

Needs Analysis for Capacity Building of Artisanal Miners in Central Africa

Steven M. Rupprecht

University of Johannesburg, Johannesburg, South Africa

Corresponding author: stevenr@uj.ac.za

The artisanal mining sector in Central Africa is largely informal, yet provides an essential livelihood for many (directly or indirectly) participants, as well as facilitating an important source for the flow of income into many communities. Artisanal mining varies from site to site, but appear largely well structured despite its informality. The artisanal mining sites in Central Africa have some inherent management structure and the extraction itself is often organised.

Artisanal mining is labour intensive and is generally conducted utilising hand digging methods e.g. shovels or hand chisels. Artisanal mining is generally more dangerous than small-scale or large-scale modern mining operations. This is especially true as artisanal operations are generally subsistence activities with artisanal miners focusing more on immediate concerns than the long-term consequences of their activities. When miners have no other source of income, they will usually find ways to evade controls and carry on working.

The objective, through proper/dedicated training of artisanal miners is to migrate Artisanal mining to establish a small-scale mining (SSM) industry in Central Africa. Through developing the necessary skills in the fundamental areas of mining it is proposed that Artisanal Mining can become more productive and safer mining operations.

The paper reviews the above focus areas, highlighting the skills and tools that are necessary to assist in establishing a sustainable small scale mining industry migrating from manual labour to semi-mechanised mining and processing. The purpose of the transformation process is to create a safe, healthy, environmental and community oriented mining operation with the objective to uplift the skills and wealth of the mineworkers and the general community.

INTRODUCTION

The artisanal mining sector in Central Africa, namely Rwanda and Burundi, is largely informal, yet provides an essential livelihood (directly or indirectly) for many participants, as well as facilitating an important source for the flow of income into many communities. Artisanal mining varies from site to site, but appears largely well structured despite its informality. The artisanal mining sites in Central Africa have some inherent management structure and the extraction itself is often organised through teams of about 10 to 20 diggers who co-operate in one working area, whether surface or underground. The miners are generally accompanied by supporting crews, e.g., transporters, rock crushers, mineral washers and waste-disposal crews.

Surface mining hazards for artisanal mining include highwall collapse or slumping, falling from heights, rock falls from slopes above the workings and under mining of pit highwalls. Underground hazards are associated with portal collapse, falls of ground, insufficient ventilation and falls from heights. Artisanal mining is labour intensive and is generally conducted utilising hand-digging methods, e.g., shovels, picks and hand chisels. Artisanal mining is generally more dangerous than small- or large-scale modern mining operations. This is especially true because artisanal operations are generally subsistence activities with artisanal miners focusing more on immediate concerns than the long-term consequences of their activities. When miners have no other source of income, they will usually find ways to evade controls and carry on working.

The objective of the University of Johannesburg's Artisanal Small Scale Mining Programme is to establish small-scale mining (SSM) in Central Africa by transforming artisanal mining to more productive and safer mining operations. An increase in productivity is a fundamental premise: without productivity improvements, artisanal workers will not support safety initiatives, as safety programmes often represent additional resources and work. The University of Johannesburg's Artisanal Small Scale Mining Programme focuses on the actual mining process with the aim of creating a sustainable mining industry, migrating from manual labour to semi-mechanized mining and processing. The purpose of the transformation process is to create a safe, healthy, environmentally friendly and community-oriented mining operation with the objective of uplifting the skills and wealth of the workers, the general community and mine owners. An important conclusion to the process is to create an empowered mining industry enabled to make informed decisions and understand the opportunities created by exploiting natural resources.

DEFINITION OF ARTISANAL AND SMALL-SCALE MINING

For the purposes of the needs analysis, it is necessary to clearly differentiate between artisanal mining and small-scale mining.

Artisanal Mining

The World Bank (1995) defines artisanal mining, as "a type of manual, low technology mining conducted on a small scale, predominantly in rural areas of the developing world". Artisanal mining is the smallest and simplest mining operations, which involve the use of simple tools and the absence of a formal enterprise. Because of the informal nature of these operations, even subsistence farmers get involved on a seasonal basis.

Small-Scale Mining

Small-scale mining involves the use of basic mining and processing technology, such as mechanical drilling and blasting, manual loading, hoisting, a mill with gravity concentrator and other similar techniques. Traditional SSM includes licensed and registered non-mechanised or semi-mechanised mining operations, usually run by individual or organised cooperatives. SSM hires labour and applies basic management principles in their operations.

BACKGROUND TO RWANDA AND BURUNDI

Rwanda

There have been four major periods of mining in Rwanda (Perks, in press).

- From the 1920s to 1974, mining was conducted largely of foreign operators;
- Between 1974 and 1985, a post-independence joint venture operation existed;
- From 1989 to 2000, a nationalised structure was implemented with limited success;
- Privatisation or a foreign-led model as of 2000 to present day.

Prior to 1994, mineral commodities typically provided 10% of Rwanda's export earnings, mainly from concentrates of tin, tungsten, and tantalum ores and gold bullion. Although the Rwandan minerals sector has largely recovered since the 1994 genocide, many obstacles continue to impede optimal use of its mineral resources. Among them include decreasing high-grade ores, lack of sufficient capital, periods of civil unrest, massive population displacement, a 65% poverty rate, a shortage of skilled labour, the country's landlocked status and transportation costs (amongst the highest in Africa), recent increases in oil prices, persistent risks of Hutu extremist insurgency and involvement in two wars in the Democratic Republic of Congo.

In 2000, the government privatised Régie d'Exploitation et de Développement des Mines, the state mining exploration company. The privatisation led to mineral production increases in tin ore (345 t), tungsten ore (130 t; tantalite ore and concentrate (83 t) and gold (10 kg) (Butura, 2014).

The Rwandan mineral industry consists mostly of a number of small companies with approximately 750 licences currently issued to cooperatives and individual artisanal miners who produce ores and concentrates from locations dispersed across a 30 km-wide zone that extends east-west through Kigali (Kagabo, 2014). While some areas are legally operating, most activities are only marginally mechanized, largely inefficient and characterised by widespread occupational safety and health risks.

Burundi

Burundi is a producer of columbium and tantalum (coltan) ore, tin ore, tungsten ore and gold, with exploration taking place for rare earths. National gold production is reportedly 750 kg per year (2011) and represents a large portion of the value of Burundi's total mineral production. Machanga Limited of Uganda and the Burundi Mining Corporation are responsible for mining much of the country's primary gold reserves, which are concentrated in Musinga Province in the north-east of the country. In 2011, the production of coltan was estimated at 68 000 kg, while 30 t tin 340 t tungsten were produced (USGS, 2011).

Burundi has identified the mining sector as a major factor for economic growth and revenue income. The Burundian mining sector is dominated by informal small-scale mining activities targeting gold, tungsten and tin, with no significant economic output for the national economy. However, the mineral resource could allow for the development of an industrial mining sector. In the period 1960 to 1980, the Geological Surveys of Belgium and France and Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) inspected deposits of nickel and gold. Despite good results, these deposits have not been exploited. Recent studies indicated a potential for hydrocarbons in Lake Tanganyika.

By granting prospecting and exploration licenses to private companies, the Burundian Government has made the first step towards the development of an industrial mining sector. Due to the complex nature of developing mining projects, including the large capital requirements to develop a mine, it may be a number of years before the Burundi mining industry commences production and revenue generation.

The present status of the Burundi mining sector is characterised by weak institutions with insufficient capacities and technical knowledge.

GENERAL NATURE OF ARTISANAL MINING IN CENTRAL AFRICA

There is a wide range of skills and abilities currently exploiting the varied deposits, but, in general, there is a low level of understanding of safe and compliant mining. The objective of government, non-governmental organisations (NGOs) and other concerned parties is to find a safe and realistic approach to improve mining conditions, raising independent operators' safety, health and environmental awareness and improving the overall productivity of the operations in a manner appropriate to local circumstances while maintaining employment levels. The capacity of government

to oversee the artisanal mining sector is limited and ineffective due to the inability to cover the area under their responsibility, lack of financial support, few vehicles, shortage of personnel and a lack of capacity and technical knowledge. The creation of an organisation to support small-scale mining, whether by the government or private sector, is considered critical for the improvement of the artisanal mining sector. Such an initiative is important so as to improve mine health, safety and productivity.

The role of mineral traders is also important, as a trust-based relationship enables miners to receive funding to develop their mining project. Examples may be funding to secure land for access to the mine site, developing roadways or the hire of equipment to assist in establishing blocks of ground for mining.

Any action taken should be transparent to the artisanal mining community and should be presented to all stakeholders with real local ownership. The formalisation initiatives must secure local buy-in in order to succeed and achieve long-term results.

SAFETY, HEALTH, ENVIRONMENTAL ISSUES AND UNDERSTANDING LIMITATIONS

There appears to be a gap in providing clear mine safety, health and environmental standards to mining operations. Occupational safety, health and environmental guidelines, which are usually unenforceable, are often set as mandatory codes of practice for mines and quarries. These guidelines discuss safety, health and environmental issues in general and are suitable for formal small-scale mining operations, rather than informal operations and are therefore, for the most part, irrelevant to artisanal mining operations. The author is of the opinion that attempting to apply standard codes of practices, which are developed and used by formal large-scale mining operations, to artisanal mining may be detrimental, as unrealistic standards or expectations could be imposed on the mines and its workers.

The implementation of mining standards to artisanal mining operations must be viewed in context. Artisanal mining is currently subsistence work for most, thus safety standards may be seen as interference and could negatively impact on a worker's income. Therefore it is critical that mine owners realise the importance of finding a balance between this and the need to improve the working conditions. Standards must be relevant, with the concept that the introduction to safety measures should be seen as a process requiring the relevant buy-in from a number of stakeholders; starting with the miners themselves and including the mine owners, governmental agencies, the community and mineral buyers. Together, appropriate minimum standards should be identified and progressive improvement in standards established. The implementation of mine health and safety standards should be seen as a process with immediate to short-, medium-, and long-term goals.

Artisanal miners must be able to understand the benefit of the proposed safety standards in order for change to take place. Initial standards must be realistic and achievable so that immediate results can be seen, thereby encouraging the miners to commit to and remain engaged in the process. Unrealistic goals will result in noncompliance and failure. To some extent, mine owners will be required to enforce basic safety standards. Failure to comply should result in corrective action being taken by the government and the threat of losing technical or financial support by government or mineral buyers should be used as further motivation.

Rewarding positive behaviour should be considered to jump start the safety process so as to create a positive response. This could be in the form of an increase in salary or purchase price in the metal/concentrate linked to general safety compliance and performance. It must be understood by all participants that the transformation required will incur costs. The cost of such action needs to be shared amongst government, owners, workers and buyers. However, by introducing improved

standards and working conditions, it anticipated that the additional costs incurred for improving conditions will be off-set by the increase in productivity.

Mining is often conducted in an up-dip orientation (Figure 1), with water being used as a medium to move the ore downwards into gullies or slushers (Figure 2) where the mineralised material is concentrated. Mining tools consist of picks and shovels. Material is excavated off the face using picks, with workers forming a line and transporting the material with shovels down-dip into the slusher formed in the centre of the mining area. In some cases, small tunnels from 2 m to several metres long are developed into the ore body, which then induce the overburden to collapse. In other cases, water is placed on the surface where the water causes swelling of the soil, resulting in the collapse of the highwall area. In the gully, the heavier material is concentrated and stockpiled adjacent to the gully at the base of mining operations. The remaining material that has not been concentrated continues downstream where the material eventual settles, with the heaviest material settling in proximity of the mine, while the lighter material can travel several hundreds of metres downstream.



Figure 1. Up-dip mining.



Figure 2. Slusher used in up-dip mining.

CAPACITY BUILDING

The objective of a capacity-building programme for artisanal small-scale miners, through the participation of a number of simple training courses, is to migrate artisanal mining to a small-scale mining industry in Central Africa. Through developing the necessary skills in the fundamental areas of mining and its ancillary functions, it is proposed that artisanal mining can become more productive and safer. The areas of instruction to build the capacity of small scale miners are as follows:

- Exploration techniques and geological knowledge;
- Mining methods and techniques;
- Material handling including mine access;
- Mine surveying, sampling and grade control;
- Mineral processing;
- Waste disposal and tailings storage;

- Safety, health and environmental management;
- Social and community engagement;
- Understanding of legal requirements;
- Business fundamentals.

Exploration Techniques and Geological Knowledge

Geological knowledge and the establishment of the mineral resources are the foundation to any mining project. However, artisanal operations have little or no knowledge to the extent of the deposit, with artisanal miners pursuing the outcrop of the pegmatite veins without knowing the extent of the mineralisation. Mining continues until the vein is depleted or hard rock is intersected, necessitating drilling and blasting.

Basic geological knowledge and exploration techniques suitable for SSM operations need to be developed so that fundamental mine planning and project evaluation can be conducted. A fit-for-purpose module is required for basic geology: for example, the identification and characteristics of rock types and minerals, including the specific economic geology of Central Africa. For prospecting and exploration purposes, basic skills like map reading, sampling and exploration techniques need to be addressed, including how to estimate a mineral resource (volume, tonnes and grade).

Mining Methods and Techniques

Artisanal miners do not understand the fundamentals of mining. Surface mining generally fails to use bench mining techniques. Underground access via portals is seldom excavated safely nor are the basic rock engineering principles used to achieve stability of the underground rock mass. Applying basic mining methods with appropriate rock breaking techniques, load and hauling of ore, support and associated facilities, such as secondary access ways, pumping and ventilation, is seldom done.

A number of mining modules are required to address mining and mining techniques. Typical areas for learning include identification of surface versus underground mining, surface mining, mine access, underground mining, rock breaking techniques, material handling, mine support, mine power and drainage, rock engineering and ventilation.

Mine Surveying

Basic survey skills are required to ensure efficient and safe mining. The ability to mine at right angles is critical for support requirements as is the ability to determine the position of the underground workings for purposes such as ventilation shafts, secondary access ways and monthly measuring of mined volumes and tonnages.

Mineral Processing

Basic principles of mineral processing are understood in the artisanal mining environment. Methodologies to optimise mineral processing are not well understood and potential increases in recoveries and profits unrealised. Therefore increasing knowledge in crushing and grinding, screening and classification and mineral separation is required.

Waste Disposal and Tailings Storage

The two main sources of waste produced in artisanal mining are waste rock and tailings. These wastes have different properties and need to be handled in different ways. Poor waste and tailings management can lead to death, cessation of mining and cause conflict with government authorities and adjacent communities.

Discussion as to the location and the stability of waste and tailing storage facilities, as well the management and monitoring of the facilities, should be covered. The construction of tailings storage facilities and water control systems should be reviewed and understood.

Safety, Health and Environmental Management

Safety and health issues should be addressed, discussing basic concepts of hazards associated with lifting heavy materials, mechanical equipment and tools, chemicals, gasses and fumes and electrical shock. Sanitation, first aid equipment and training, risk identification and control measures should also be addressed as learning outcomes.

Although mining permits include guidelines to protect the environment, compliance is poor. Promotion of good environmental management practices should be covered in course work: for example, Environmental Impact Assessments (EIA) can be beneficial to mine developers in that compliance can lead to good community interaction, are a requirement for finance and create a positive relationship with the government. Understanding of environmental impact assessments and monitoring should be covered.

Understanding of Legal Requirements

Artisanal miners need to be issued with a license to legally mine. Some of the benefits in having legal tenure include secured tenure, government-assisted training and support, access to financing and a voice with government. Understanding the mineral policy of the country where operations are taking place is critical because items such as financial, environmental, social and mining acts and regulations have a major impact on any mining operation.

Business Fundamentals

Business skills are important in order to convert artisanal to small-scale mining. It is a common occurrence for miners to invest in equipment without understanding the value of the acquisition. Understanding market demand and pricing is equally important. Candidates will be instructed in estimating the amount of precious material contained in the run-of-mine material; how and to what extent the precious metal is removed/concentrated and in what acceptable form must the metal concentrate be to achieve reasonable market prices.

CONCLUSION

Small-scale mining represents a significant sector for the Rwandan government and promises to be an important source of foreign exchange for Burundi. In order to achieve a sustainable mining industry, basic mining skills need to be developed. The capacity-building programme is designed to produce mining personnel equipped with basic technical skills necessary to work productively and safely in the Central African mining industry. Learners will be trained both theoretically and practically to meet the requirements of the mining industry to supply knowledgeable and skilled personnel capable of supporting the industry, as well as developing their own careers in the mining industry as specialists.

REFERENCES

- Butura, J. (2014). Mineral Economics, Minirena division of Geological and Mines Department, Rwanda. Personal Communication, November 2014.
- Kagabo, J. (2014). Department of Geology and Mining Department (GMD) and Rwanda Natural Resource Authority (RNRA). Personal Communication, November 2014.
- Perks, R. (2015). Mining cooperatives: re-invigorating small-scale mining participation and benefit in Rwanda. PhD thesis, University of Reading, United Kingdom (in press).
- US Geological Survey (2011). *Mineral Commodities Summary 2011*. US Department of the Interior.
- World Bank (1995). *Regularizing Informal Mining. A Summary of the Proceedings of the International Roundtable on Artisanal Mining*. Mamadou, B. (ed.). Organized by the World Bank, Washington, D.C., May 17-19, 1995.

