

# VALORIZATION OF GOLD ORES BY THE SUSTAINABLE MANAGEMENT OF GOLD PANNING ACTIVITIES IN MADAGASCAR

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## ABSTRAIT

*Artisanal mining takes an important place in the Malagasy mining sector because it is one of the engines of local economic development. Indeed, such a study makes it possible to serve as a reference for the understanding of the importance of gold panning, the impacts of exploitation on the environment, on local economies as well as the social development of populations.*

*The highlights of the study highlight a much higher gold production in Madagascar, than that officially declared, despite its current state of exploitation: Based on official exports of about 11 tons in 2017 and about 3 tons in 2018 and 8 tons in 2019 on the largest gold sites of Madagascar, and this despite the under-equipment and the under-technicality displayed by gold miners.*

*This study aims to acquire new techniques for processing gold ore and manage environmental impacts.*

*For the realization of the study, we valorized the following specific steps namely the typologies, the different modes of gold mining, the environmental stakes of artisanal mining, the impacts of gold mining in natural environments, and the valorization of gold ores by advanced processing techniques.*

*The results expected by this study concern the increase of gold production by the appropriate processes, the measures of mitigation of environmental impacts in order to draw the recommendations for a sustainable management of the gold panning activity in Madagascar from the social, economic and environmental point of view.*

**Keywords:** *ores- gold- valuation-advanced technique- gold panning- Environment- Sustainable development-Madagascar*

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## INTRODUCTION

Madagascar because of its mining potential has attracted international mining investors for about ten years. This is also due to the various reforms in the sector during which the legal and regulatory framework has been improved. At the same time, the mining administration has set up the various institutions necessary for the smooth running of the sector. Among others, the Mining Cadaster Office (BCMM) for the management of mining titles, the Environmental Cell for the environmental assessment of any mining project. Madagascar's geoscience and mining data have also been updated or updated. All these steps lead to a clear increase in mining activities in Madagascar.

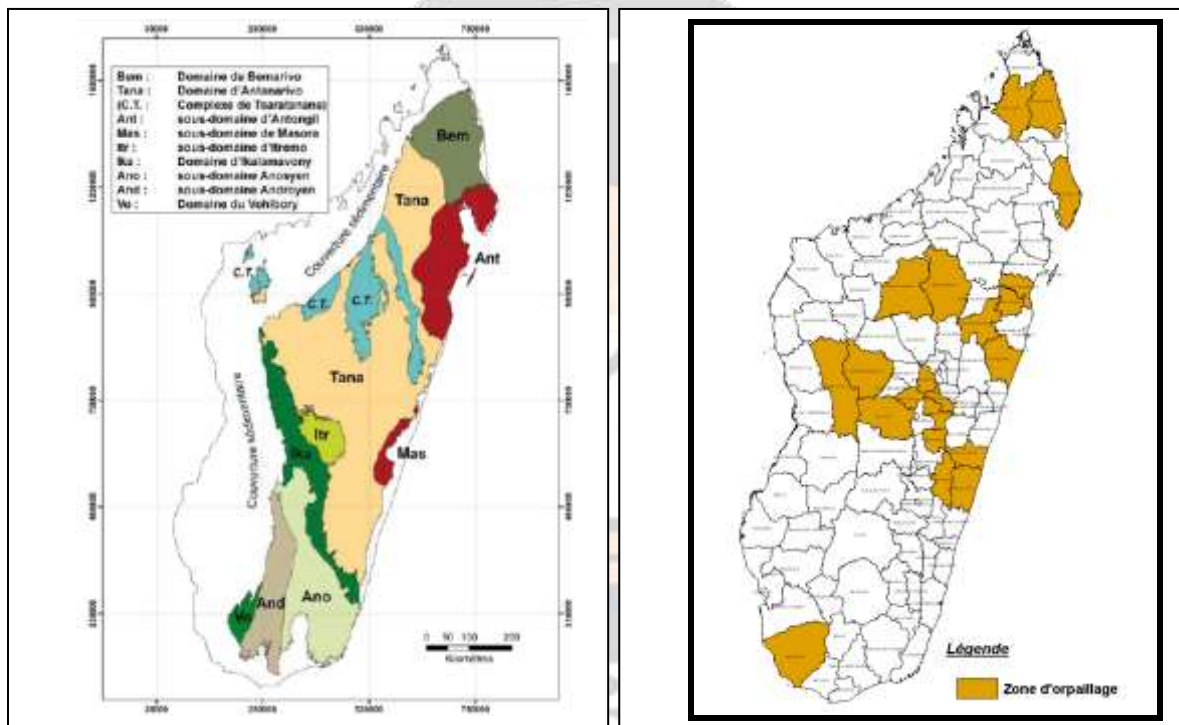
Thus, the purpose of the study is to valorize gold ore by advanced processing techniques of an artisanal gold mining project that can be used in all Madagascar, to evaluate the environmental impacts and to take

mitigation measures to manage the positive impacts for the sustainable management of the gold panning activity in Madagascar.

The highlights of the study highlight a much larger gold production in Madagascar, than that officially declared, despite its current state of exploitation: about 8 tons of gold is produced annually on the four largest gold sites of Madagascar (Andavakoera, Maevatanana, Ampasary, Dabolava) and this despite the under-equipment and the undertechnicity displayed by the gold miners. The 70% of this production of gold miners comes from terraced and primary deposits, which reveals the extension of the deposits they exploit towards those reserved for leavers. As a result, there are few on-site operating permit holders and this situation makes it possible for gold miners to move to primary roosts.

**I- The current geological context and the gold showings of Madagascar**

Madagascar is an island belonging to the mainland Gondwana; it is separated by East Africa by the Mozambique Channel (Fig.1).



**Fig.1:** Geological map with gold showings of Madagascar (PGRM, June 2012)

**Fig.2:** The main areas of gold panning in Madagascar

The western 1/3 of Madagascar is constituted by sedimentary formations, while the eastern 2/3 by the Precambrian crystalline basement in other words by metamorphic and magmatic rocks. The majority of gold deposits are concentrated in this Precambrian crystal basement (Fig. 2).

**1- Gold panning**

Gold panning is a residual occupation of the population in Madagascar, this observation invalidates the assertion that gold panning affects 80% of the active population of the sites. The different types of operators are gold miners and leavers.

Under the gold panning regime, gold miners cannot carry out their activities without the gold panning permit, which is embodied in the gold panning card. On the one hand, there are also mining permits for gold, issued by the BCMM. The difference between these two is the costs, the award procedures, and their characteristics. However, gold miners can work, with the agreement of the permit holder, within their perimeters.

They are mostly unskilled to practice the profession and have trained on the job, using the same production techniques as their predecessors (relatives, friends, etc.) or simply by watching other things (the school of tradition)

**2- Type of deposit**

The gold exploited in Madagascar comes from four categories of deposits, which are of primary, elutenary, terrace and alluvial type (Bésairie, 1949)

The exploitation of certain deposits seems too difficult with rudimentary means made available to gold miners and which mobilizes more human resources. However, it should be noted that easy-to-work deposits, of the alluvial type, attract gold miners.

Gold miners, who would normally have to exploit exclusively alluvial and eluvial deposits, extend their mining areas to primary deposits and terraces. Due to material constraints, deeper primary deposits are not well exploited.

Alluviales, in the exposed bed of rivers during the dry season. • A bowl is dug into the dry bed until it reaches the dzi, which is then washed with pan. • Gold recovery is done only by gravimetric concentration, pan, and without any use of mercury. • From 2 to 6 people work per bowl. Division of roles follows gender norms.

Eluvial, out of the riverbed and require an uncovering to reach the vein, either through a small open-pit operation or via galleries of shallow depth and therefore without woodwork. • The extracted earth is washed in improvised sluices before the use of the pan. Mercury is not used. • The division of roles follows gender norms.

Mixed, similar to elusival farms • But often suffer from significant infiltration, which not only forces them to use pumps and also increases the risk of collapse of roadways.

**3- Operating technique and treatment process**

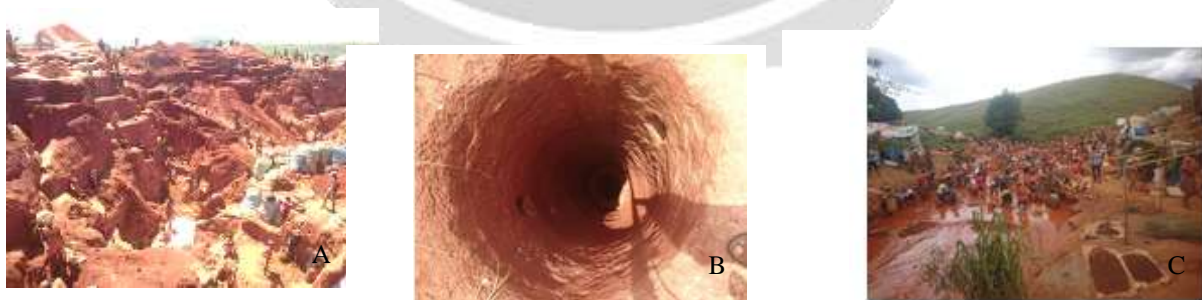
Observation at the places of exploitation shows that for primary deposits and terraces, the mode of exploitation is often underground and for alluvial and eluvionary deposits the mode of exploitation is opencast.

The mining methods and treatments used by gold miners differ according to the deposit conditions.

**Table 1:** Method of exploitation and treatment process by type of deposit

Types of deposits	Operating method	Treatment process
Primary	Slaughter, Kopaka lalambato, Well, Rat hole	Crushing – Sorting – Grinding – Sieving – Beating – Recycling – Pitching Crushing – Sorting – Grinding – Sieving – Beating – Recycling – Pitching
Terraces	Rat hole	Sorting - Settling - Batéage
Eluvionnaire	Abattage, Lakantany, Sasatany, Excavation, Mandakana	Sorting - Settling - Batéage
Alluvial	Alodrano, Bright bed	Sorting - Settling - Batéage

The mining equipment used by gold miners is generally rudimentary and handcrafted and is available locally.



**Fig. 3:** Photo of the type of artisanal farm : A :open pit , B : well exploitation, C: secondary deposit exploitation  
The technique of processing ores varies according to the deposits and the geographical location of the place of exploitation.

Whatever the type of operator, pan is the most widely used method of final gold concentration. Gold miners have not yet used the chemicals for gold mining. Since the processing of gold ores requires significant water consumption, gold miners use rivers, puddles and water sources in general (Ramiandrisoa et al, 2009)



Fig. 4: Crushing

Sieving

Beating

#### 4- The quality of Mandanivatsy's gold

In the site of Mandanivatsy Andranomadio we meet gold in nuggets, powder and glitter. Nuggets range from 1 to 15 grams, but powders and flakes are the most abundant. Glitter is found especially in alluvial deposits. According to collectors, Mandanivatsy gold is 20 carats with a density of 19, and its color is yellow. It is for these reasons that its quality is inferior; it is not suitable for processing into jewelry.



Gold spangle

Gold nugget

Gold powder

## II- Environmental issues of gold mining

Degradation of vegetation cover leads to a simplification of the structure of the forest stand with a predominance of light species after gold mining or abandonment of cultivation, an irreversible change in the forest ecosystem in savannah following repeated passages of bushfires, a modification or decrease in floristic and faunistic biodiversity because of habitat loss.

Soil destabilization causes an aggravation of erosive phenomena, namely increased runoff, decreased soil infiltration capacity and recharge of aquifers, subsidence and lavaka formation, siltation or siltation of low-lying areas, and loss of soil nutrients.

At the water level, we note the erosion of the banks of the watercourse which plays the role of sediment filter by loss of rupicole vegetation; water that becomes unfit for consumption as a result of contamination of runoff containing waste; the reduction of water availability in dry periods as a result of the diversion to the gold mining area; and habitat destruction and loss of spawning grounds for aquatic wildlife and reduction of aquatic vegetation after silting up. (Razafintsalama, 2010).

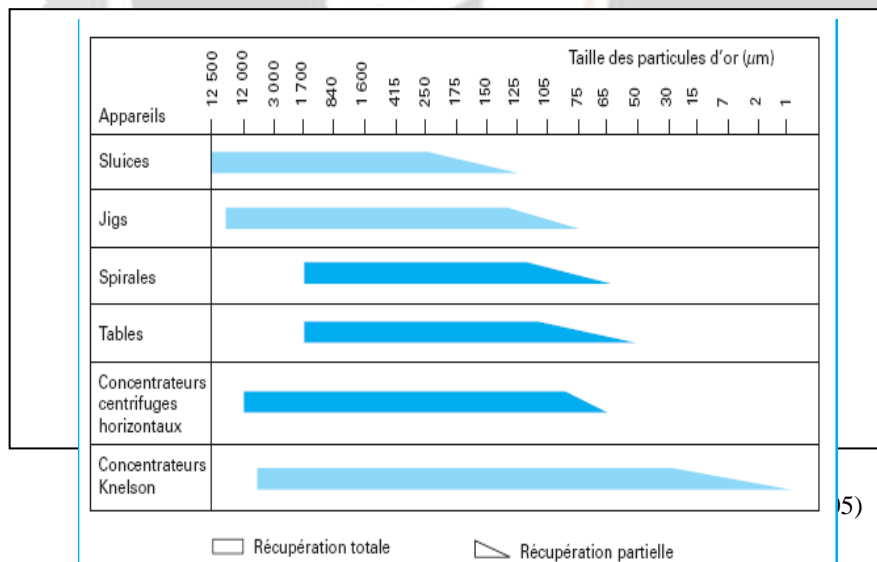


**Fig. 5:** Environmental issues (A: Water pollution; B: Effect on fauna, flora; C: Accumulation of residue, environmental degradation; D: Erosion - failure to restore the abandoned site)

### III- Upgrading of gold ores by advanced processing techniques

#### 1- The choice of treatment

The sector is underexploited and poorly exploited because the prospecting of deposits is carried out groped and without reinforced knowledge by specific training in the necessary concepts and techniques; farms are based on know-how limited to knowledge transmitted on the job; areas near the places of habitation as well as deposits formerly exploited, are preferentially exploited before abandoning them to their exhaustion; the working methods and materials and equipment used are rudimentary and insufficient. Indeed, the main use of the pan as a technique of concentration of gold without sieve, limits the recovery of gold because the pana leaves the finest gold to pass. This is how we proposed to use the Knelson type centrifugal concentration to recover gold flakes of less than 100  $\mu\text{m}$  because this device has a capacity for gold enrichment by gravity of less than  $1\mu\text{m}$ . (Fig.6) and in addition, it has brought for twenty years a revolution in the conventional gravity processing of gold, and it can be used both in artisanal farms and in factories (Ramiandrisoa ,2009)



**Fig. 7:** Separation by Knelson-type centrifugal concentrator in the laboratory

## 2- Analytical technique by lead fusion and coupellation



**Fig. 8:** Plumbing fusion (Minerals engineering and Recycling Laboratory, ArGenCo, ULg.)

## CONCLUSION

Artisanal mining takes an important place in the Malagasy mining sector because it is one of the engines of local economic development. Indeed, such research makes it possible to serve as a reference for the understanding of the importance of gold panning, the impacts of exploitation on the environment, on local economies as well as the social development of the population.

The use of this process has advantages such as the reduction in the use of mercurys or cyanides, the awareness of gold miners to environmental rehabilitation, concomitant with technical assistance of exploitation such as the systematic restoration of the site after each unsuccessful prospecting / exploration or at the end of exploitation; water management without damaging agriculture and finally the construction of settling ponds to reduce water pollution as well as the exploitation of the basin in rice because rice is the first food of Malagasy.

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