

Technology transfer activities in Peru

Background

In Peru, there are around 300,000 artisanal miners who have been working in this activity in the 25 regions of the country. The government, through Legislative Decree 1293, declared the formalization of artisanal and small-scale mining (ASM) activities to be of national interest, creating the Comprehensive Mining Formalization Process, where 88,000 miners (between individuals and legal entities) decided to register and start their process of formalization. To date, there are more than 10,000 miners who have achieved formality, however, these Peruvian entrepreneurs must still take on the challenge of being sustainable with this economic activity and improving their environmental and mining practices, as well as strengthening their management capacity business, for which accessing to the services offered by the financial system represents an opportunity to invest in technologies and equipment that allows them to stop using mercury and increase their profitability.

According to figures from the Ministry of Energy and Mines, the small-scale and artisanal mining sector contributes 20% (20 tons) of gold volume to the national gold production (150 tons). Arequipa, Puno, Piura and Madre de Dios are the regions that contribute with the greatest volume of production. This volume places Peru as the first gold producer in South America and sixth worldwide.

Alluvial gold mining and underground mining are practiced in Peru's ASM. Alluvial gold mining is an economic activity that takes advantage of detrital gold deposited in terraces, placers, plains, riverbeds, etc. This geological condition allows artisanal miners to obtain gold-bearing material more easily, using rudimentary technology and low-skilled labor.

On the other hand, underground gold mining is an economic activity that involves the use of gold veins or veins found within the subsoil, which are difficult to access and require greater investment. However, artisanal miners carry out this activity in conditions of risk to health and the environment, with limited

technical assistance, lack of financing and rudimentary or adapted technologies, known as "hechizos".

It is estimated that 80% of the miners registered with REINFO (Integral Mining Formalization Registry) work in areas where underground mining is practiced, while the other 20% practice alluvial mining. The topographic and geological conditions of Peru make primary deposits predominate, making it necessary to carry out underground mining to access the resource with empirical exploitation techniques and where mineral processing with mercury predominates.

Description of technology deployed



In order to identify clean and environmentally friendly technologies adapted to local conditions, planetGOLD Peru carries out, as a **first step**, the *technical diagnosis* of the artisanal mining operation, both in terms of extraction and metallurgical processing.

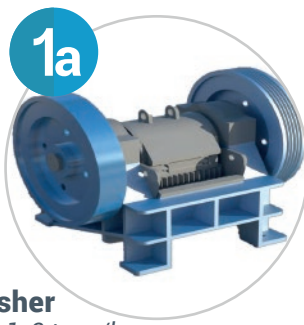
As a **second step**, a *topographic survey* is conducted inside the mine and geological sampling is performed.

As a **third step**, the *samples are analyzed in the laboratory* to determine the type of ore (oxidized, sulfide, or mixed), particle size distribution, reserve, and grade.

Finally, as a **fourth step**, after conducting some *tests and evaluation the feasibility of ore recovery* through clean processes, the implementation of a metallurgical processing circuit based on gravity separation is recommended.

The implemented technology is suitable for both alluvial mining and underground mining, as shown in the following flowchart. The key is to liberate the gold and allow the material to enter the agitation tank with the ideal mineral size according to the type of deposit. For example, we recommend that for alluvial mining, the material should be up to 165 microns (mesh 90), and for underground mining, it should be up to 106 microns (mesh 140).

UNDERGROUND MINING



6' x 8' Jaw Crusher
Crushing capacity: 1-3 tons/hour
USD 9,500



3' x 3' Ball Mill
Grinding capacity: 0.4 tons/hour
USD 9,500

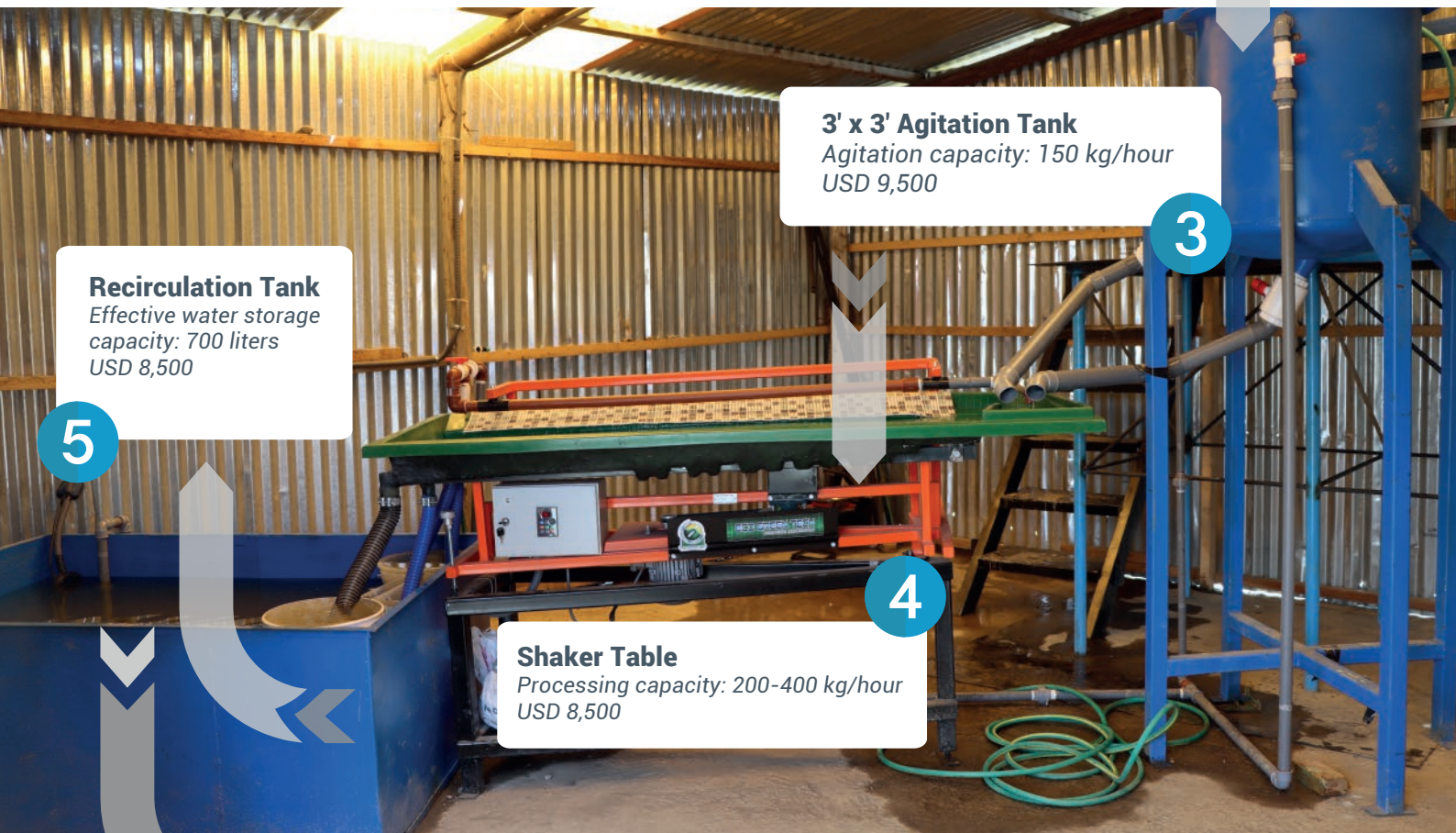
ALLUVIAL MINING



Sluice box



Vibrating Screen
USD 4,000



3' x 3' Agitation Tank
Agitation capacity: 150 kg/hour
USD 9,500

Recirculation Tank
Effective water storage capacity: 700 liters
USD 8,500

Shaker Table
Processing capacity: 200-400 kg/hour
USD 8,500

Smelting



6

Final product



7

FLOWCHART OF A GRAVITY PLANT FOR GOLD WITHOUT MERCURY RECOVERY

Equipment function description

- 1a Jaw Crusher:** Reduces the size of the extracted mineral rock from the underground tunnel so that it can pass into the mill.
- 2a Ball Mill:** It liberates the gold, and it is recommended that the mineral be reduced to 106 microns and pass through a 140-mesh screen.
- 2b Vibrating Screen:** Used for alluvial mining. The pre-concentrated mineral from the sluice box is separated, and a 165-micron mineral that passes through a 90-mesh screen is obtained. This concentrate then goes to the agitation tank to form the pulp.
- 3 Agitation Tank:** The tank homogenizes the mineral pulp that will enter the gravity table. It works by generating a vortex-like movement, created by a shaft attached to the paddles that allow the movement of the pulp. To regulate the intensity of the movement force, it has a frequency regulator (VR) and a gearbox, which adds force to the work being done.
- 4 Shaker Table:** The table utilizes the physical properties of minerals to selectively separate them and obtain gold and reject material. The table vibrates longitudinally through its mechanism, using a slow leftward stroke and a quick rightward return, causing mineral particles to slowly drag along the deck in the direction of the slower movement.
- 5 Recirculation Tank:** This tank, a quadrilateral structure, stores water from the gravity table. It serves as the water supply for the table using a water pump, creating a closed circuit and improving water utilization, which can be reused. It receives the 4 ports from the gravity table where the concentrated gold that will go to the smelter is collected.

The equipment implementation involves a process of adaptation and calibration by the miners with the assistance of an metallurgical engineer. This system has demonstrated an **average gold recovery efficiency of 90%**, and any unrecoverable mineral is sold to a cyanidation plant, in this way no tailings are generated.

It is worth noting that the metallurgical equipment transferred by the project is co-financed by the miner ally. This investment covers civil works, electrical supplies, equipment coverage, and security. This co-financing reflects the level of commitment of artisanal miners towards technological change, a progressive mechanization process.

Summary of training and dissemination activities to encourage uptake by miners

To date, 9 gravity plants have been transferred in the regions of Puno and Arequipa, with 6 more plants pending transfer in 2023. Undoubtedly, technical support is crucial for the proper use and management of the metallurgical equipment, considering variables such as:

- ▶ Type of mineral.
- ▶ Association with other minerals.
- ▶ Shape and size of gold particles.
- ▶ Density and viscosity of the pulp.
- ▶ Equipment cost.
- ▶ Availability of spare parts.
- ▶ Access to energy and water resources.



Map of plants and equipments delivered by planetGOLD Peru until June 2023.

The project, in collaboration with regional governments, provides training to artisanal miners, university students, and professionals in ASM, demonstrating that gravity plants are a viable option for gold without recovery. In this way, the project contributes to the multisectoral national policy for artisanal and small-scale mining, which aims to promote the use of clean technologies.

