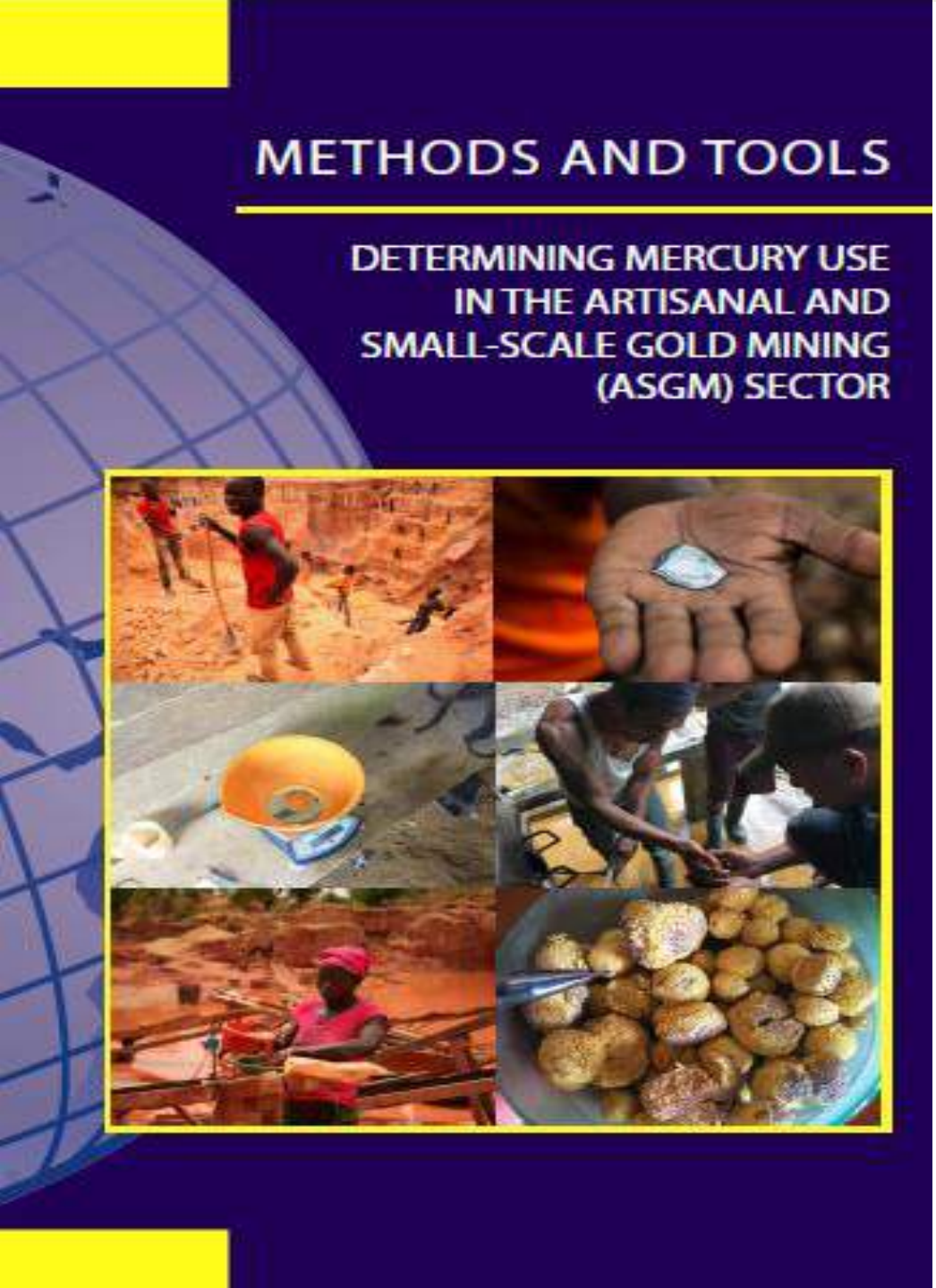

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gef

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Lecture 1

Introduction to ASGM

ARTISANAL GOLD COUNCIL

Introduction to ASGM

Overview

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- What is ASGM?
- Geology and Gold
- Mineral Extraction
- Mineral Processing
- Mercury Use in ASGM
- Gold Supply Chains
- Formality and Governance
- Spatial Distribution & Seasonality
- Health and Environment

What is ASGM?

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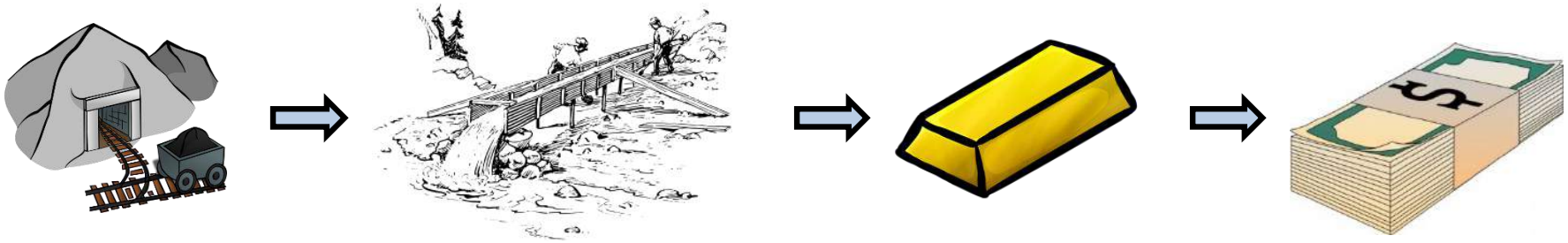
ASGM (Artisanal and Small Scale Gold Mining):
Gold mining done by individual miners, communities, or small enterprises with limited capital investment and production. ASGM uses largely manual and semi-mechanised techniques.



Where does gold come from?

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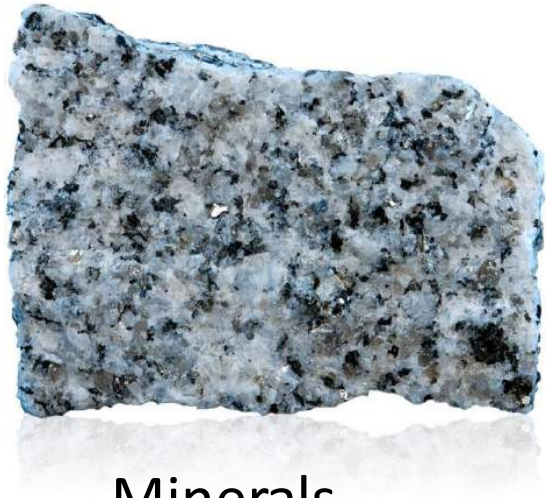
Rocks



Minerals

Gold

Where does gold come from?

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gold vein

disseminated gold

gold in surface sediments

Rock containing gold that is targeted by miners = **gold ore**.
To produce gold, the ore must be processed to remove the other minerals.

Ore Grade

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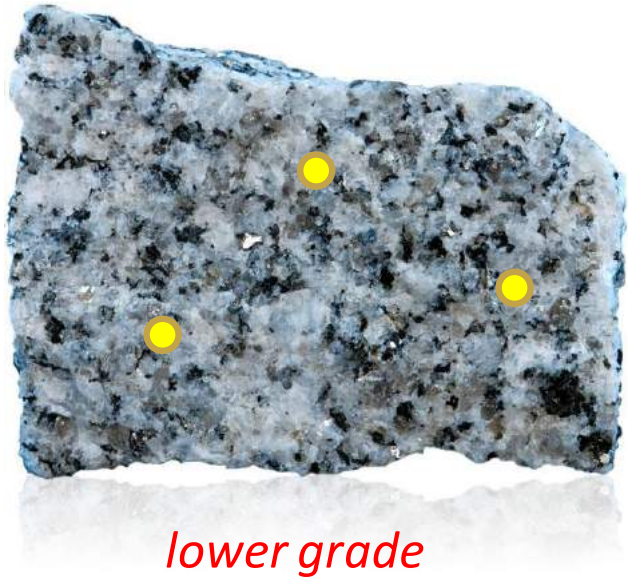
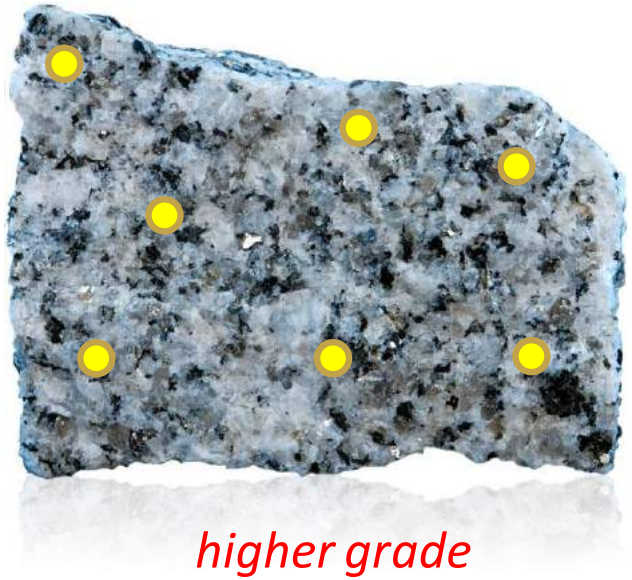
The amount of gold in the ore (expressed in g/T)



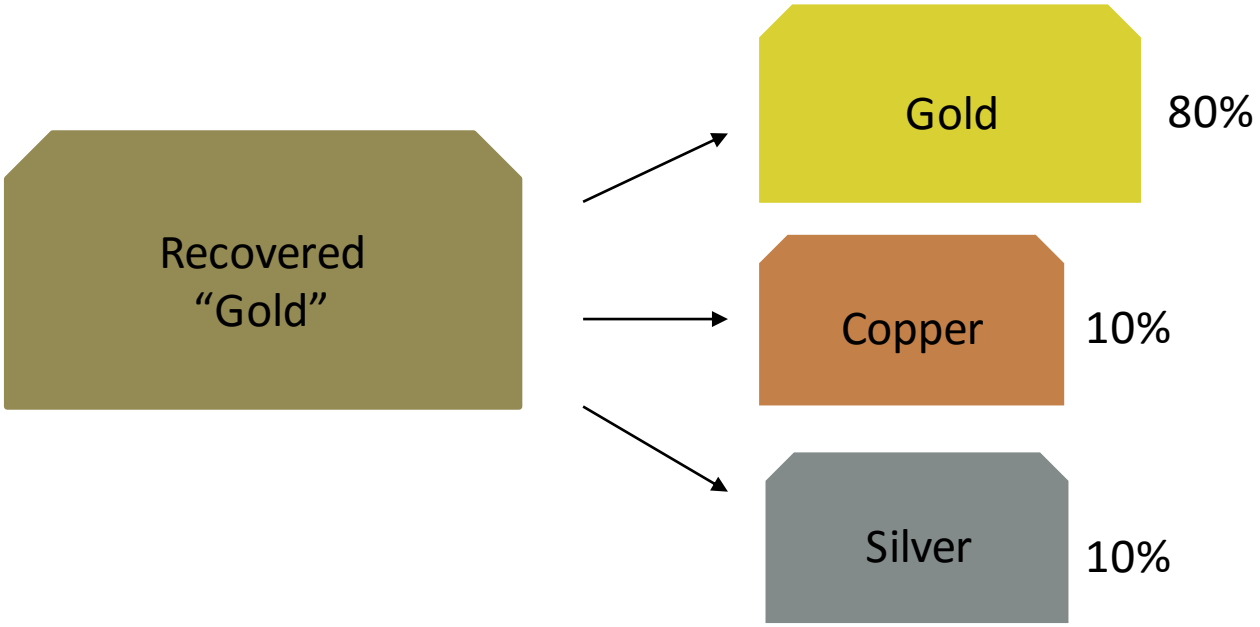
lower grade



higher grade

- Range from <1 to >100 g/T
- Can vary significantly between sites, and even within deposits

Gold Purity



- The "gold" recovered from ore is typically a mix of metals
- **Purity is the proportion of this mix that is gold**
- Expressed in % purity (0 to 100%) or in karats (0 to 24K)
- Can vary significantly between sites and less so within a site

Gold Purity

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Correcting from impure to pure (24K) gold:

Weight of gold x (purity of gold/24K)

e.g., You have 100 g of 18K gold. How many g of pure gold?

100 g x **18K**/24K = **75 g**

100 g of 18K gold is 75 g of 24K gold

Mineral Deposits

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Hard Rock Deposits

(Primary Deposits)

Soft Rock Deposits

(Alluvial Deposits)

Extraction – Hard Rock

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Open Pit

Mine Shaft

Extraction – Hard Rock

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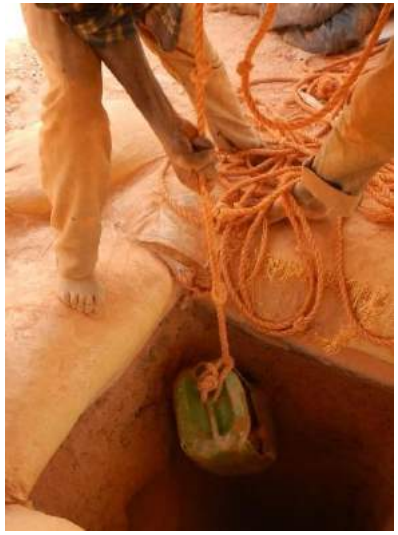

Extraction – Soft Rock

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Extraction – Soft Rock

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Processing

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Crush → Mill → Concentrate → Amalgamate with Mercury → Burn Amalgam → Smelt/ Refine










Processing

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Crushing

Reduces size of ore rocks

Manual Hammering

Jaw Crusher

Hammer Crusher

Processing

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Milling

Reduces grain size further. Liberates gold from other minerals in the ore.

***Good Liberation**: grain size of the ore is fine enough to separate gold particles from other minerals.*

** Proper grain size varies with ore.*

E ill

Processing

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Grain size Control

Improves recovery by ensuring the proper grain size for the best liberation of gold has been achieved.

Processing

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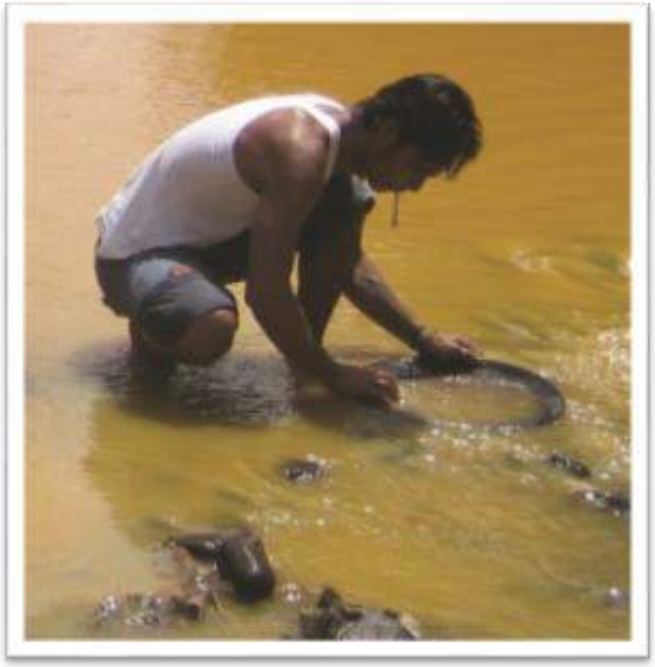
Gravimetric Concentration

Removes non-gold minerals from the milled material, reducing the total volume of the milled ore and concentrating the gold particles within it.



Pan

Sluice

Shaking Table

Processing

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Smelting and Refining

Melts concentrated ore or gold into a solid gold piece. The gold can be further refined (usually by a gold shop or refinery) to pure 24K gold.

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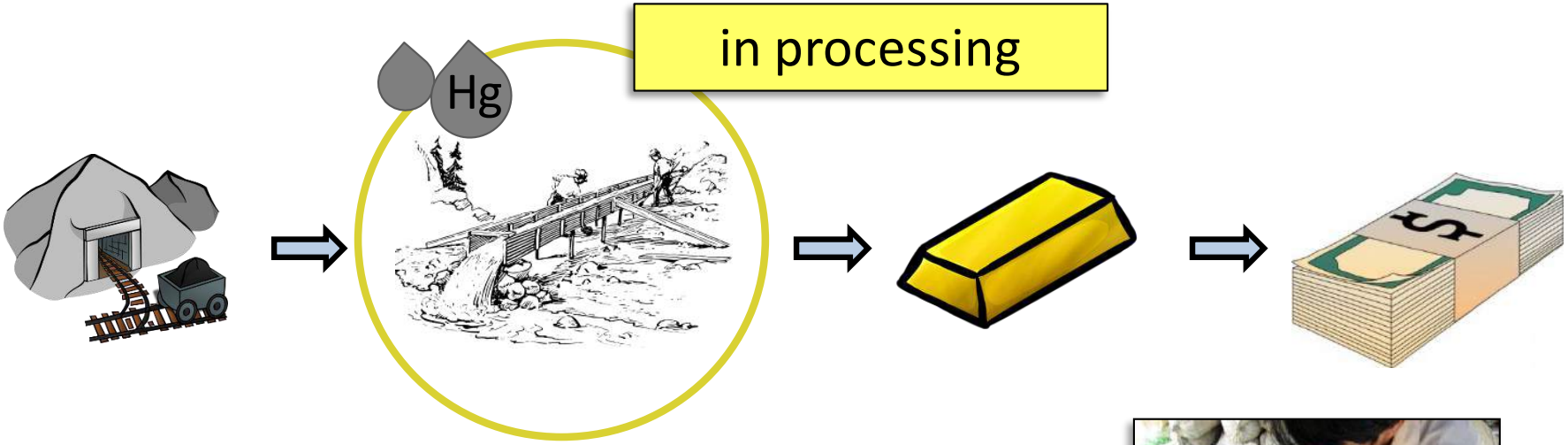
Where is mercury used in ASGM?



- Mercury is added to ore to extract gold
- Mercury binds easily with gold, making a heavy mercury-gold amalgam that is easier to separate from the rest of the ore

“AMALGAMATION”

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Mercury is added to ore to extract gold

Mercury Amalgamation

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Mix mercury with ore → Recover amalgam (squeeze) → Vaporize mercury → Sponge gold

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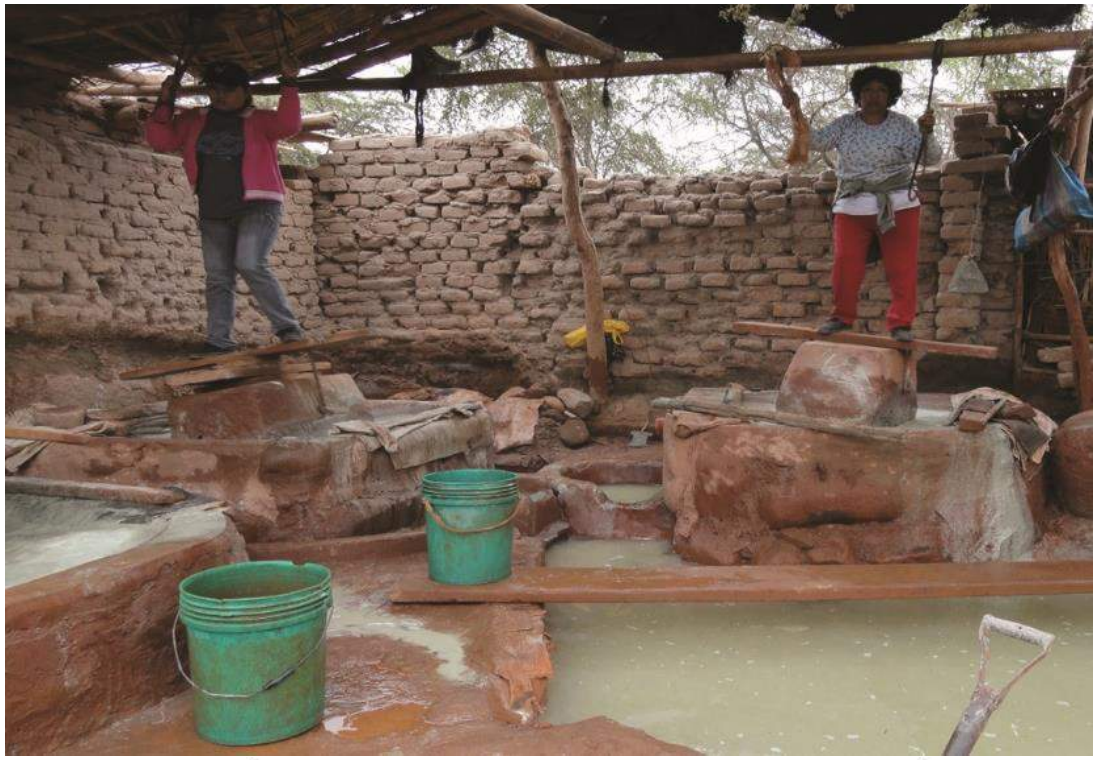
Whole Ore Amalgamation



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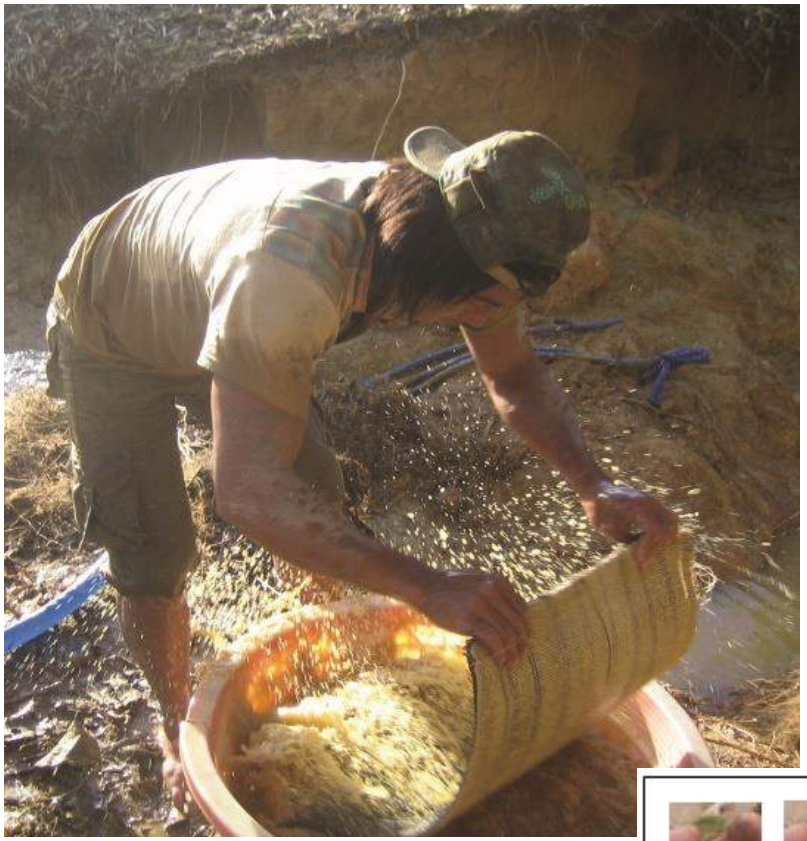
Concentrate Amalgamation



Mercury Use

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"Mercury use" in ASGM in a Minamata context means:

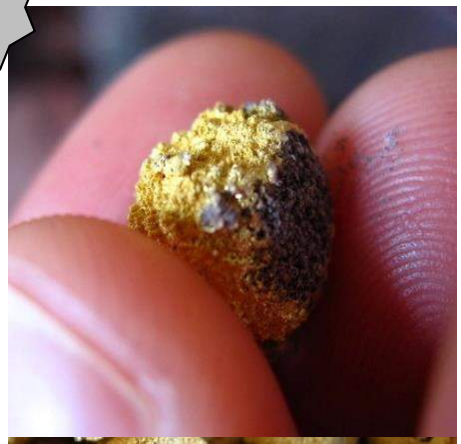
The net loss of mercury during ore processing

or in other words, the amount of mercury that is lost to the environment during ore processing operations.

Where is mercury lost to the environment?

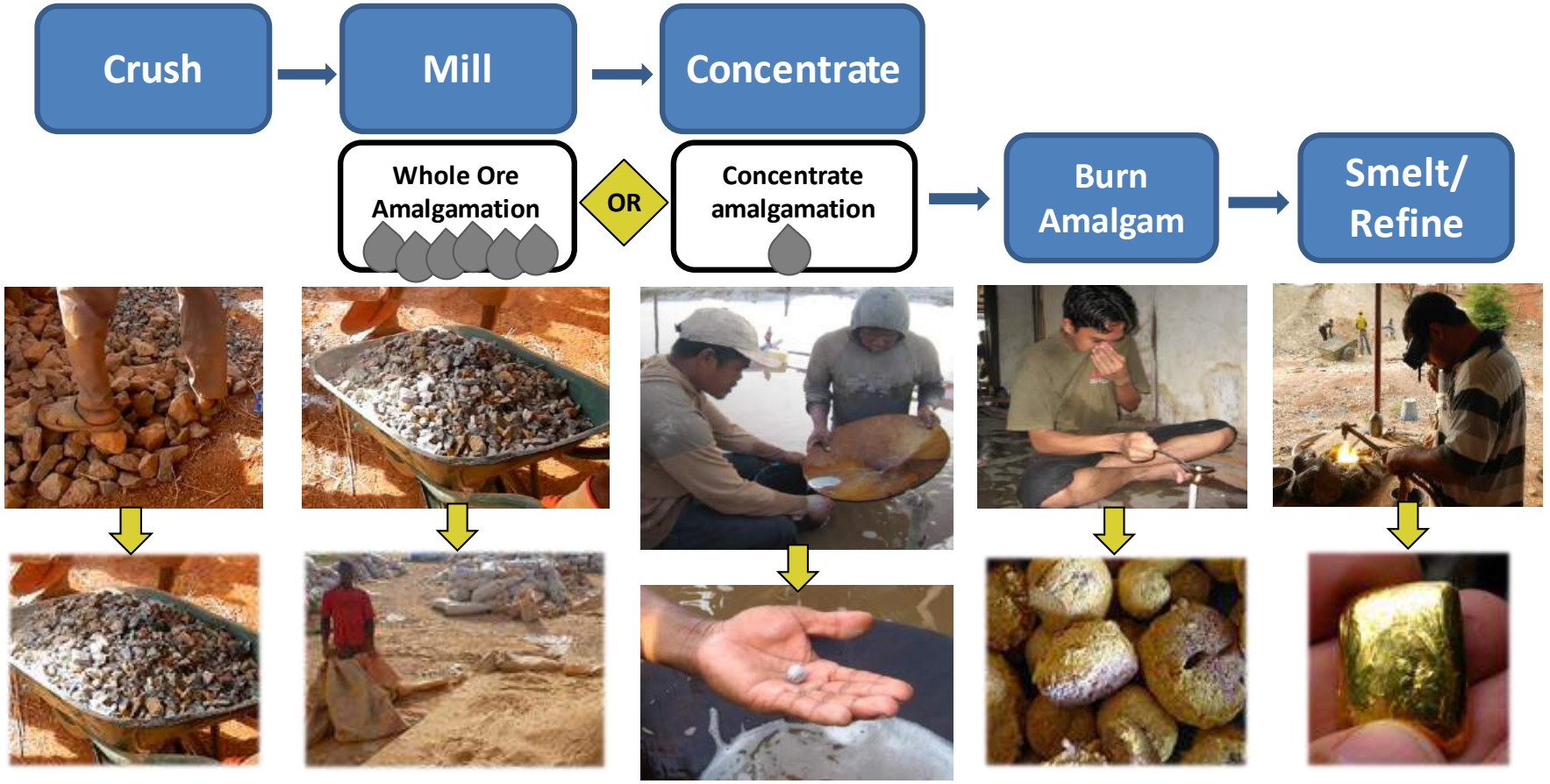
Mercury Use (loss to environment)

Mix Mercury With ore → Recover Amalgam → Vaporize Mercury → Sponge Gold

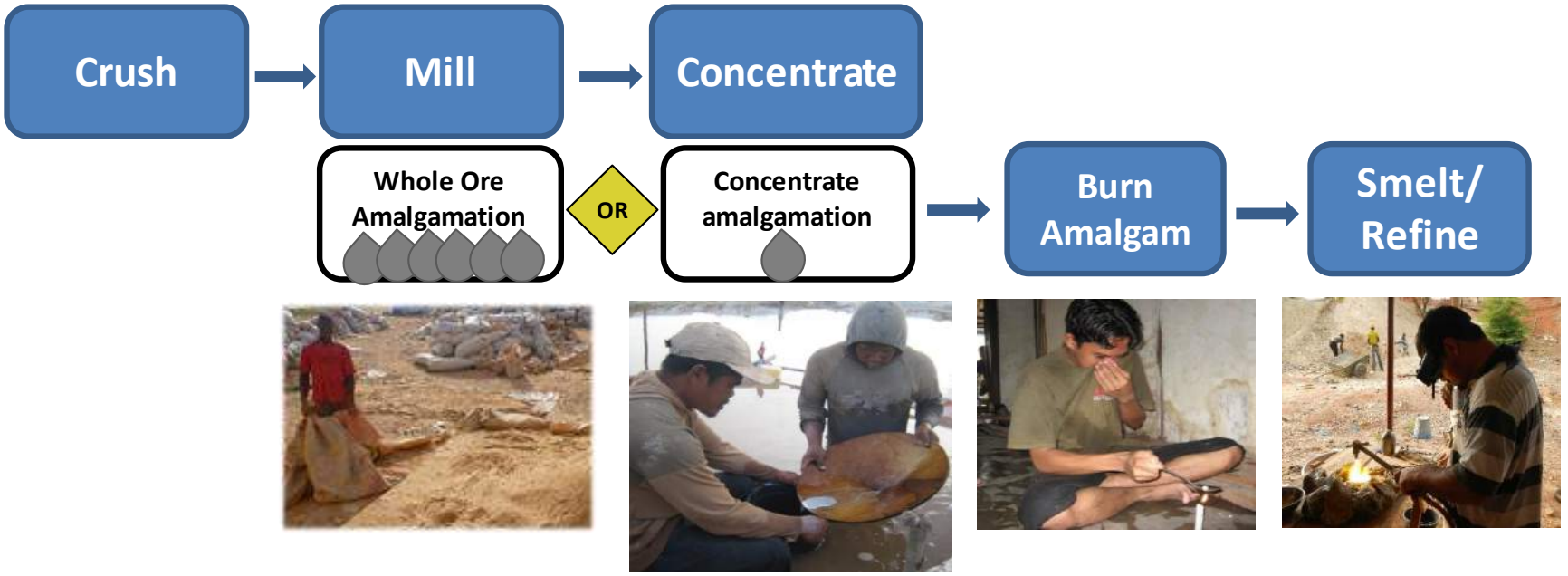


Hg

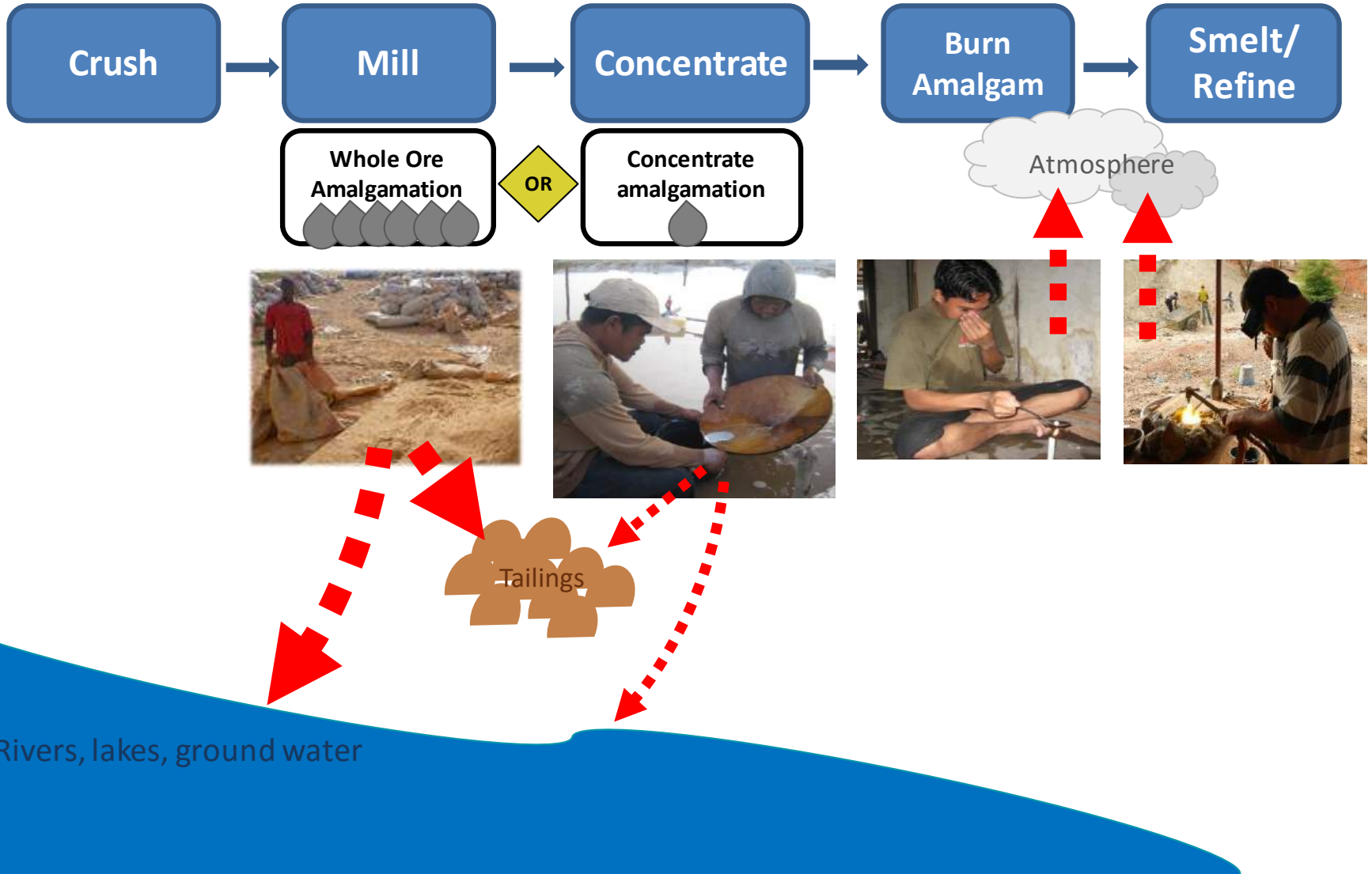
Mercury Use (loss to environment)



Mercury Use (loss to environment)



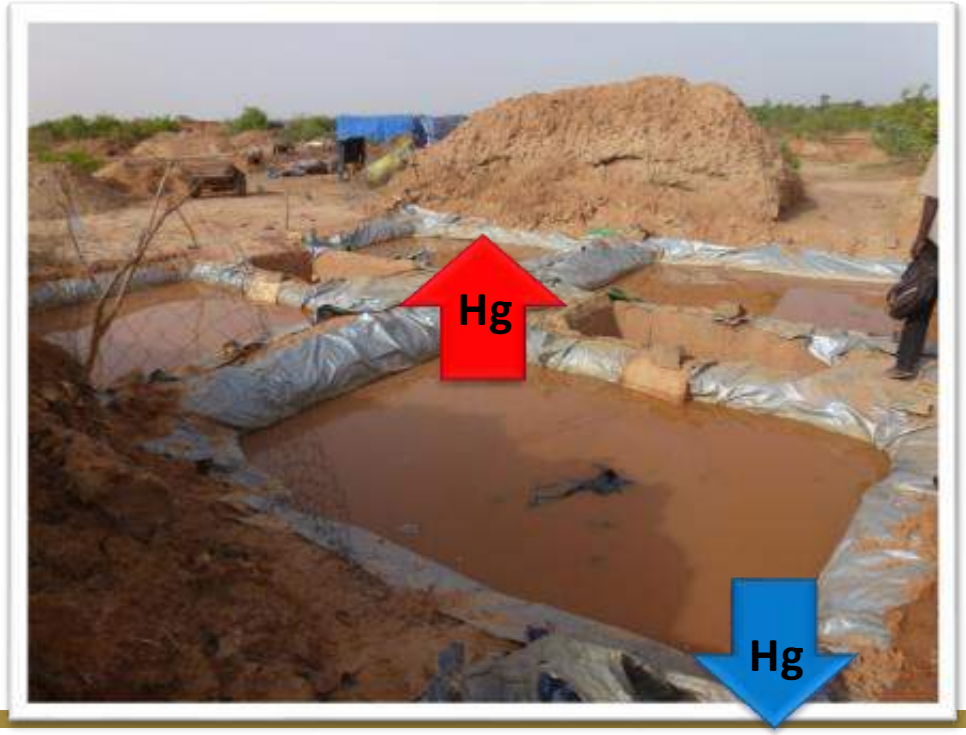
Mercury Use (loss to environment)



Processing

Processing Tailings (waste)

If waste rock contains enough gold, it is sometimes reprocessed by leeching with cyanide. (worst practice banned by Minamata)



A typical workflow

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A typical workflow

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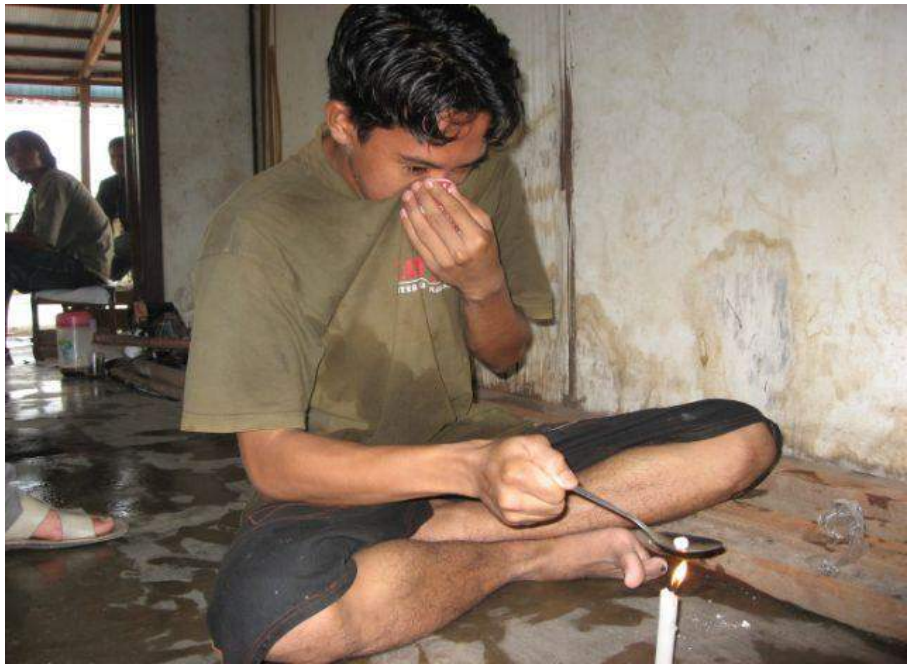

A typical workflow

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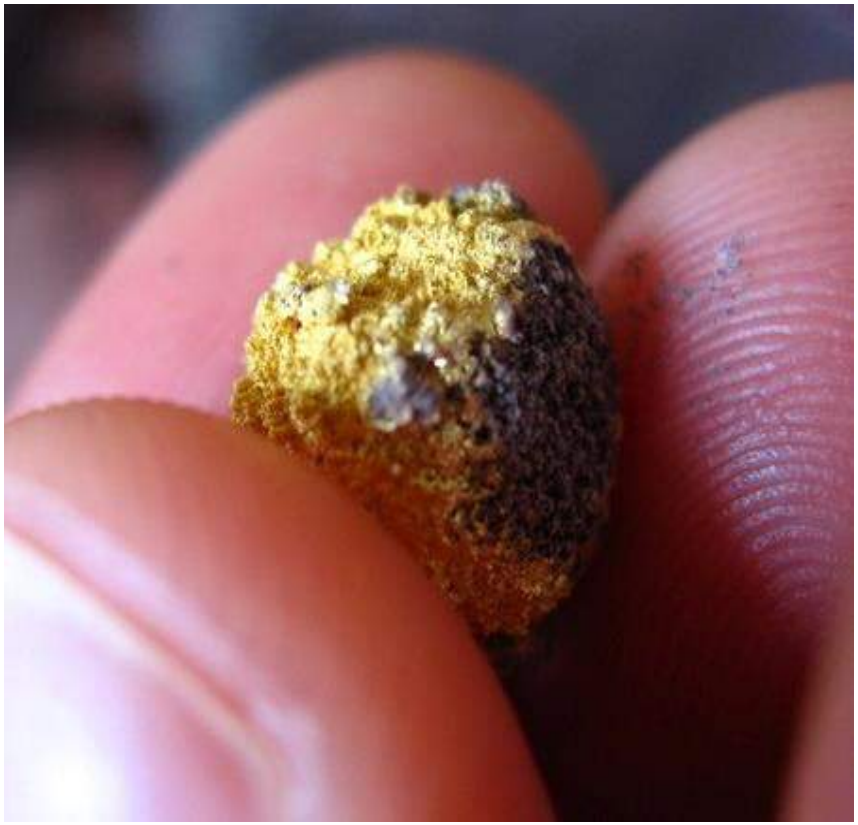

A typical workflow

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A typical workflow

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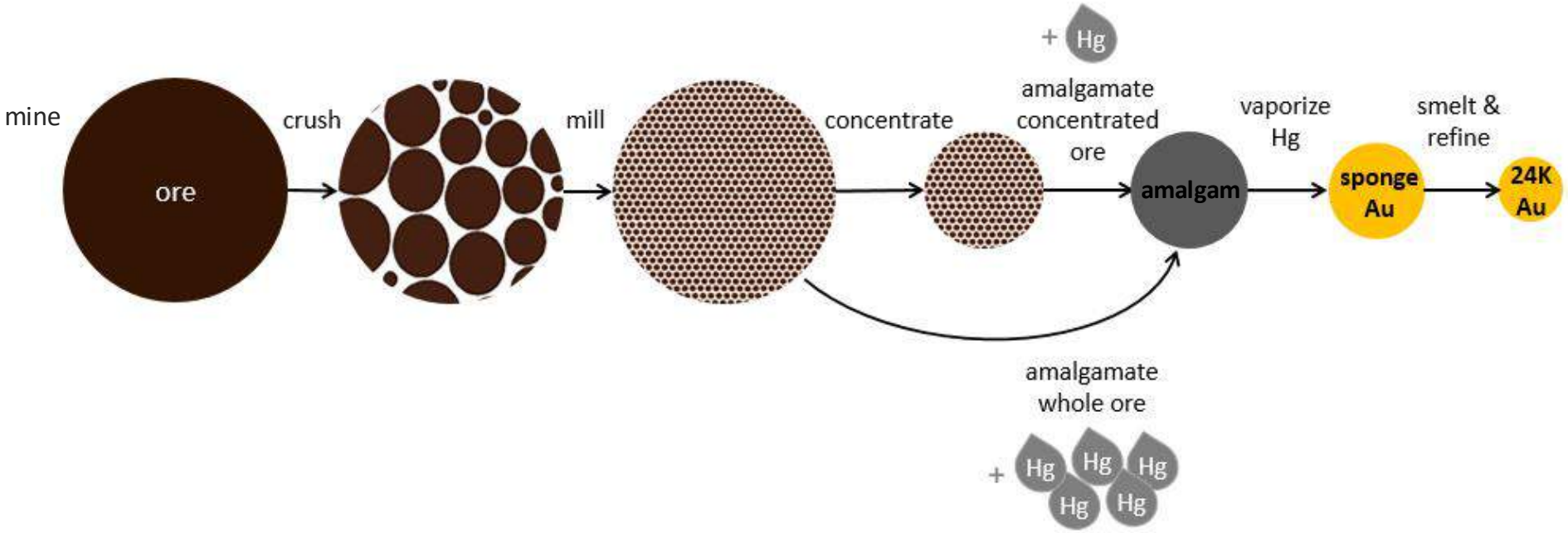

A typical workflow

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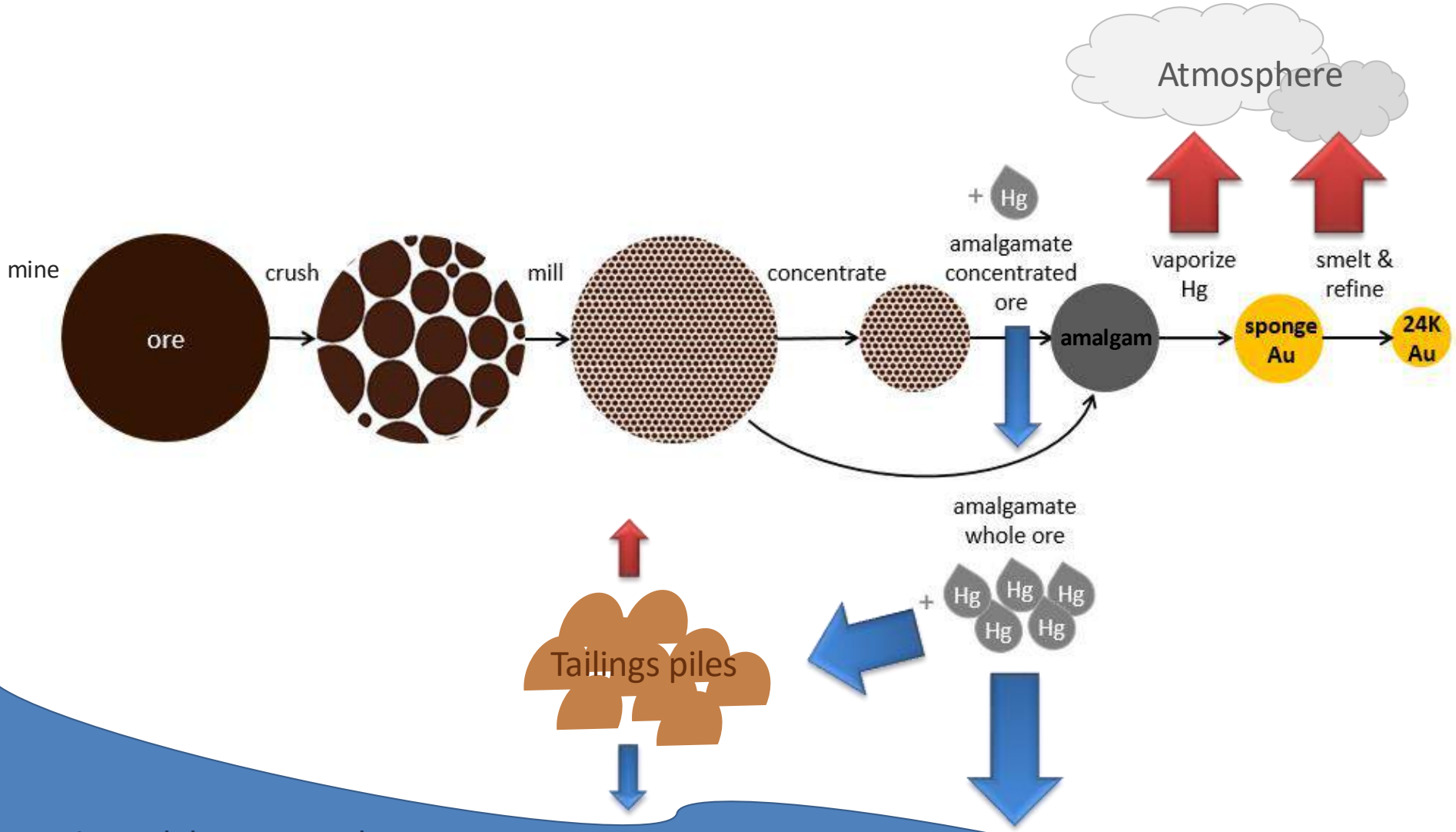

Organization of ASGM

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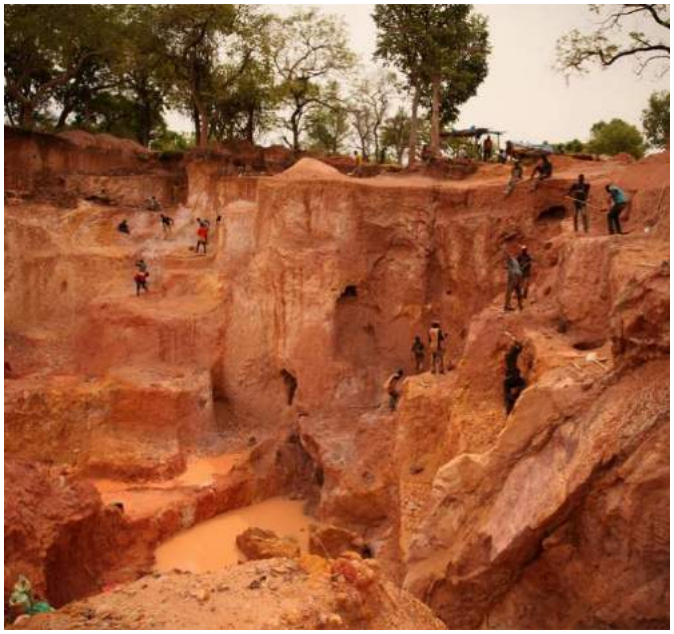
Organization of miners

Individuals

Small Businesses



Cooperatives

Workforce

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Primary ASGM workforce - number of workers directly employed in the gold production system (receive direct payment from the gold proceeds).

- miners (extraction workers, processing workers, mining/processing foremen), business owners, mining coordinators, cooperative leaders

Secondary ASGM workforce - number of people indirectly financially dependent on the ASGM sector (provide goods and services to the sector).

- agricultural producers, merchants, traders, service providers

Organization of ASGM

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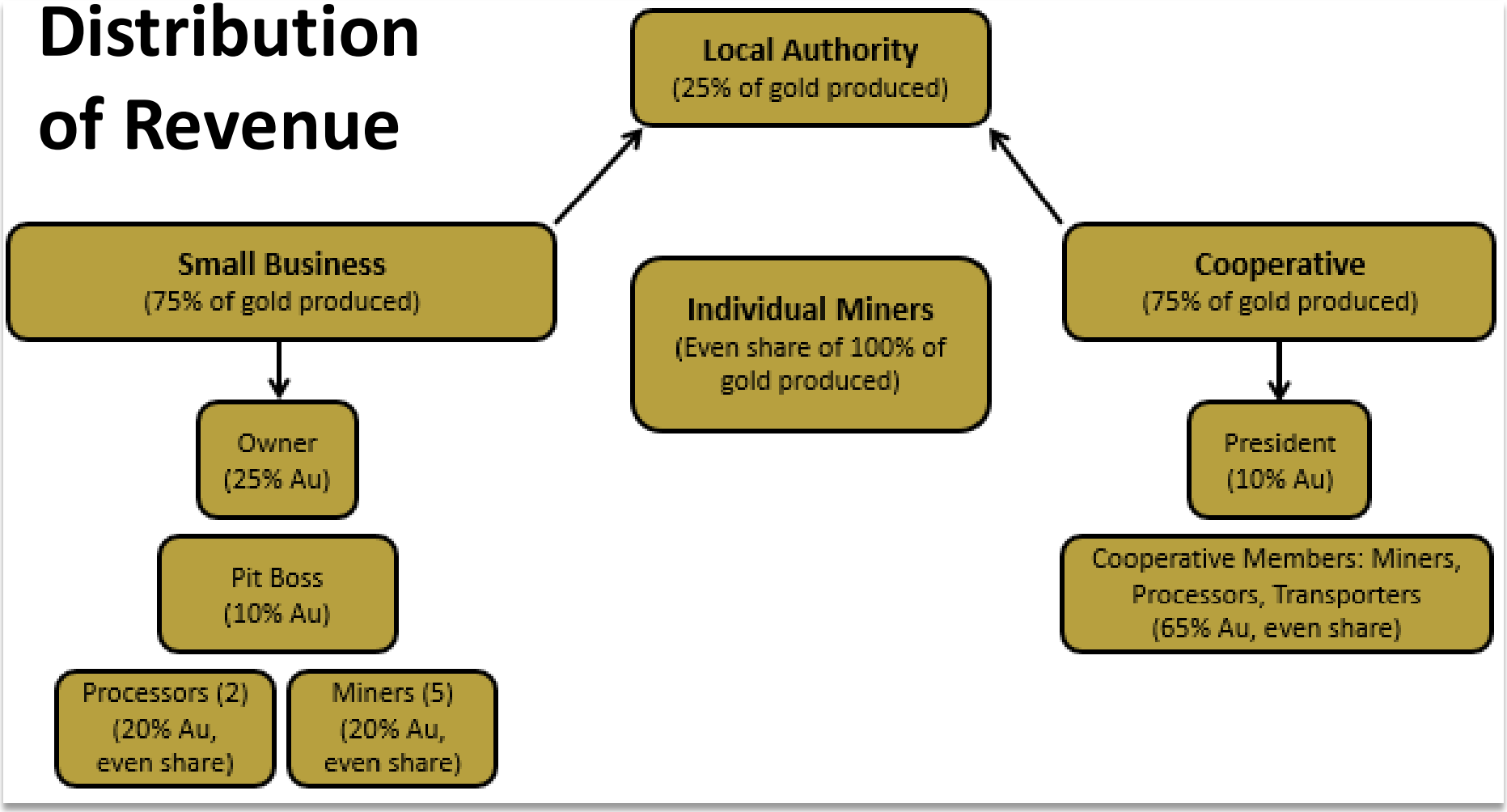
Distribution of Revenue



Organization of ASGM

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Formality / Governance

- Few ASGM operations adhere to national legal frameworks
- Often local governance (Community, Municipality, Local police)
- Understanding the governance structure can provide useful information for inventory work:

  - Understand key stakeholders
  - Determine who to interview
  - Provide insight into local operations

Gold Supply Chain

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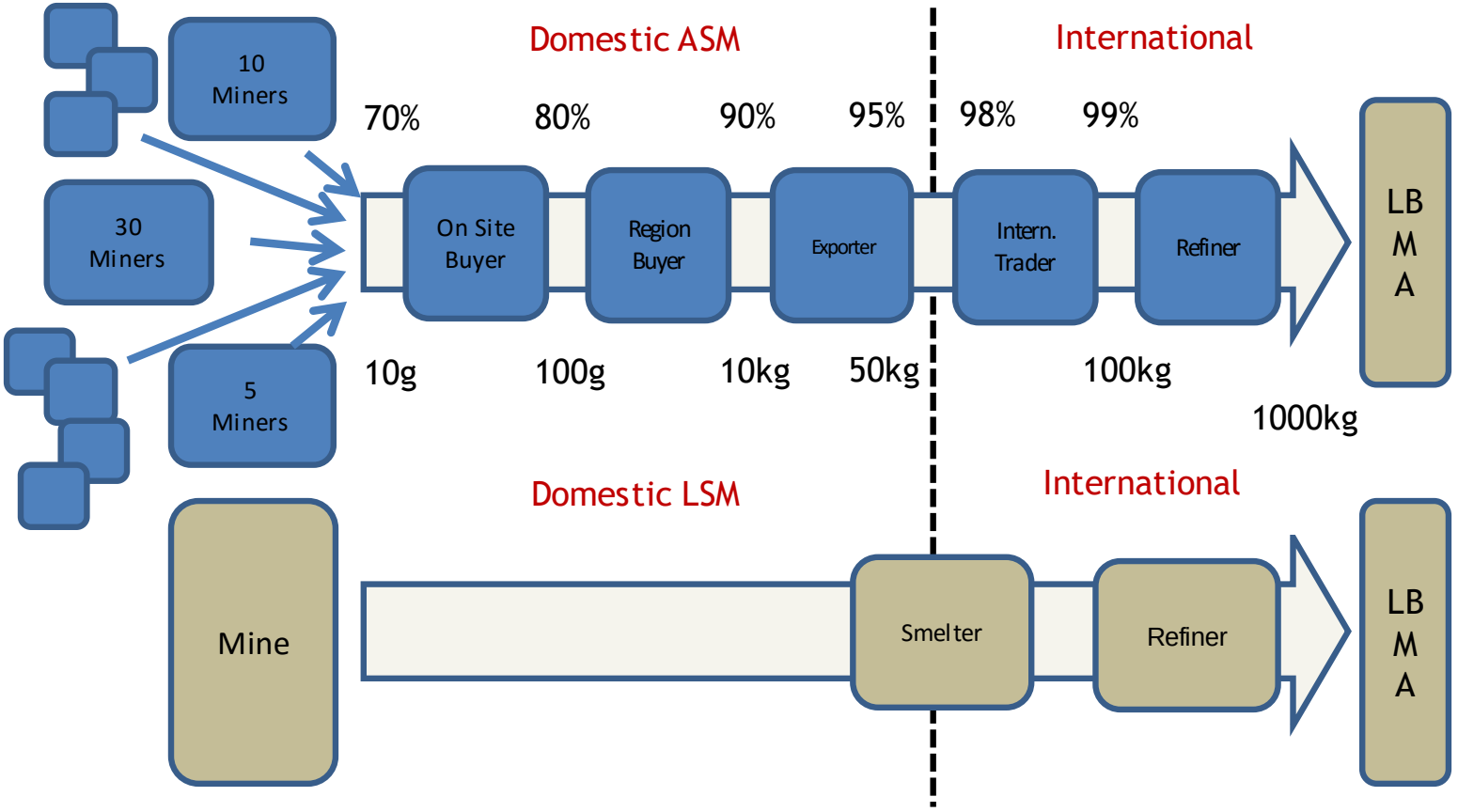

Spatial Distribution

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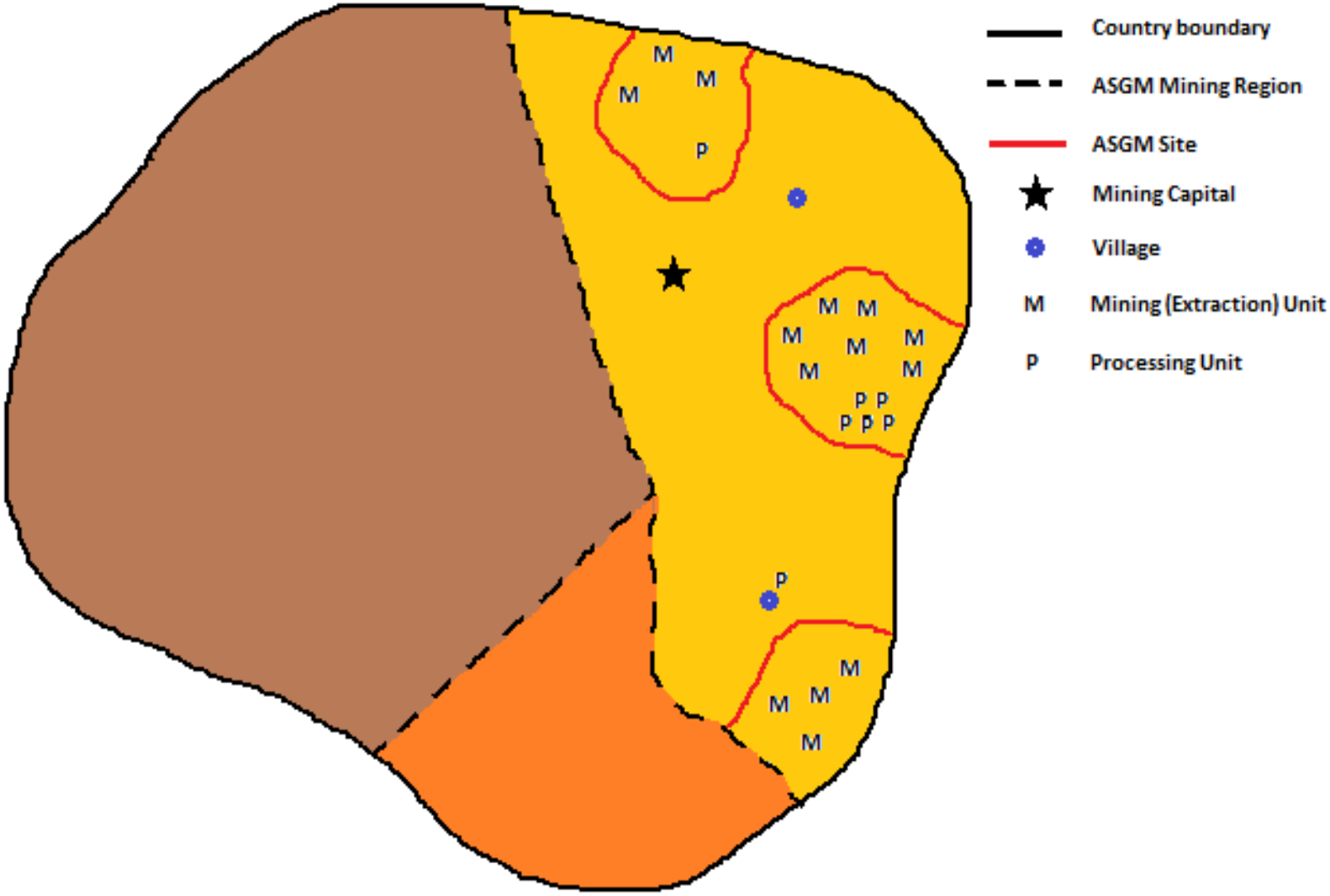

Seasonality

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- ASGM activity can vary greatly throughout the year, especially in regions with a heavy rainy season and seasonal flooding. During these times of the year, productivity and workforce, and thus mercury use in processing may be drastically reduced.

Relevance: Annual mercury use and gold production are often calculated by interviewing about daily productivity. It is important for a researcher to ask clear questions about the seasonality of ASGM in the region so that productivity is not over or underestimated. For example, on Site A, a baseline team finds that 1 kg of Hg is used per day on the site. Miner interviews indicate they work 5 days per week and have 10 holidays per year (250 days of work per year). This would lead the officer to believe: **1 kg Hg/d x 250 d/y = 250 kg Hg/y**.

However, further questioning reveals that all extraction work stops for three months (~60 working days) of the year due to flooding. There are 190 active mining days and the annual mercury use estimate for the site is **1 kg Hg/d x 190 d/y = 190 kg Hg/y.**

Environmental Impact

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Tailings (waste) release

To water:

- increased turbidity
- increased erosion
- circulation changes
- coastline alteration
- loss of habitat

To land:

- Loss of habitat
- Loss of mining opportunity

Health Impact

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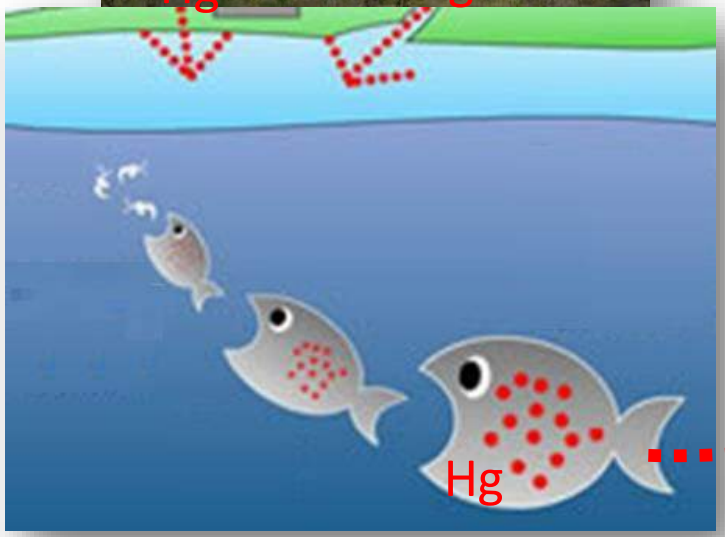
Mercury is a **neurotoxin** – detrimental effects on the nervous system

– Skin contact / absorption

– inhalation

Health



– ingestion

Summary

- 3 key components of ASGM – each offering important information that can be used for ASGM inventory
    - Extraction
    - Processing
    - Markets
- Must understand each facet of ASGM - each is a source of valuable information
- Significant variation in practices between sites, regions and countries -- approaches will be different in every country and will be tailored to each region within.
- To understand ASGM must embrace its variability

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Thank you very much!

Questions?