

Re-opening of old gold mines for small scale mining in South Africa -

The Process of Creating a Small Scale Mine in a Historically Mined out South African Gold Field

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The opportunity to re-open old abandoned gold mines in South Africa, many of which are forgotten and vandalized, presents the investor, government and community a viable way to establish a legal small scale mining industry. Under the right circumstances many of these abandoned mines offer a potential return on investment. The value add is not only for the investor and state, but also benefits the surrounding communities that were established around these mines years ago and could uplift the community's current socio economic status.

Many of these gold mines have substantial mineral resources that could support small scale mining for the next 10 years and play a material role in the inland revenue of South Africa and the rejuvenation of the local economies.

The issue of abandoned gold mines is important to the South African nation because it represents many former mining sites that continue to pose a real threat to human health and safety, environmental damage and regional poverty and in many cases, abandoned mines are considered a negative legacy to the mining industry. The presence of old abandoned gold mines negatively influence the public perception of the mining industry. Generally, abandoned mines are sites where exploration, mining or mine production ceased often without rehabilitation having been implemented or incomplete.

The re-opening of abandoned mines offers an opportunity to provide employment for now defunct historical mining communities. If properly done, small scale mining can offer employment to persons currently conducting illegal mining - an extremely dangerous activity that most people undertake due to a lack of other safer and legal opportunities.

This paper documents the methodology that is required to gain legal access to an abandoned mine (shaft) for the purposes of exploration, technical economic evaluation and fulfilling the necessary legal requirements to eventually bring the abandoned mine to production.

INTRODUCTION

Mining in general, and South African hard rock mining industry in particular, has faced a number of challenges over the past three decades resulting in declining production and subsequent mine closure. *Figure 1* illustrates the overall decline of the South African mining industry since 1980 (COM, 2015;). As can be seen, the gold industry accounted for over 60% of all mining-related employment in the early and mid-1980s. Currently, gold mining represents just over 20% of the employment for the South African mineral industry with direct mining-related employment steadily decreasing from 800 000 in the 1980s to 464 000 employees in 2017 (Rupprecht, 2016).

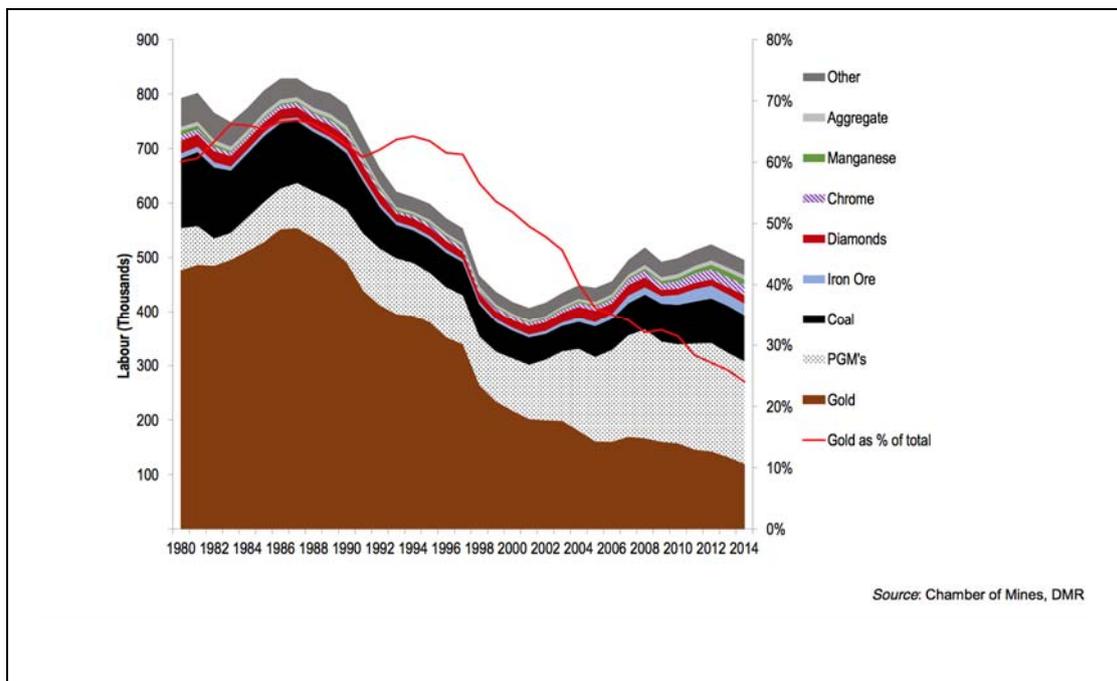


Figure 1. Direct employment in the South African mining sector in 2014 (COM, 2015).

The scope of this paper is to highlight the requirements in order to open an abandoned shaft with the objective of providing a viable and sustainable small scale mining operation. Mining. Through the act of reviving abandoned shafts in the South African gold fields companies can contribute to the economically and sustainable growth of depressed communities. Creating a small-scale mining industry will positively impact on the livelihood of many South Africans, as well as benefit the growth of the wider economy. This paper looks at the process of navigating the governmental and legislative requirements of achieving an exploration license and mining right, as well as discuss the technical inputs that demonstrate the viability of small scale mining.

The reader should note that much of the following material is sourced from Mr James Pieters Mtech dissertation, "Re-opening of closed mines for small scale mining in South Africa", which was accepted in June 2018.

GUIDELINES TO RE-OPENING CLOSED SHAFTS

The following section provides guidelines for the re-opening of closed shafts, obtaining legal permissions; conduct mine design and run a techno-economic evaluation of establishing small-scale mining based on the established mineral resources of a defunct mine. The following guidelines highlight the various steps required to gain both financial and governmental approvals for small-scale underground gold mining in South Africa.

Reconnaissance

The first step in developing a project must be gaining a fundamental understanding of the deposit, its geological continuity, and the potential grade and tonnage of the mineralised material. Obtaining adequate information on the deposit and potential mineable targets is critical in project development, as funding for small-scale mining can often be difficult to obtain due to the uncertainty associated with small-scale mining of an abandoned operation and/or the lack of a mineral resource.

- Obtaining historical information of the mine or shaft's potential is a critical first step, as funding for small-scale mining can often be difficult to obtain due to the uncertainty associated with a closed operation and/or the lack of a mineral resource.
- Access to underground working, although may not always be available, is a good way to source information regarding the potential of the project area.
- Obtaining sufficient geological information is paramount, as financiers require Mineral Resources as a means to justify investment and to reduce financial risk.

The small scale miner must apply a systematic approach to exploration in order not to waste time and money. Exploration operations in the manner of reviewing historical data may prove useful. If available, survey sheets and block plan sheets can be used to identify target areas for further exploration activities. Figure 2 provides an example of an extraction schedule for a large barrier pillar found to be suitable for mining.

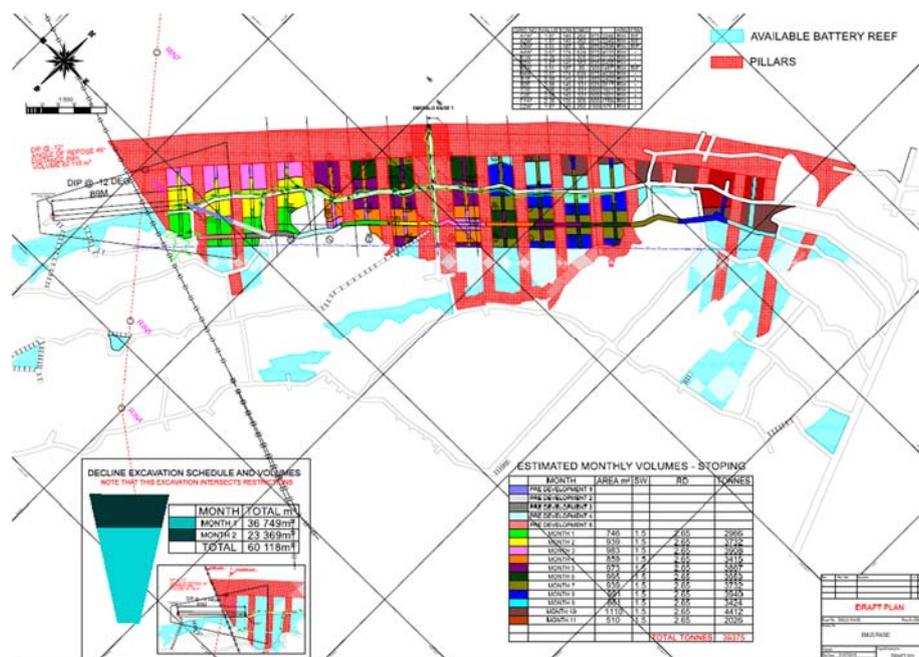


Figure 2: Example of extraction schedule

Social License to Operate

The mine operation must co-operate with the Integrated Development Plan (IDP) of the mine communities. This means that the plan provided by the mine through consultation with communities and any relevant authorities must be in line with the existing IDP's of the community. The Social and Labour Plan (SLP) should also include the key economic activities around the mining community, as well as any negative impacts that may occur due to mining activities. Development projects such as infrastructure projects and all income generating projects must be specified. A project plan summary must also be attached under this section. Any means of addressing housing and living conditions of employees and community members should be provided. This plan should be integrated in the municipality's housing plan.

In addition to the above considerations a large number of legal conditions must be met before exploration or mining activities can take place.

- Upliftment of Section 54
- Exploration Permit;
- Mine Works Programme;
- Social and Labour Plan;
- Environmental Impact Assessment;
- Community Scoping Report; and
- Rehabilitation plan.

Re-opening and Equipping

Re-opening of old defunct shafts is a major undertaking both from a safety point of view and financially, the latter is the greater of the two as unforeseen failures and equipment might be required to be replaced to ensure the safety of both men and machinery to execute the works. Once the shaft system is safe to operate the underground workings can be rechecked / resonances done with mining teams to establish the full extent of the equipping that will be required to ultimately set these shafts back into production.

Although mine access may have been secured for reconnaissance purposes, mine access is now required to support mining operations. The rehabilitation of the shaft, its infrastructure, as well as stations, haulages and working areas are required and may represent a significant cost and time.

Other technical issues such as ventilation and cooling, rock engineering, infrastructure and mineral resource management need to be addressed. Establishing a mineral reserve should be viewed as a mandatory requirement and is undoubtedly required if further funding is required from outside investors. Thus a robust mine plan and schedule is required inclusive of equipment requirements, human resources and related operating and capital cost requirements. Infrastructure requirements, such as compressed air, water, mine drainage, and material handling is also required. Mineral processing, tailing storage facilities and surface services are also required and should be considered and costed. Finally, closure requirements must be considered and financial provisions provided.

Underground Mapping

Obtaining underground mapping is an essential step in the acquisition and interpretation of geological information required to establish the geological and techno-economical potential of a closed mine. The geological mapping involves making geological observations, taking measurements, plotting and interpreting geological features. Geological mapping involves the recording of quantitative and qualitative databases on 1:200 and 1:1,000 plans. Based on this data a geological map or model can be created on which a mining plan can be developed. The above data can either be recreated by undertaking new underground observations or in some case the geological information can be sourced from historical mapping found on survey sheets and block plans.

Historically, all on-reef working places and crosscuts were mapped geologically at least once a month. All off-reef working places, with the exception of box holes, were mapped geologically at least once a month. Within the development tunnels and stopes, the survey pegs are precisely located in three dimensions by X, Y and Z coordinates, hence they were used as fixed reference points in order to correctly orientate and plot the mapping on the working plans on surface.

Stope Mapping

The objectives of stope mapping is largely to identify and record the positions of faults, dykes and any other disturbances of the reef zone so that projections can be made ahead of the face. The other objective of stope mapping is the recording the thickness and nature of the reef, as well as the grade of the reef, which is later, reconciled with the geological model. Lastly, stope mapping records reef left in the footwall or hangingwall.

Mineral Resource Determination

Mining in the South African Goldfield has continued over many years with the geology and structure of the Witwatersrand reefs well understood. For many abandoned mines there exists un-mined areas that have a high level of geological confidence, especially those areas that previously held Measured and Indicated Mineral Resources.

The data collected in the mapping process forms the basis for the geological interpretations. The geological model is, therefore, based on years of geological information and is also used to compile geological domains. These domains can then be used to help set up historical sampling grids and sampling widths. Ultimately, all this geological data leads to the development of a geological model, which enables the mineral resource geologist to evaluate the mineral resource blocks and establish a Mineral Resource.

Mine Design and Plan

Based on the estimated Mineral Resource a suitable mining method (mine design) should be selected, and a life of mine plan established.

- Determine appropriate production rate, mining method, and design criteria;
- Based on the design criteria, the equipment selection process can take place;
- Infrastructure, engineering and other services requirements should be determined i.e. power, water, pumping, ventilation etc; and
- Mineral beneficiation, toll treatment versus owner operated with associated responsibilities of tailings storage facilities.

Financial Evaluation, Sensitivity and Risk Assessment

Before deciding to actually reopen a closed shaft, sufficient technical and financial evaluations must be conducted to convince interested parties to invest in the project. In order to do this the following best practices should be undertaken:

- Technical inputs must be sourced based on appropriate assumptions that can be based on historical information, neighbouring projects or other relevant information;
- Financial evaluations should be based on appropriate market information supported by a realistic LoM plan (grade and tonnage schedule); and
- A risk assessment must be conducted identifying the technical, environmental, social, economic, political and other key risks to the project. The sensitivity analysis should include actions that will be taken to mitigate and/or manage the identified risks.

Things to be considered / completed prior to a company / investor opening a closed mine:

- The mining right and title should be in your / company name to have legal access to the premises;
- Engage with a reputable legal firm to assist in handling all legal matters on your behalf;
- Gather as much first hand info as possible from locals that were working these mines, to establish what was the cause, and how did the mine close e.g. Abruptly or a slow death. The latter is the worse of the two, as this would have had a cancerous effect on all employees and vandalism would have occurred before mine closure and all underground work was stopped;
- Obtain any mine plan information where surveyors measured and or grade etc., to support your competent persons report and feasibility study to determine whether this is a feasible proposition or not;
- Establish if there is any zama-zama activities at the mine, their mining methods, and access ways into the underground workings;
- Have open discussions with the local ward leaders about your intentions as well as anybody that might have an interest in the re-opening of the mines.
- Discuss with ESKOM regarding the power reticulation re-establishment or re-connection and the cost involved, also the previous maximum monthly capacity that the previous owners had with ESKOM, as you will be required to install a secondary source of electricity generating systems like a diesel generators or generators to power up essential infrastructures such as winders and main fans in the event that there is a ESKOM fall out on the grid. We must be able to safely remove all employees from underground.
- Assess the surface infrastructure and estimate the cost to repair, with specific reference to the winder houses and shaft headgear and attachments.
- Discuss with DMR possible section 54's that were issued on the previous owners of the mine or mines, and start working around these to have them uplifted;
- Inspect all ventilation shafts or ducts, and do a complete environmental survey or air quality;
- Inspect all sewerage systems and discuss with local municipalities the cost to re-instate these systems.
- Discuss with local municipalities the re-connection of potable water to the shafts and the estimated cost;
- Employ a security company to secure and patrol the premises on a 24hr basis to prevent any theft of critical structures or property;
- Put an advert in the local newspaper that you will reward anybody that can assist or provide information, plans and possible electronic mineral resources information of the mines at time of stoppage to gather information;
- Fly a drone over the entire property or properties and get a holistic picture of the extent of the property and damages or infrastructure;
- Build an estimated budget to repair the surface infrastructure called Phase 1 of the operation. Use the principal of worst-case scenario in the estimate;
- Get a reputable company to develop your environmental management programme and an Environmental Impact assessment.
- Seek information in the market with previous stake holders regarding possible info sharing on ore reserves or ore resources as this is vital in any decision making with regards to mining plans and payback periods to get investors to invest into this new venture;
- Appoint a certificated mine manager and submit;
- Establish what your rehabilitation liability will be at mine closure and prepare a financial statement/ guarantee to support this and submit to DMR regional manager for processing/ evaluation and acceptance;
- Develop a Mines Work Programme and SLP and submit this to DMR; and
- In the surrounding town and townships meet up with real estate agents or ward leaders to gather information on available accommodation for your planned labour force to stay close by the operations.

Once all the legal requirements have been addressed the project must address the actual technical and economic factors to facilitate mining activities. Key areas to be considered for start-up include the following:

- Refurbishing and repairs to all surface infrastructure;
- Commissioning of the electrical reticulation and backup generators with a connection into ESKOM substation;
- Front-end rope cutting and testing done by CSIR non-destructive testing;
- Civil and structural engineers to assess the infrastructure, conveyances and submit a detailed programme and cost v/s time lines to repair or replace components;
- Commission the winders and the attachments to conveyances.
- Conduct another environmental air quality assessment on all shafts and ventilation shafts;
- Enter into an agreement with the local trade unions and ward leaders of the communities regarding the hiring of labour for the project; this will assist your SLP greatly;
- Install a complete weather station at each shaft head and ensure that the shaft headgears are equipped with aircraft red beacons as required by the Mines Health and Safety act of 1996;
- Service all equipment that is not vandalised beyond repair and keep a detailed log sheet on all equipment;
- Secure the shaft area with a double row of fencing and install massive spotlights on the headgear, lighting up the perimeter of the shaft area at night;
- Assess the explosives bay and magazine and apply for your Explosive license and transport license with SAPS;
- Install an electronic finger print access control system to prevent any unauthorized personnel from entering your system;
- Request permission from DMR to issue a temporary winder license for every individual winder you intended to use;
- Get a 3rd party to inspect the winders individually and do a dynamic brake test on all winders and present this with your application to DMR;
- Ensure that all your employees are medically examined and screened by a registered institution;
- Start preparing your COP's (codes of practice) and special instructions and risk assessments for the tasks you intend to perform and submit to the DMR; and
- Appoint a GCC certified engineer to oversee all engineering aspects of the project and submit his appointment to the DMR.

SUMMARY AND CONCLUSIONS

According to the SA Human Rights Commission 30 000 illegal miners are involved in illegal mining with most illegal miners being foreigners working only to survive. Currently, illegal miners pose a significant problem for the South African mining industry as illegal mining poses challenges in terms of job loss, revenue lost due to illegal mining and the loss of life through illegal miners operating under dangerous conditions.

The re-opening of closed shafts in South Africa offers an opportunity to make a positive impact to the mining industry, local communities and the country as a whole. The largest impact that introducing small-scale mining would be job creation within poor communities that have been previously affected by mine closures.

A distinction needs to be made between customary law and legislative law. By doing this, South Africa can start to formalize the informal sector that is typically based on customary law.

By using these informal structures, the country can start to formalize the sub-sector of small-scale mining. Creating a legal small-scale mining sector creates an opportunity for entrepreneurship for traditional communities and individuals. It can also play a role in development and poverty alleviation.

This paper highlights a number of areas that require consideration before re-opening closed mining operations. Evaluating the assets and available mineralisation is the first step in a long and complex process. Establishing mineral resources is the most important task, as mineral resources are the foundation to any mining project. Based on the mineral resources, the mine owner is able to demonstrate “reasonable and realistic prospects for eventual economic extraction” (SAMREC Code 2016). This is generally a prerequisite to obtain a mining right and acquiring financial funding for the project.

The economic evaluation used to demonstrate the potential viability of small-scale mining is based on a single shaft producing 12,000tpm at a ROM head grade of 4.5g/t. The base case example indicates that the re-opening of a closed shaft can provide a positive, even robust, return on investment. Critical constraints are access to funding, however if this constraint is removed there is a potential to create jobs for a number of persons, 200 to 300 for a small 12,000tpm operation increasing to 2 000 to 3 000 employees for a medium scale mining operation.

Re-opening of previously closed shafts provides a potential solution to the illegal mining pandemic that is currently affecting the South African mining industry, as well as provide economic relief to depressed mining communities. It’s important that the mining industry and government use the outcomes of this research to initiate pilot projects to validate the findings in other gold fields thus initiating the first step towards alleviating poverty associated with abandoned shafts/mines and convert these disused operations into viable operations to ensure medium-term sustainability. Government and the mining industry should look to providing financial and technical support for the re-opening of these defunct (closed) shafts.

It may be advantageous for the government and/or mining companies to commission research to determine the available mineralised material that could potentially be converted to mineral resource or mineral reserve based on the small-scale mining model.

REFERENCES

- Chamber of Mines South Africa. (2015). Overview of the South African Mining Industry. Cape Town Mining Indaba, February 2015
- Chamber of Mines South Africa. (2018). Mines SA 2017, Facts and Figures Pocketbook. February 2018
- Pieters, J. Re-opening of Closed Mines for Small-Scale Mining in South Africa. MTech Dissertation University of Johannesburg. 2018
- Rupprecht, S.M., The need for material change in the South African mining industry. New Technology and Innovation □in the Mineral Industry, Southern African Institute of Mining and Metallurgy, Emperors Palace, South Africa, 9–10 June 2016 pp.253-262. ISBN 978-1-920410-82-7