



ICMGP 2024
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How Projects on Mercury-Free for AGM Could be More Effective

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Professor Emeritus

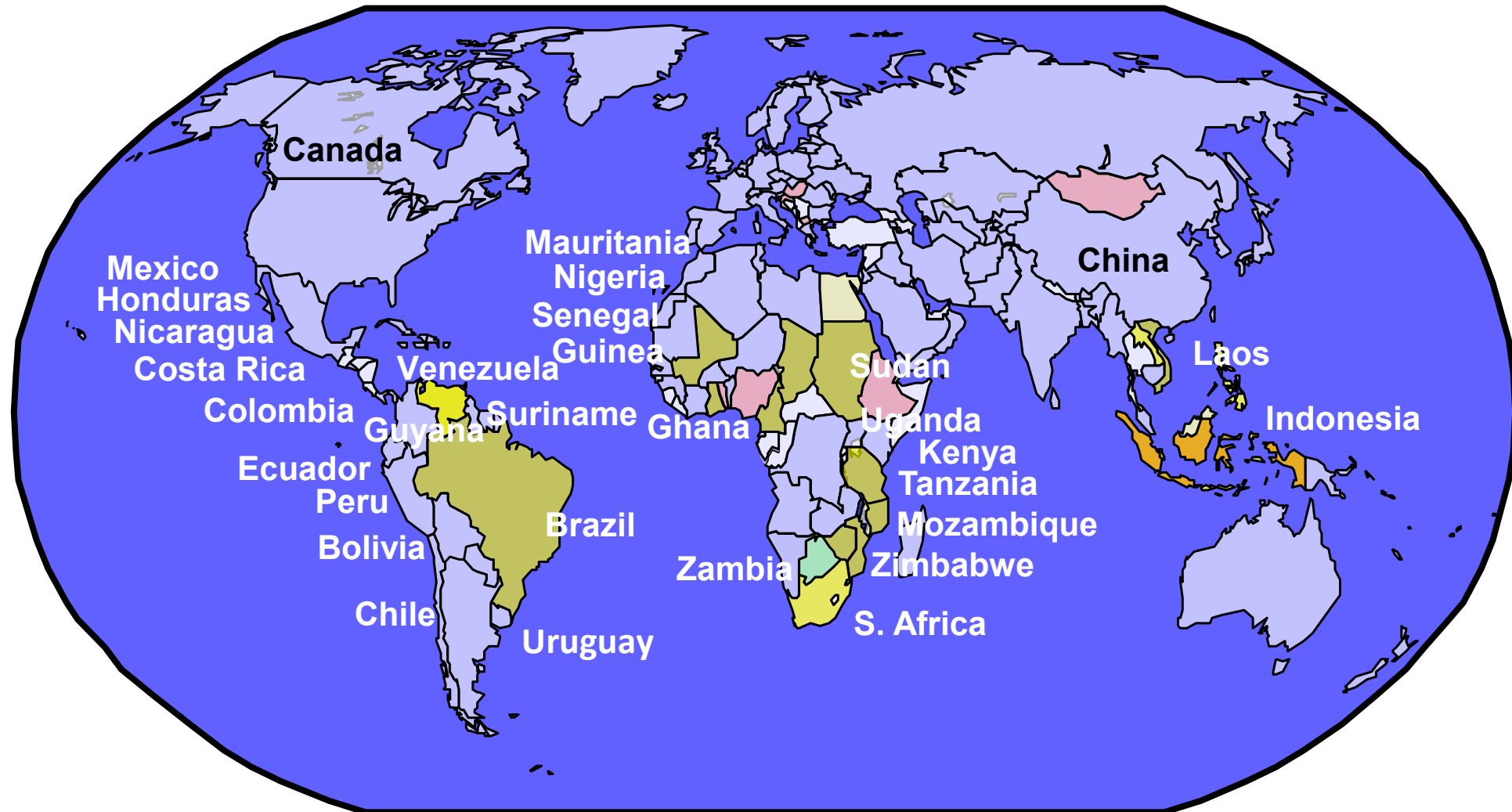


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WWW.MERCURYCAPETOWN.COM

Projects on Artisanal Mining where Marcello Veiga Participated since 1980

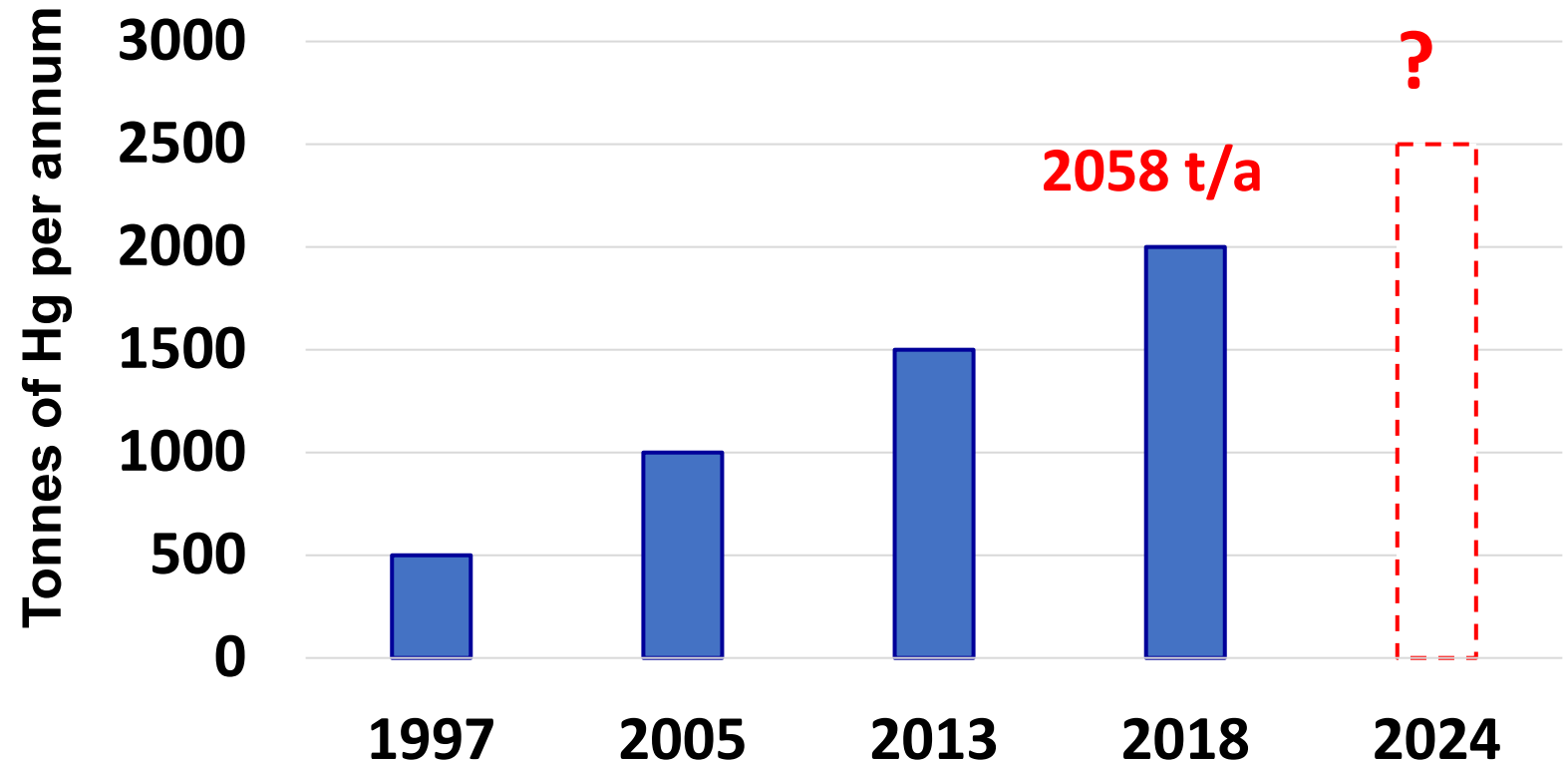


Solutions for Artisanal Mining

- Many solutions were tried to solve the Hg problem in artisanal gold mining:
 - Environmental approach
 - Health approach
 - **Technological approach** ← **This Talk**
 - Social approach
 - Fair Trade approach
 - Formalization/legal approach

Annual World Hg Released to the Environment by Artisanal Gold Miners

All these statistics about Hg releases were obtained from reports and guesstimates but... very few field measurements

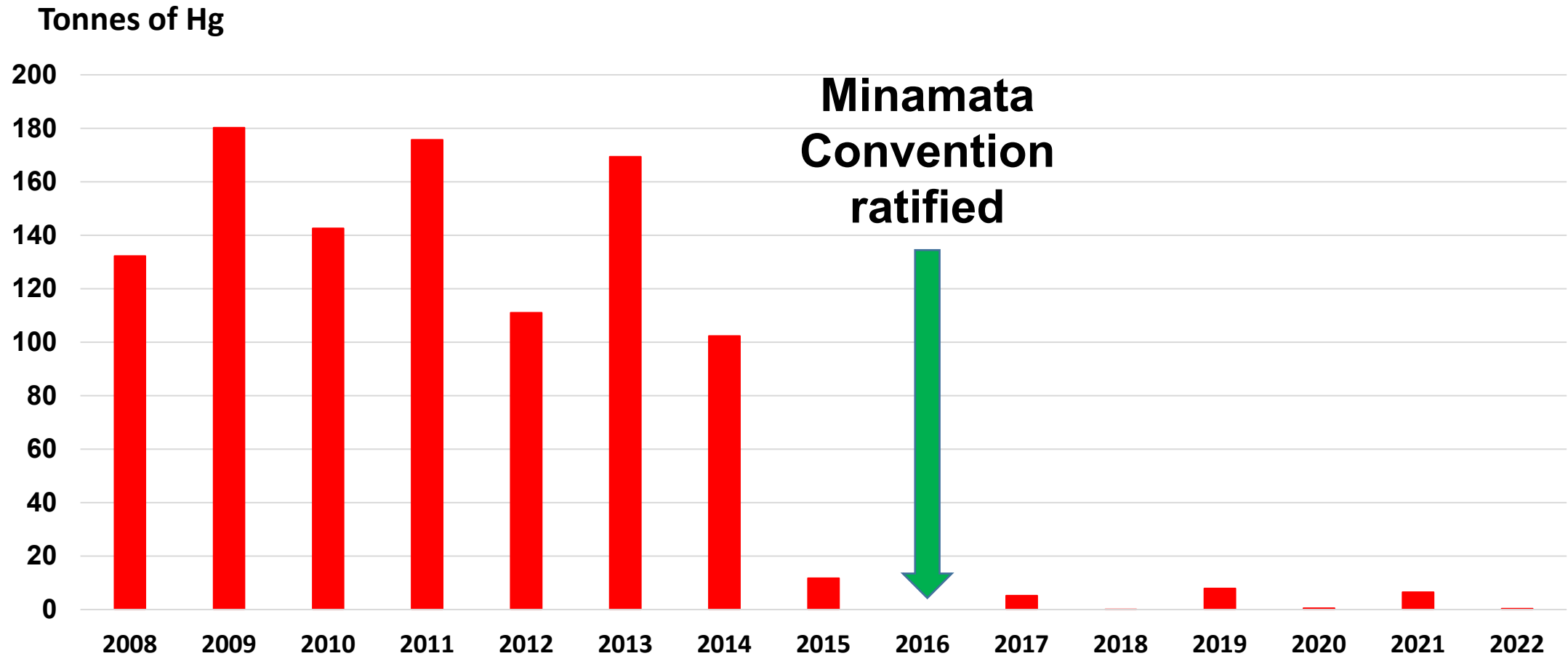


Veiga, 1997, Swain et al., 2007, UNEP, 2013, UNEP 2018

Are Hg Releases from AGM Reducing or Increasing?

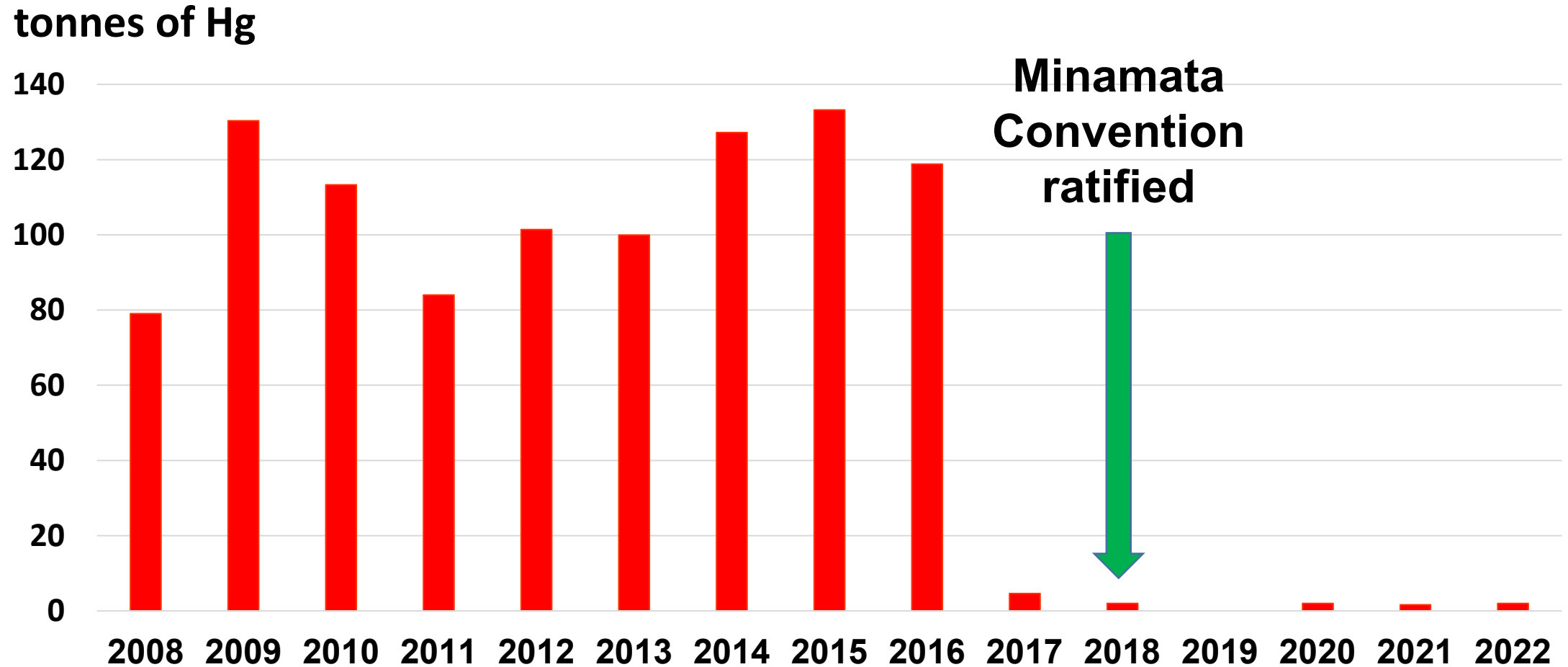
- **UN Planet Gold working in 23 countries + US Dept of State + ARM + Universities + Mining Companies + NGOs invested recently probably US\$ 450-500 million in projects to eliminate Hg in AGM**
- **Are these projects really reducing Hg in AGM, when more people are becoming artisanal miners, and 1 gram of gold is close to US\$ 80?**

Tonnes of Hg Imported by Peru



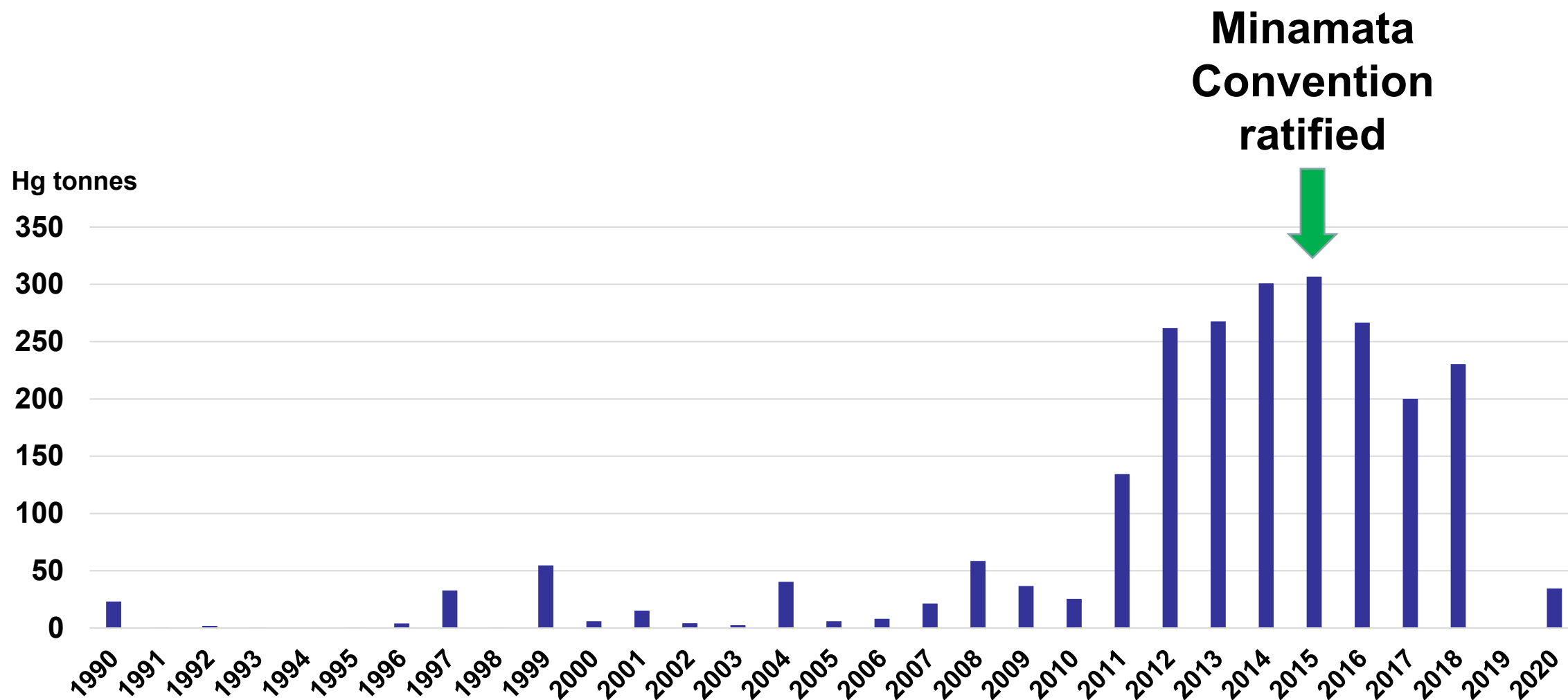
Source: UN COMTRADE, 2024

Tonnes of Hg Imported by Colombia



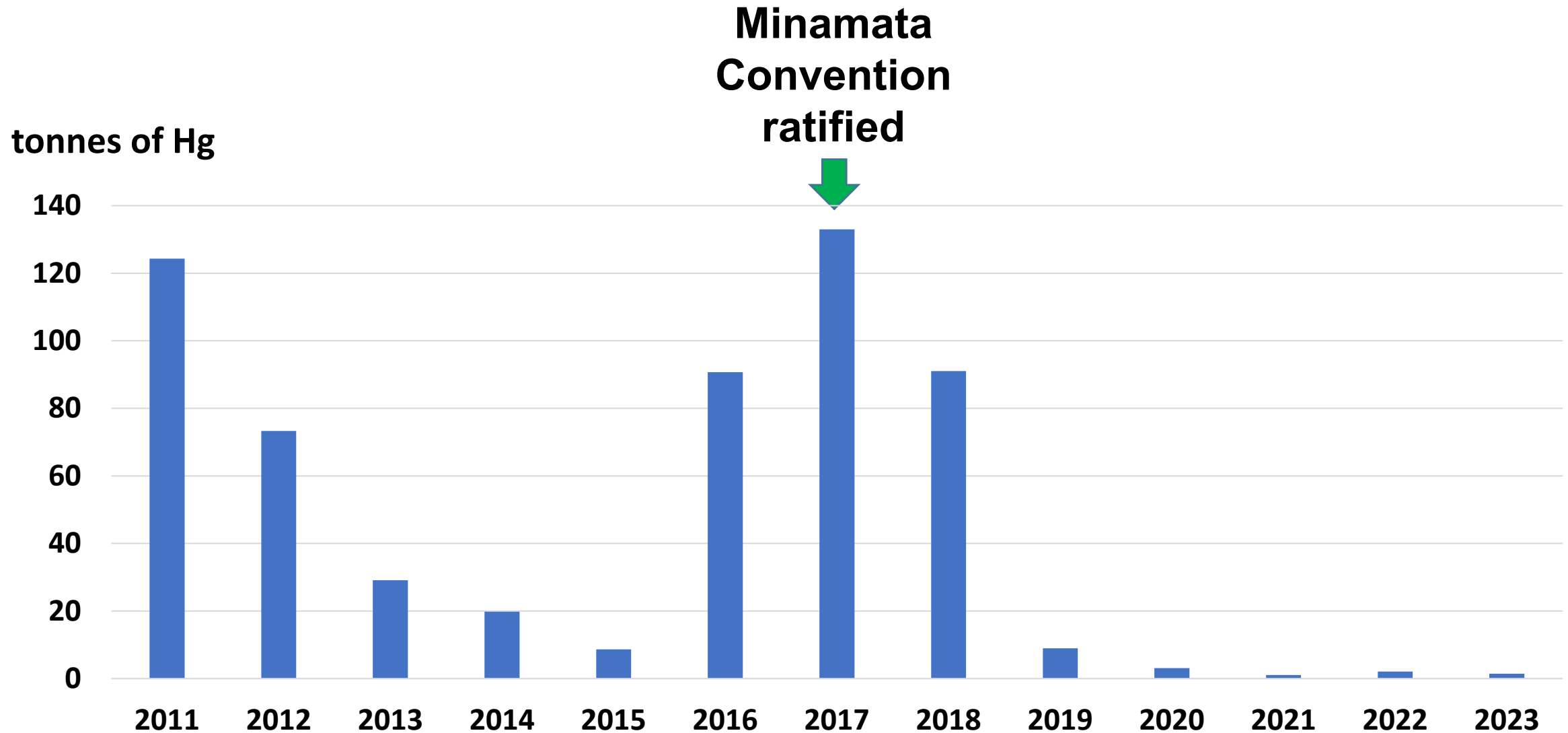
Source: UN COMTRADE, 2024

Tonnes of Hg Exported by Mexico



Source: UN COMTRADE, 2024

Tonnes of Hg Exported by Canada



Source: UN COMTRADE, 2024

How to Convince Miners to Adopt New Techniques?

GOLD !!!

- Are the miners concerned about the health problems caused by Hg?
- Are the miners impressed with the environmental pollution?
- Can miners buy equipment suggested by interventionists only based on Hg?
- What is the main interest of miners?

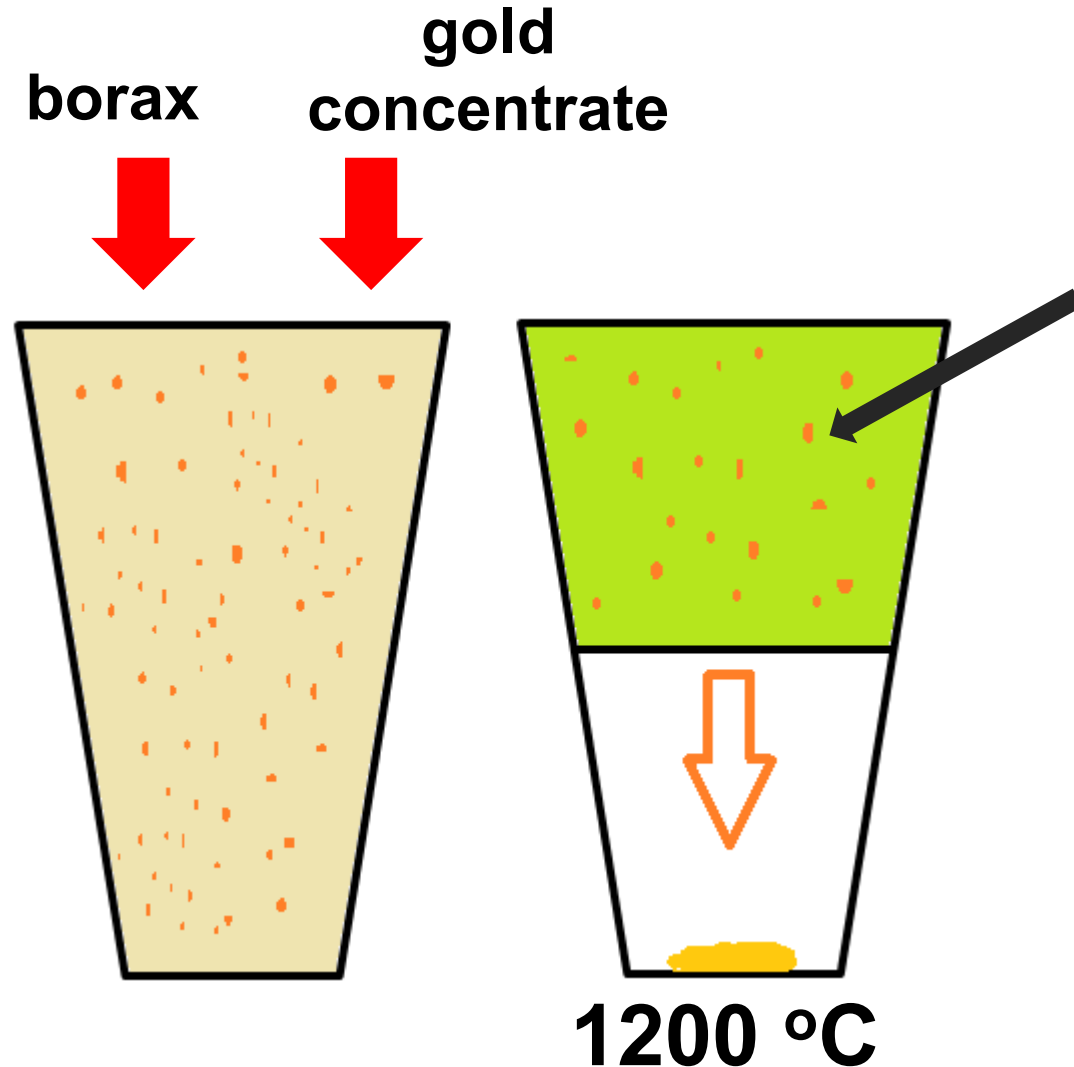


Gravity Concentration as a Solution

- Most Interventions in AGM suggest a **shaking table** (1 t/h) to replace amalgamation...only good to process small amounts
- Worldwide, the mining companies (e.g. **Shanxi**) are using shaking tables to concentrate the ore and the rest by cyanidation
- Conventional cyanidation
- Conventional cyanidation
- Why would the companies use shaking tables?
- Well...the equipment is cheap and easy to operate



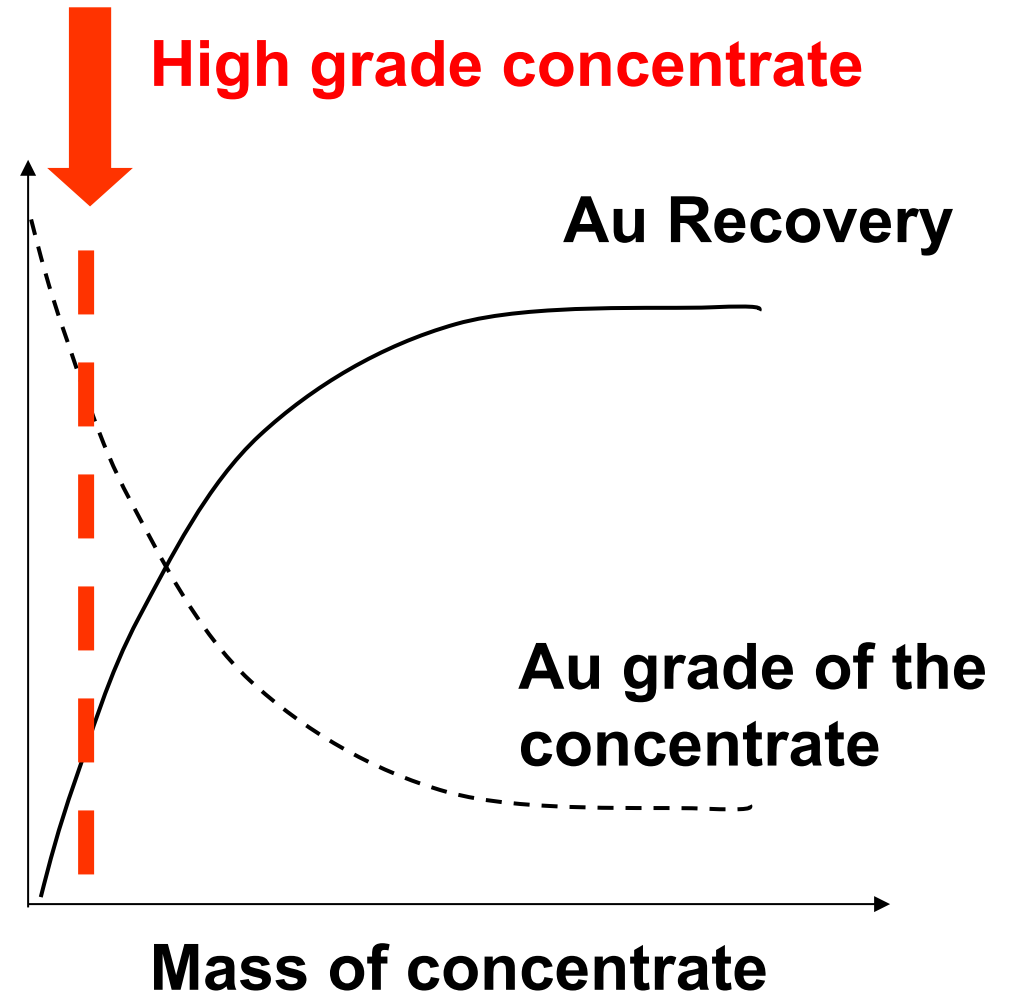
Direct Smelting of Concentrates



- All gold particles must coalesce... get together, to sink in the melted mixture
- If the concentrate is not very rich (3 to 5% Au), gold is lost in the slag
- THIS MUST BE A YELLOW CONCENTRATE

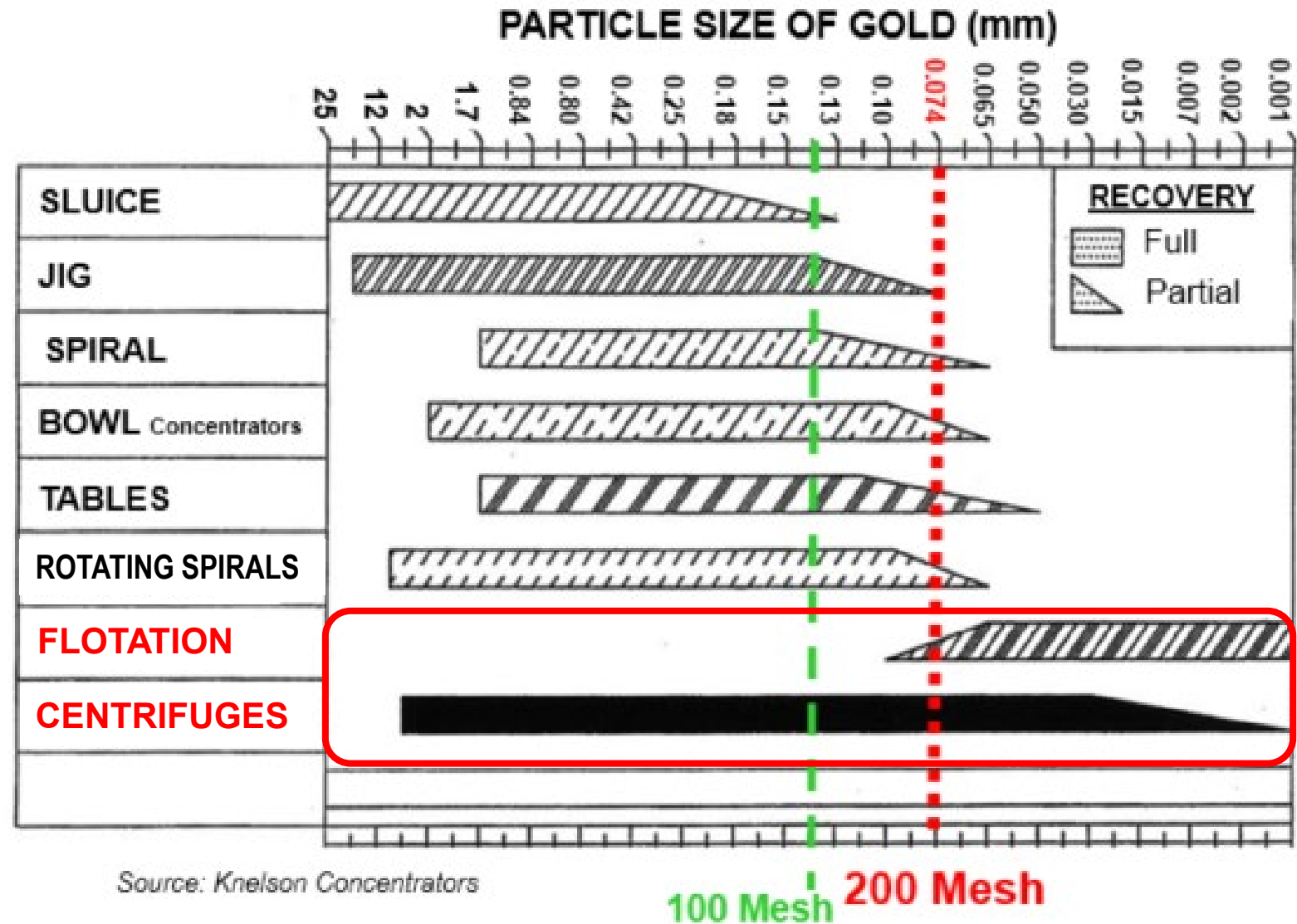
More Yellow = Rich Concentrate but Low Recovery

How to convince a miner to lose 90% gold in the concentration process to have a **yellow concentrate** that can be directly melted?



Types of Gold Concentrators

It is hard to increase gold extraction only with gravity concentration... but we can try!!!



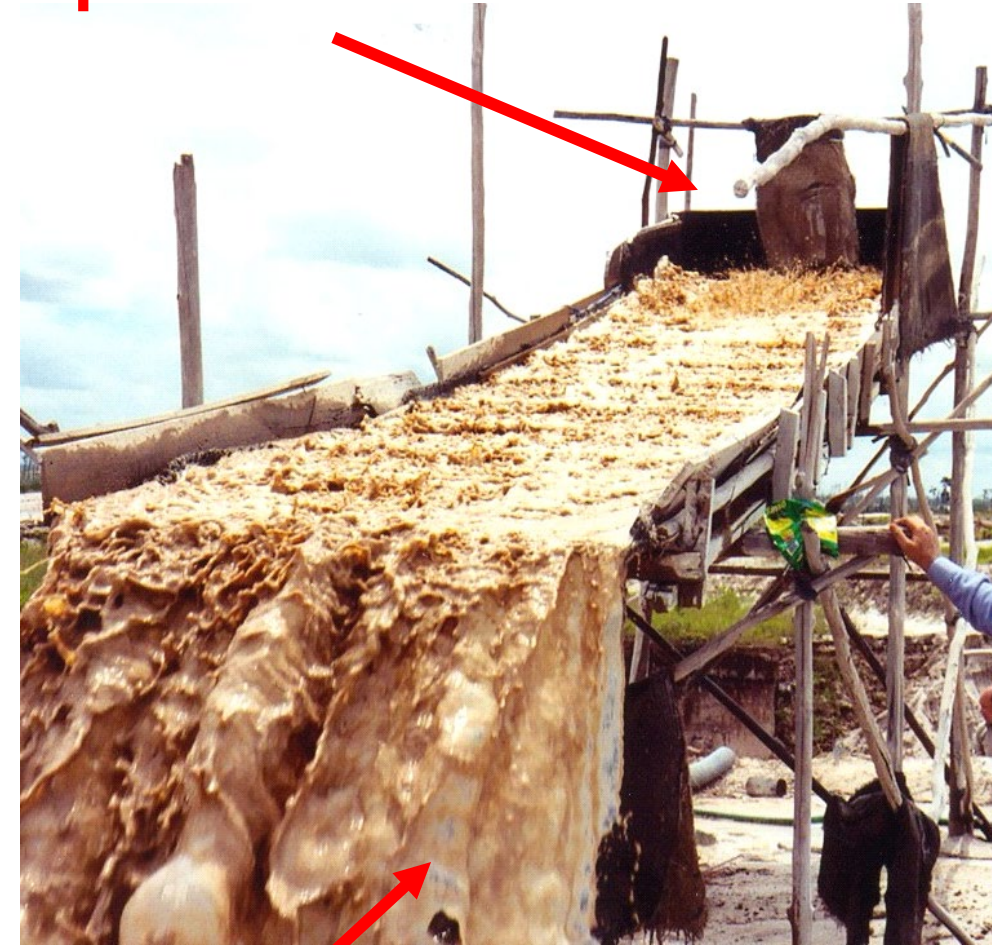
Gold Metallurgical Balance

- The best strategy to engage with miners is to show the their **current %Gold Recoveries**
- Then we suggest improvements on the process to reduce gold losses
- The **%Gold Recovery is NOT the gold produced**
- The %Gold Recovery is a parameter to control the concentration step

Obtain the Current Gold Grades & Recovery

- Sample every 15 minutes a little bit (300 mL of pulp) and obtain a composite sample of 2-4 hours
- Dry the samples, homogenize and take triplicates for analysis
- Analyze gold in the Feeds and Tailings (never in the Concentrates)

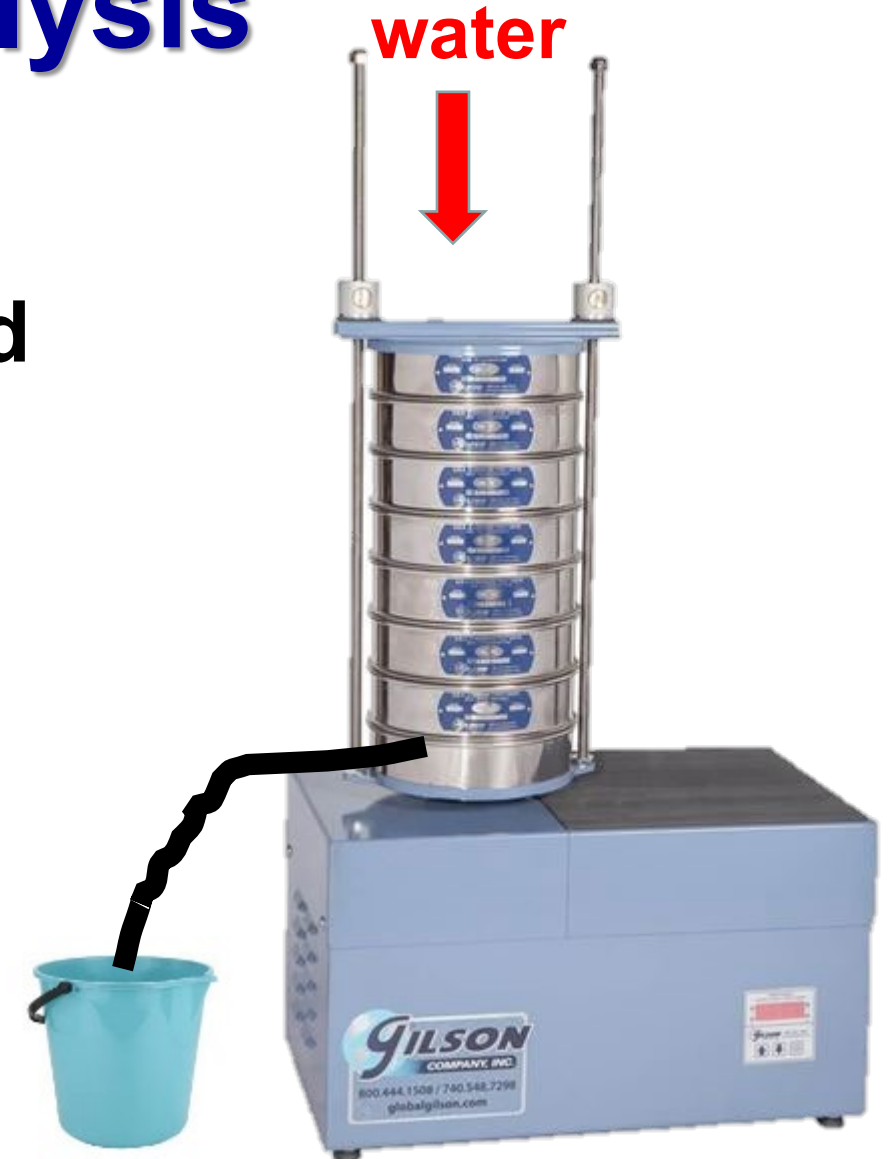
Sample from feed



Sample from tailing

Grain Size Analysis

- Grain Size Analyses of some **TAILINGS** will show where the gold is lost :
 - in the **FINES** or
 - in the **COARSE** fractions



Obtaining the Current Gold Grades & Recovery (Colluvial Ore - Suriname)



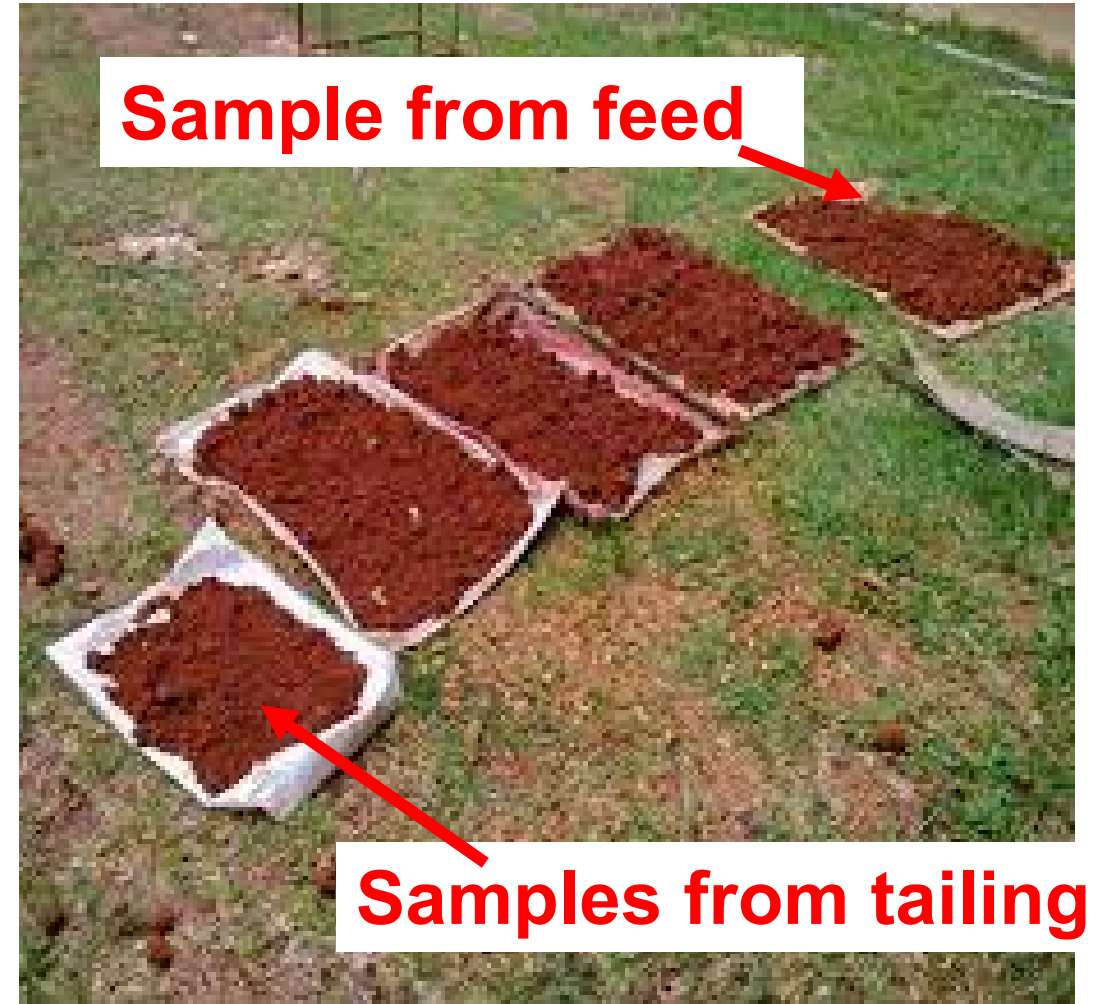
Sample from feed



**Sample from
tailing**

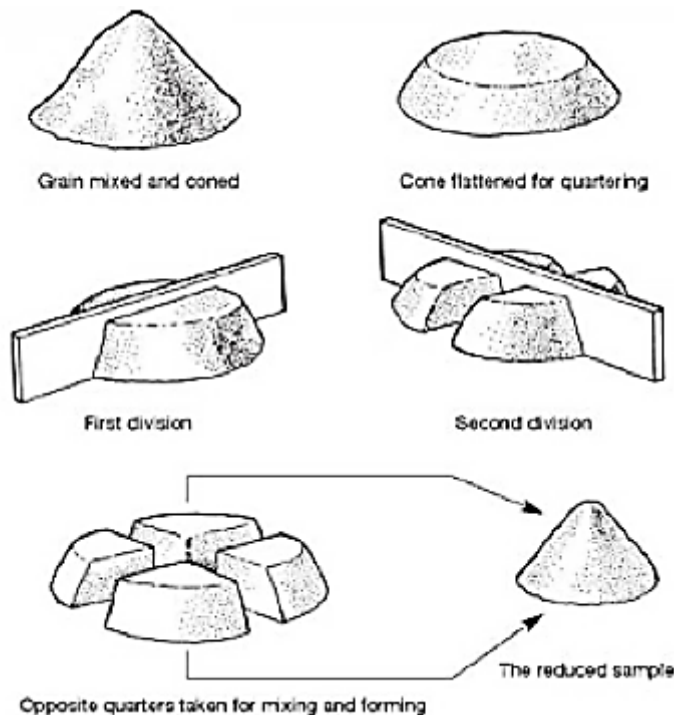
Obtaining the Current % Gold Recovery

- Samples are dried at the sun
- 
- Samples of feeds and tailings are pulverized and analyzed

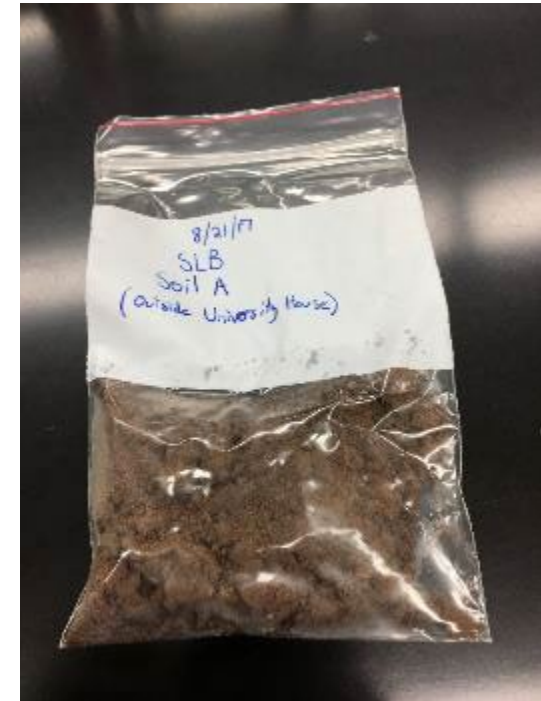


Split the Pulverized Samples

- Make a cone with dry samples and take a small sample in a Ziplock



100 g



Gold Recovery (Distribution)

$$R_{Au} (\%) = \frac{\text{Mass of GOLD in the product (g)}}{\text{Mass of GOLD in the material (feed) (g)}} \times 100$$

$$R_{Au} (\%) = \frac{\text{Mass of concentrate} \times \text{Au grade of concentrate}}{\text{Mass of feed} \times \text{Au grade of feed}} \times 100$$

- Miners are not happy to give samples of concentrates
- Analyses of concentrates generate nugget effect
- The mass of concentrate is insignificant when compared with the mass of feed, then $M_{\text{feed}} = M_{\text{tailing}}$
- Than we analyze feeds and tailings

Obtaining the Current % Gold Recovery

- When the analytical results arrive (in ppm or g/t)
- Example:
- FEED = 1.2 ppm Au
- TAILING = 0.78 ppm Au
- Au Recovery (%) = $100 - \left(\frac{0.78}{1.2} \times 100 \right) = 35\%$



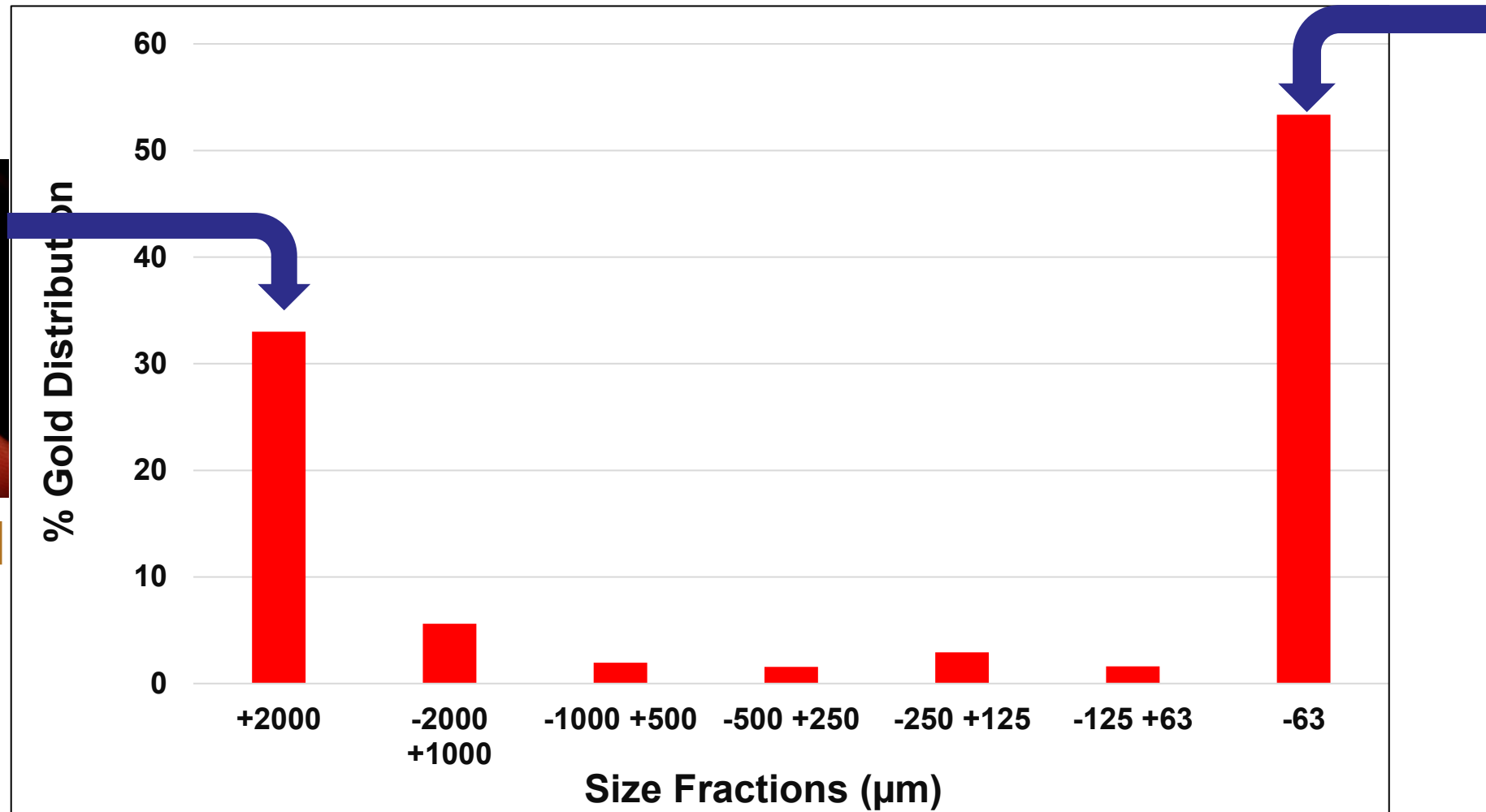
Also known as
%Au Distribution

% Gold LOST with Tailing = 65%

Tailings from Mr. A
colluvial ore, Tail = 0.20 ppm Au Au Rec = 39.4%
(Suriname)



**Unliberated
gold**

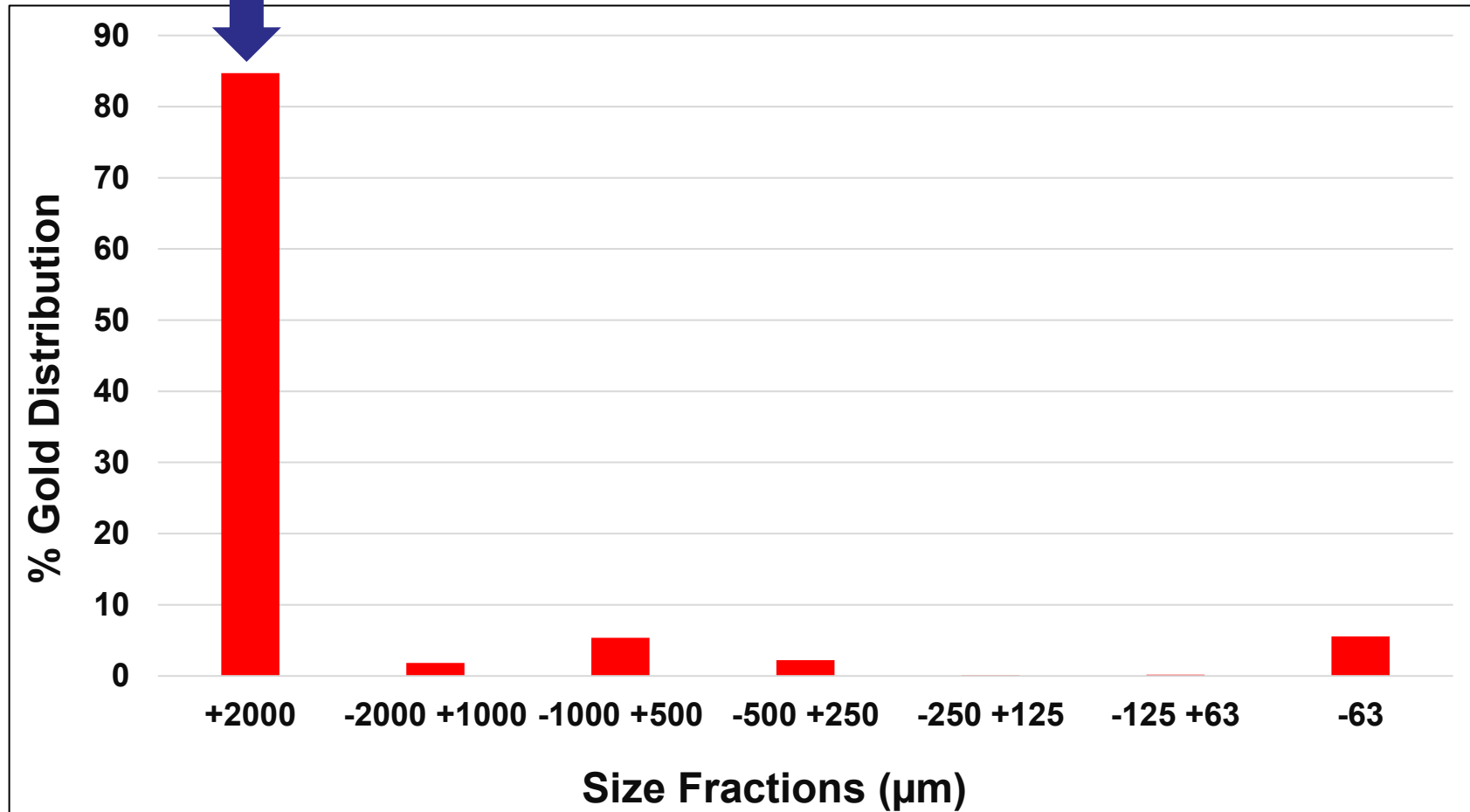


**Fine
gold**

Tailings from Mr. A
colluvial ore, Tail = 0.23 ppm Au, Au Rec. = 32.4%
(Suriname)



**Unliberated
gold**



%Gold Recovery (Alluvial Ores) - Suriname

- Sluice boxes in zigzag are operating very good with high gold recoveries: **up to 98%** (81 to 98%) **EXCELLENT**
- Some gold is lost with fines

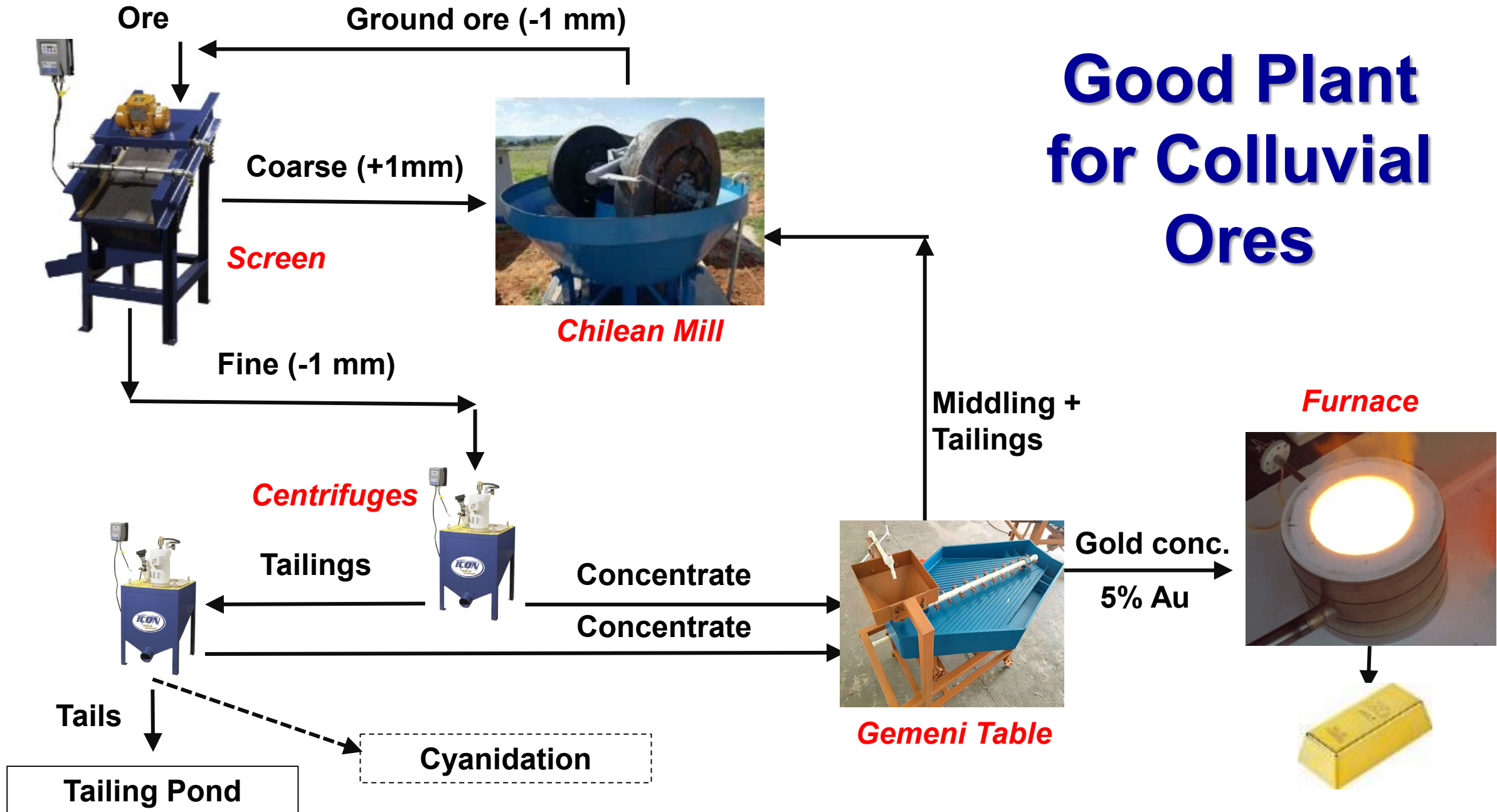


Liberated
Alluvial Gold



Zigzag
sluice boxes

Good Plant for Colluvial Ores



Processing Plant in Sudan

- Six Chilean mills (500 kg/h each)
- Screen 0.25 mm
- Four centrifuges (2 in series)
- 70% Gold Recovery
- Leaching the tailings



Conclusion

- The technical interventions must continue but always with great engagement with miners...Mercury elimination is a consequence of good engagement
- Interventions must focus on increasing % Gold Recovery using centrifuges...Hg can be eliminated
- The only process eliminating Hg use is the **coexistence** of AGM with small companies: miners mine and sell the ores to companies to process...
- 15,000 miners in Latin America working with 25 companies

Conclusion

- Solutions for alluvial and colluvial ores are different from the ones for primary ores.
- Main problem: worldwide most miners working with **primary ores** use Processing Centers to extract their gold... P.C. use mercury and cyanide
- Projects must intervene in Processing Centers but... be careful as...

... Sharks Have Sharp Teeth



Acknowledgements to



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Mr Mauricio Winkelried



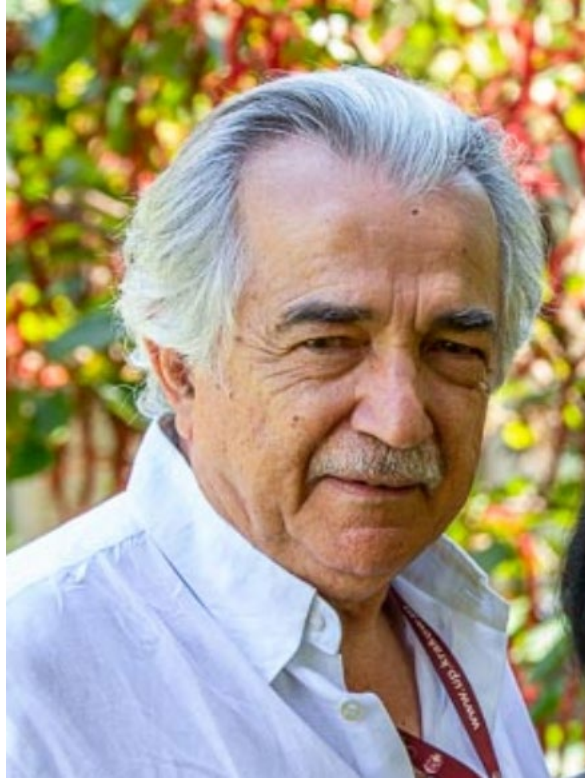
ARTISAN MINING
أرتيسان للتعدين

Mr Hassan Elmour

In Memoriam of my friends who would be here...



Randy Baker



Jose Dorea



Dario Bermudez

***“The crime we have committed is having
been born with gold at our feet and having to
die of hunger “***

A miner in Remedios, Colombia

Thank You

**Miners have stolen my dreams.
I hate you Marcello.
Let's stop ALL MINES**

