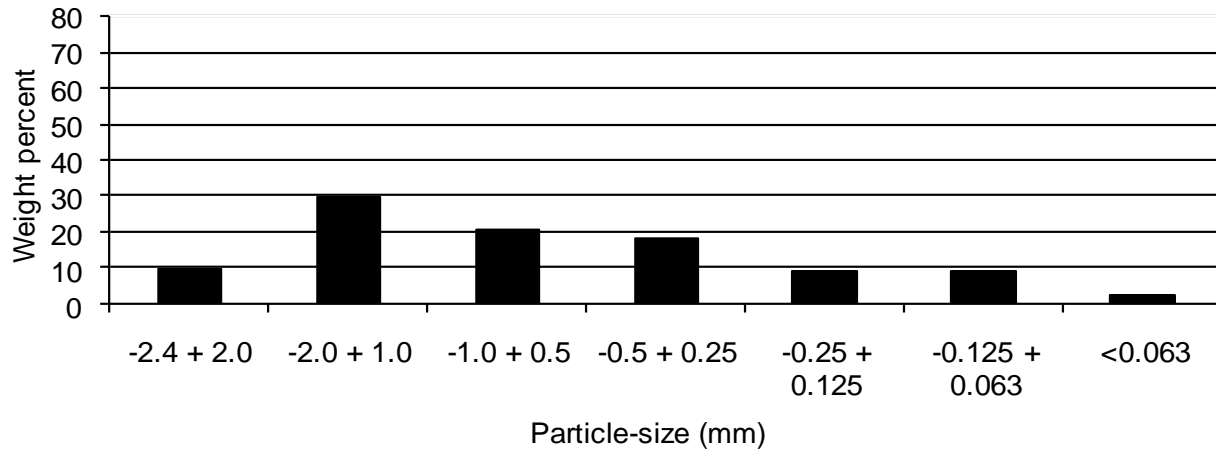


# **Mineralogy and Size Reduction**

# Mineralogy is important



# Gold particle size range that should be considered during size reduction





# Size reduction in ASM



# Disc mill



- Particle size is generally 80% passing 425 microns



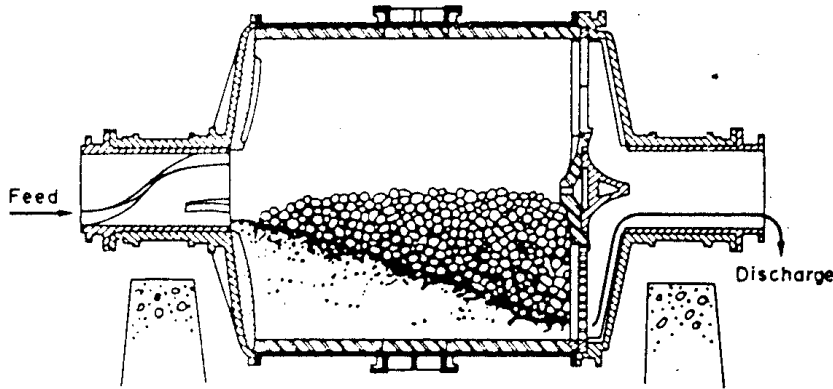
# Hammer mill in series with a deslimer



- Particle size is generally 80% passing 1 mm

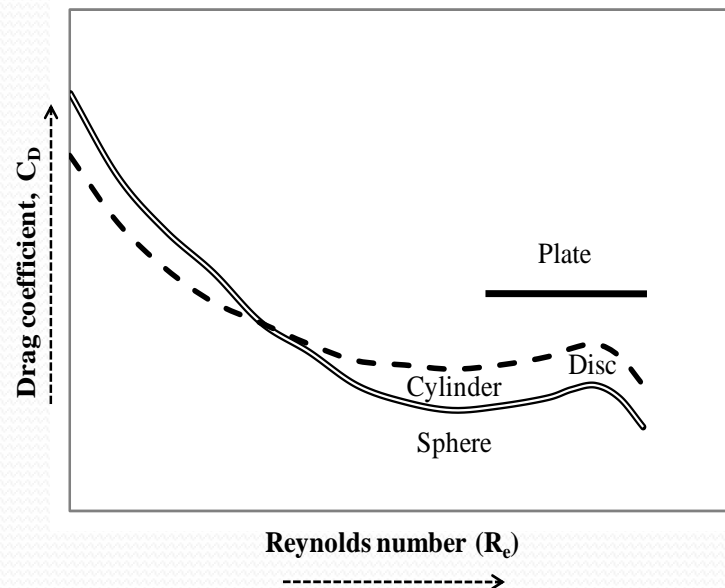
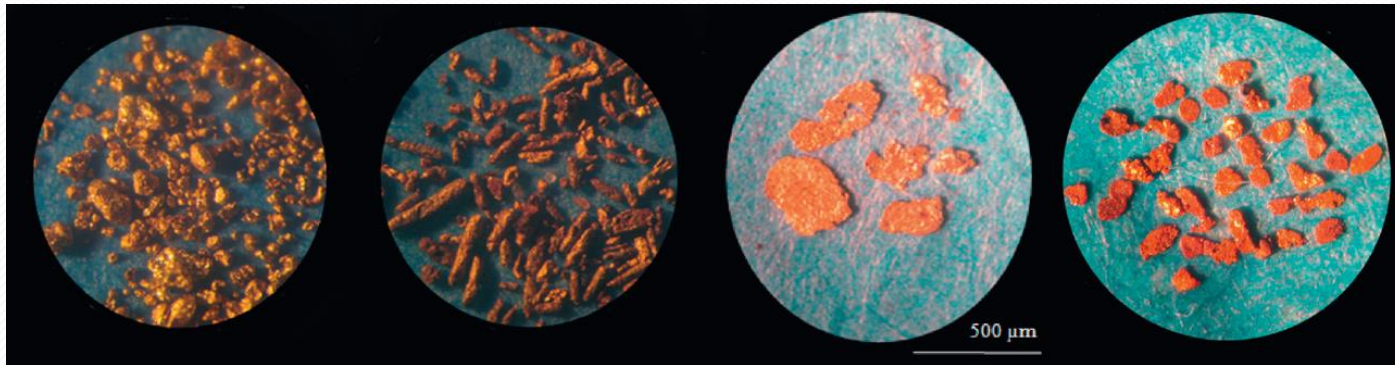


# Ball mills

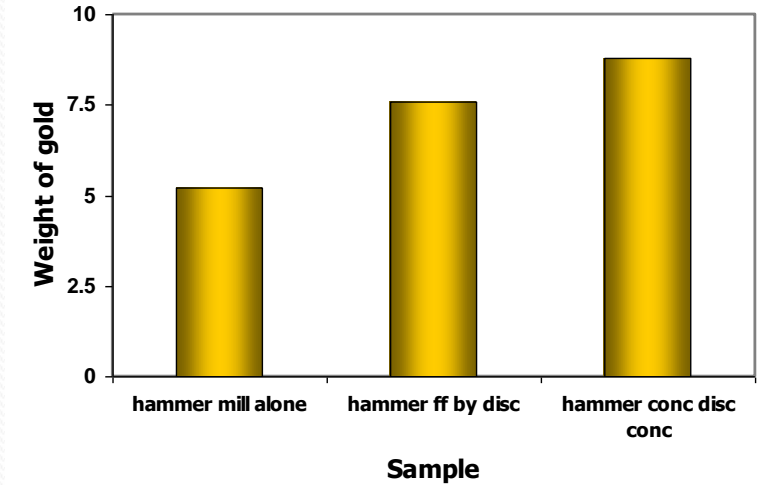
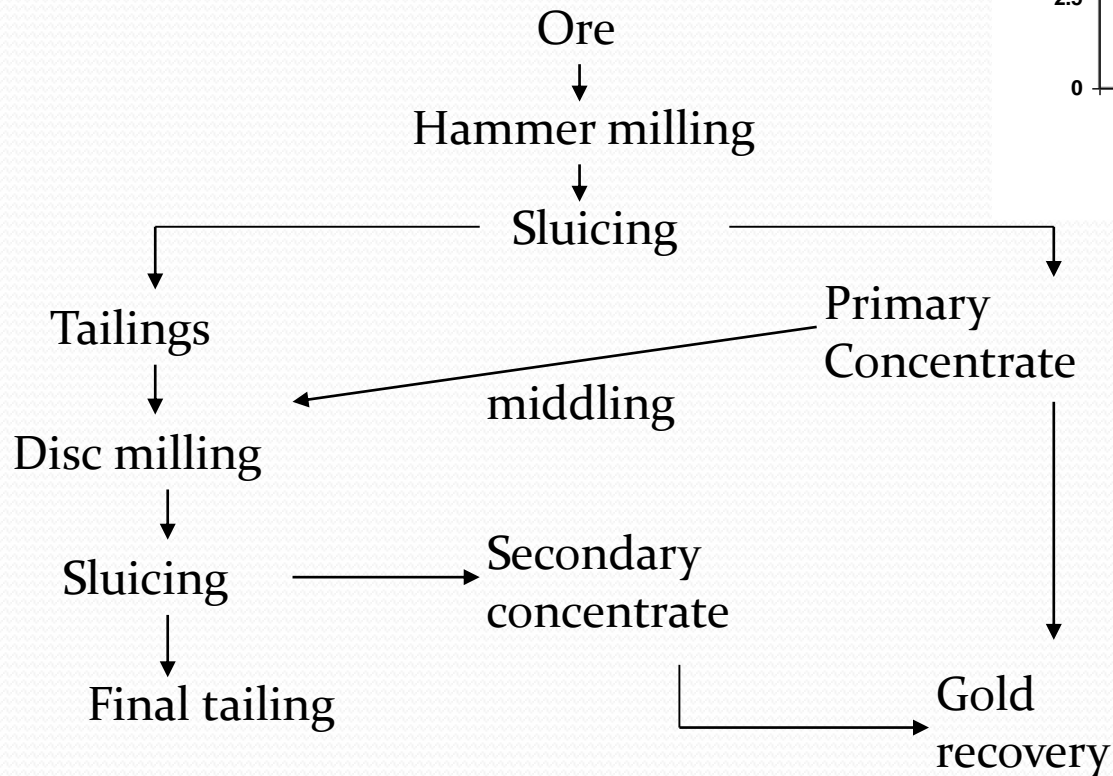


- Particle size can be generally 80% passing 106 microns
- The main challenge is how ASM handles the mill discharge – screening or cycloning?

# Particle shapes after size reduction



# Improved flow sheet for ASM





# Gravity concentration



# Winnowing



# Trommel for larger operations



# Sluicing





# Gold Particles trapped on a sluice



# When do we use each of these mats?





# Panning (2<sup>o</sup> concentration process)



# Gold concentrate in pans





# Amalgamation



# Amalgam

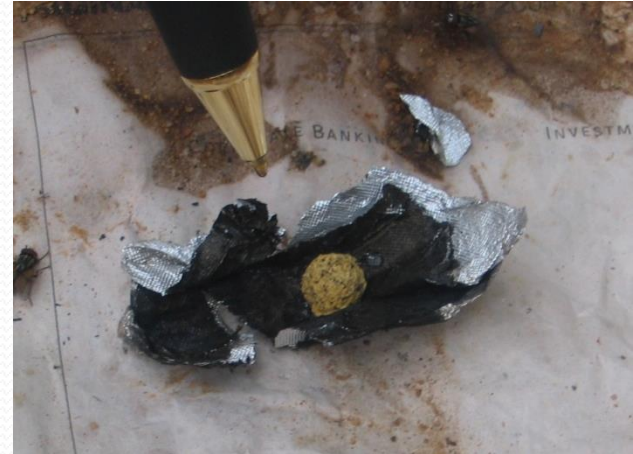


# Safer alternative





# Burning of amalgam



# Open hearth for smelting gold





# **Mercury use exposure and control**

# Mercury Loss in ASM activities

- Spillage during amalgamation
- Poor amalgam distillation
- Disposal of amalgamation tailings
- Further processing of sponge gold

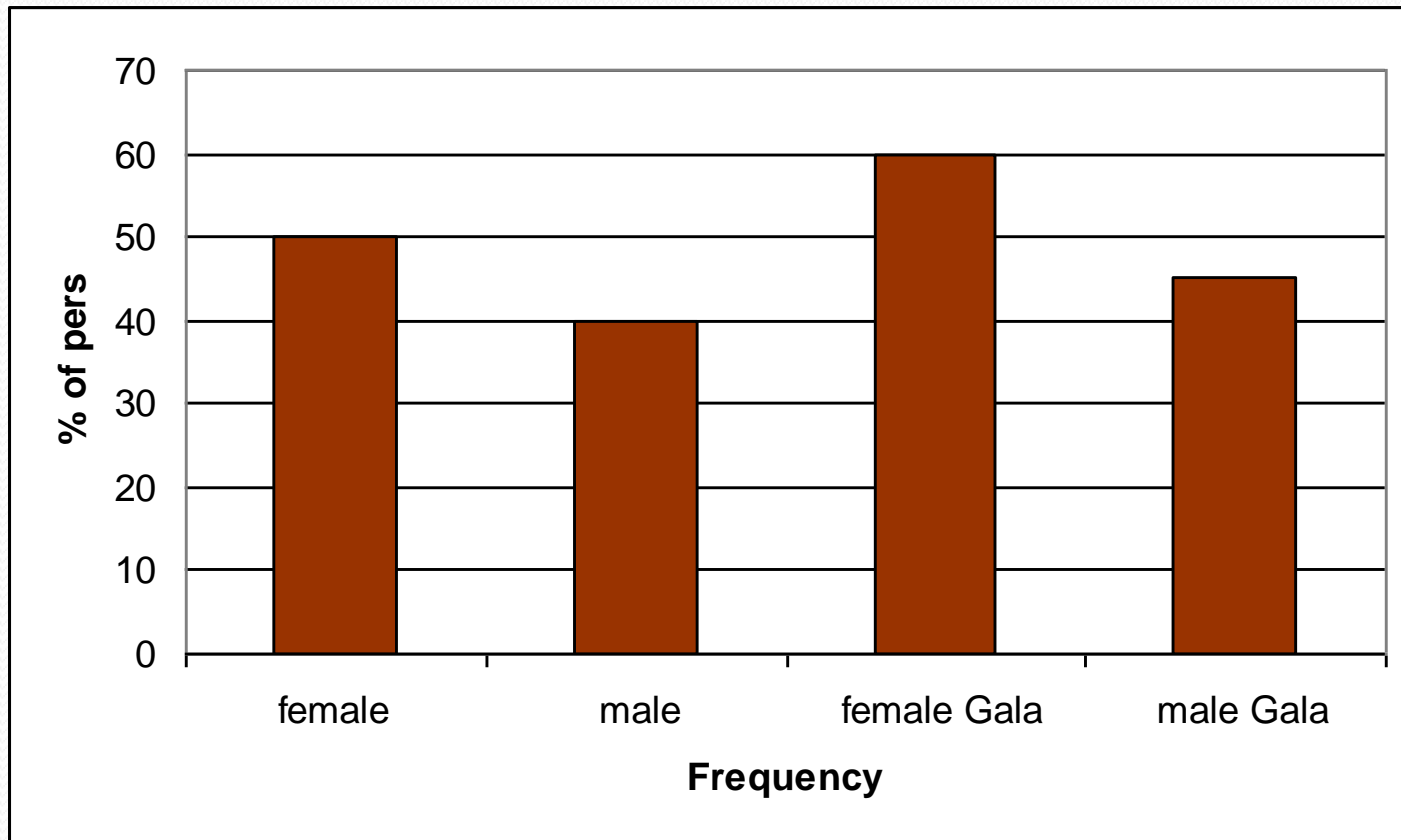


# Effect of mercury on people in one 'galamsey' village (Dumasi)

## Sample space

- 187 people (117 males, 70 females)
- 74 men galamseys
- 23 women galamseys
- 90 traders and farmers

# % of persons declaring health problems



# Health perception

- 90% - complained of metallic taste in the mouth and salivation problems
- 65% - complained of sleep disorders
- 20% - claimed to have tremors
- All these are symptoms of mercury intoxication

# Mercury in biological samples

Hg content in	Blood ( $\mu\text{g/l}$ )	Urine ( $\mu\text{g/l}$ )	Hair ( $\mu\text{g/g}$ )	Nails ( $\mu\text{g/g}$ )
Mean	24.4	23.9	3.85	3.99
Mode	18	3.6	2.6	2.1
Minimum	1	1.1	0.39	0.66
Maximum	96	252.9	44.6	55.7
Health Standard	25 (BAT)	50 (WHO)	10 (WHO)	10 (WHO)

# Control measures introduced

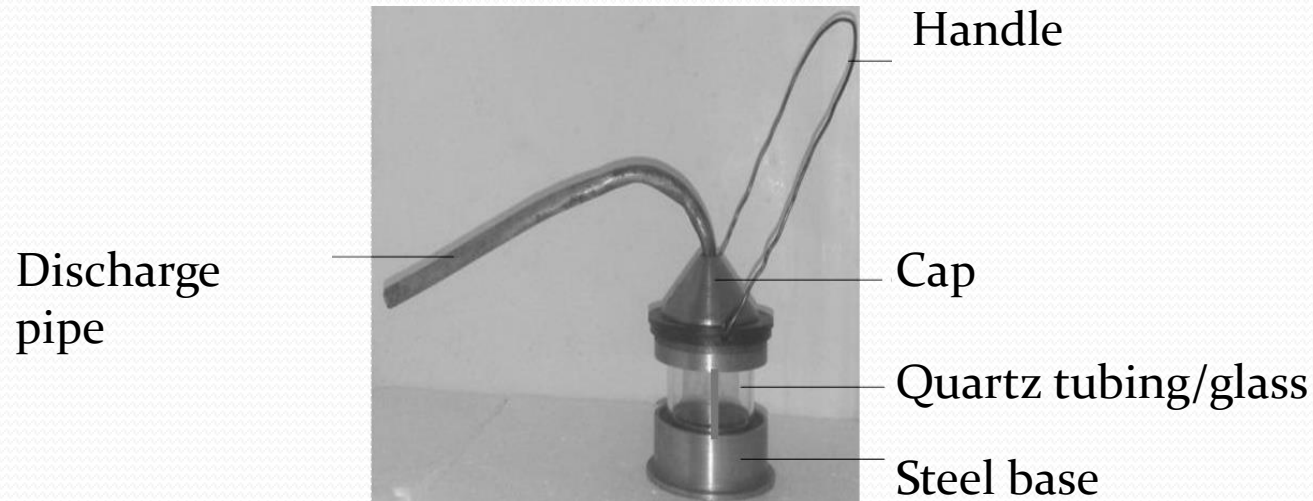
- Reduction in mercury use
  - Techniques that avoid mercury
- Reduction in mercury loss
  - Retorting
- **Ghana has already ratified the Minamata Convention**

# Two kinds of retorts made available





# Lantern retort

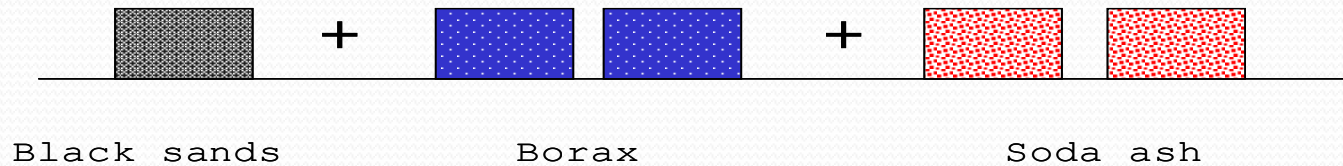


- Still on trial and 30 have been distributed
- Some miners are asking for bigger ones – such players should do for direct smelting
- Requests have come in and I am trying to link up with Kristo Asafo for commercial production

# Direct smelting

- Smelting is a high-temperature melting process used to recover metals from ores and concentrates
- Fluxes are added to the concentrate to assist melting and react with impurities so that the metal separates out
- The final products are pure metal and a glassy slag containing the unwanted components

# Charge (black sands and flux)





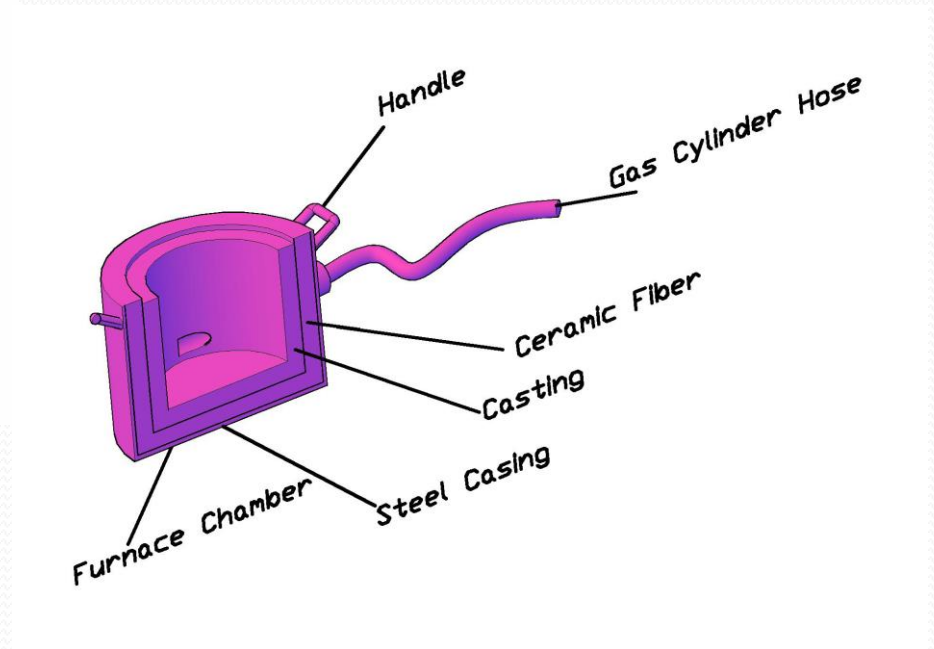
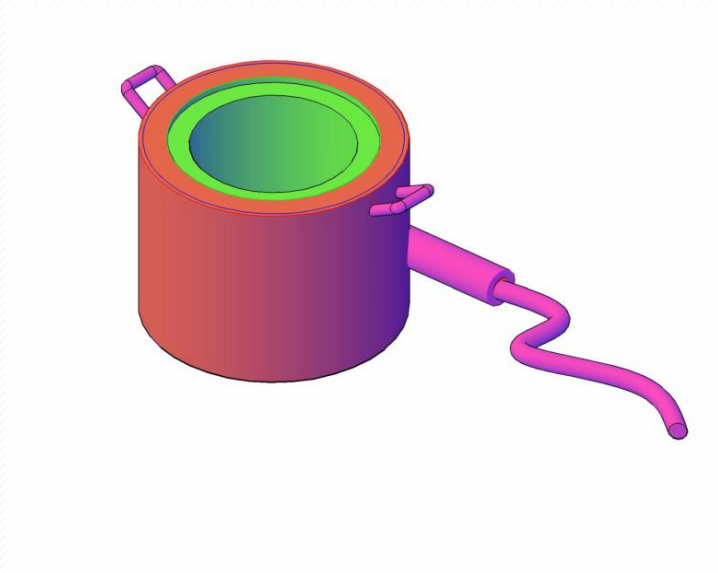
# Mixing charge and feeding crucible



# Direct smelting – Charcoal furnace



# Direct smelting – Gas furnace





# Gas furnace in action



# Pouring of molten material and separation of gold



# Challenges with direct smelting

- Sulphides in the concentrate
- Broken chips from crushing/grinding machines that appear in the concentrate



# Advantages of direct smelting

- Faster
- Transparent
- Recovers fine gold that is lost during removal of excess mercury through handkerchiefs
- Un-liberated gold in the final concentrate
- It modifies the supply chain



# Tailings Management

# Some current tailings disposal practices in small scale mines

- Waste rocks/tailings are stockpiled
- Discharges from sluice boards and trommels are channeled into rivers and streams
- Mercury polluted effluents also discharged into nearby rivers and streams
- Part of the waste rocks/tailings used to reclaim some of the pits
- Waste rock scattered around the mining area
- Tailings are sold

# Problems caused by current tailings disposal practices

- High suspended solids in rivers and streams
- Low house-keeping records at small scale mining sites
- Low resource exploitation
- Disturbed landscapes
- Abandoned pits

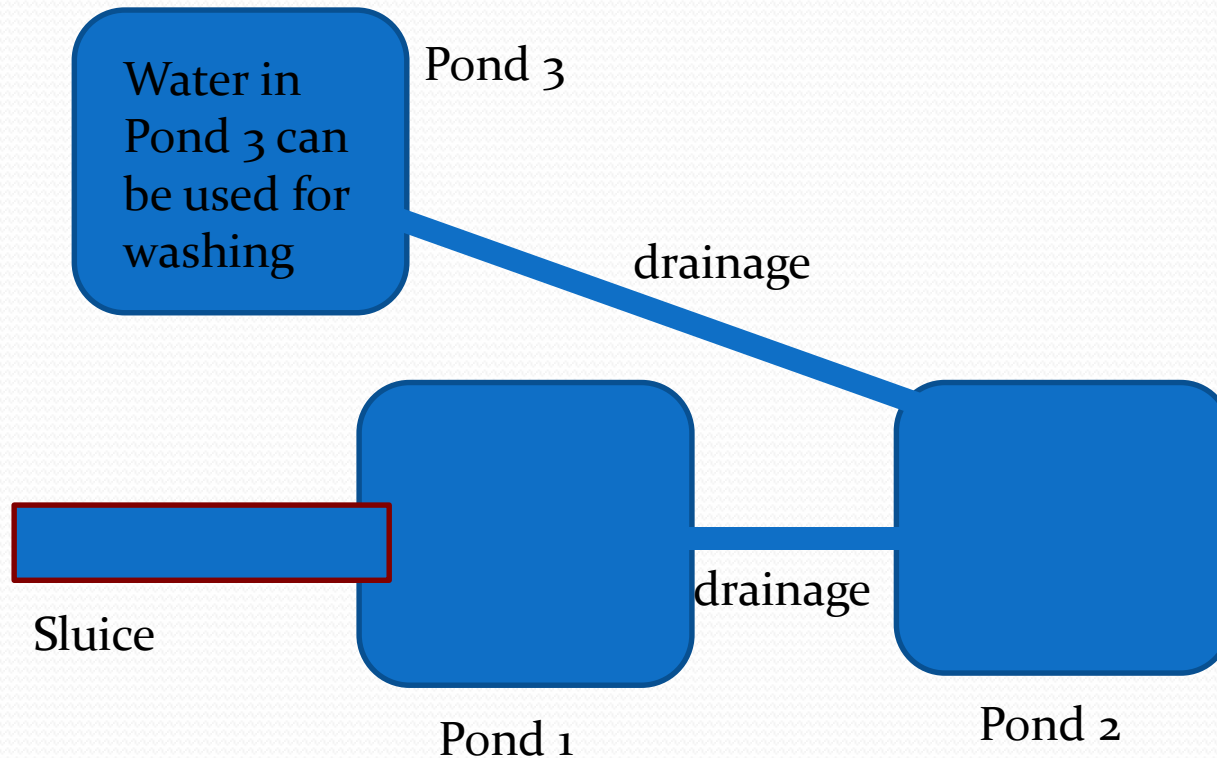


# Moving from waste disposal to waste management

- How do we handle boulders that will not be processed for gold?
- How do we handle barren pebbles?
- What about the sluice or trommel discharge?
- Do we have to wash directly into river bodies?
- What are the best practices handling tailings?

# Water recycling

- 3-pond water purification system



# Moving forward

- Education
  - General and specific
    - Blasting
    - Recovery optimisation
    - Mercury usage
    - Tailings/water management)
- Enforcement

Thank you for your  
attention

