# ROCK FILLA: ORE PROCESSING IMPACT ASSESSMENT

**COMPILED BY: (Albert Venter)**

| Title | Signature | Date |
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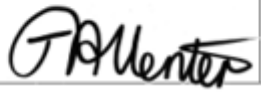
| Technical Manager |  | 27 Nov 2017 |

# DOCUMENT CONTROL

## Document Information

| | INFORMATION |
|---|---|
| Document Owner | Albert Venter |
| Issue Date | 27 November 2017 |
| File Name | RPT_201703H_Rock Filla_Ore Processing Impact Assessment_20171127 |

## Document History

| VERSION | ISSUE DATE | CHANGES |
|---|---|---|
| 1 | 27 November 2017 | None |
| | | |
| | | |

## Distribution List

| NAME | TITLE |
|---|---|
| Nardus Potgieter | Consultant |

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# 1. INTRODUCTION

Stemming material is used in the mining industry to plug the blast holes after charging. The aim of the stemming material is to contain the energy of the blast and thus improve blasting efficiency. Stemming material is usually evaluated for its ease of use, cost effectiveness and effectiveness during blasting. Any material that is used during the mining process needs to comply with health, safety and environmental regulations.

It is also important to fully understand the downstream impacts of any foreign material that is used during the mining process. This foreign material can possibly impact the material handling and/or can introduce deleterious elements into the process that negatively impacts the product recovery and/or yield.

# 2. MINING VALUE CHAIN

Each and every mine consists out of a mining value chain (Figure 1), with each of the processes in the chain having upstream and downstream impacts. The aim of this report is to assess possible impact of material used in the mining process on the processing plants.

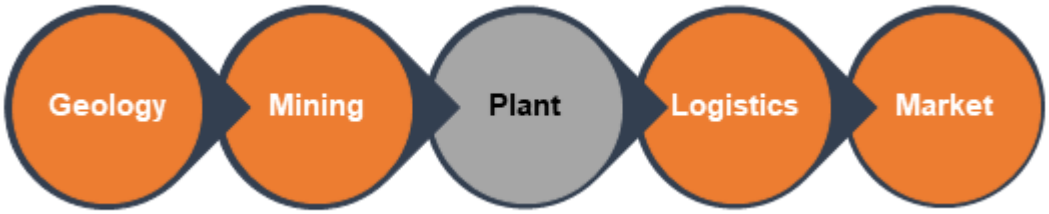


**Figure 1:** High level mining value chain. The plant area (indicated in grey) is the focus of the current report.

The stemming material is used during the blasting process. After blasting the blasted material is loaded and transported to the processing plants. Depending on the type of commodity and mine the ore will undergo a variety of treatments in order to produce a specific product at a specific quality. During this process it is vital to optimally recovery the value mineral/product as any loss directly translates to a loss in revenue.

## 2.1 ORE PROCESSING DESCRIPTION

To extract value from the mined ore, the ore needs to undergo certain processing steps. As indicated previously this is commodity and mine specific, however the processes can be subdivided into certain main steps. These steps are:

- Ore preparation
- Ore separation
- Hydrometallurgy
- Pyrometallurgy

### 2.1.1 ORE PREPARATION

Ore preparation is the process where the ore is reduced in size after mining. This is achieved by using the following processes:

- Crushing – reduction of particle size (range between 1200mm and 3mm).
- Screening – classification of particles on basis of size through the use of static or vibrating screens.
- Milling – reduction of particle size through grinding (range between 3mm and 10µm).
- Hydro classification – use of hydrocyclones to perform ultra-fine particle classification on basis of size. Used in conjunction with mills.

### 2.1.2 ORE SEPARATION

Ore separation is the process where the wanted and unwanted minerals are separated by utilising ore specific characteristics. The most common processes are:

- Dense medium separation – separating different minerals on the basis of individual mineral densities in a dense medium solution.
- Magnetic separation – separating different minerals on the basis of individual mineral magnetic susceptibilities.
- Flotation – separation of minerals based on surface properties via the use selective chemicals and bubble attachment to induce particle flotation.

- Gravity separation – separating different minerals on the basis of individual mineral settling at different rates in water due to density differences.

### 2.1.3 HYDROMETALLURGY

Hydrometallurgy refers to the process where metals or other elements are dissolved from ores and then recovered and refined from the liquid phase. The most common hydrometallurgical processes are:

- Leaching – this includes cyanidation for gold recovery and acid leaching of base metals.
- Solid/liquid separation – separation of the non-dissolved solids from the mother liquor.
- Electrowinning – the re-deposition of metals onto electrodes from mother liquors through application of current.
- Precipitation – this is done by pH control, addition of anions or cations to form insoluble salts or through additions of reductants to precipitate metals.
- Solvent extraction – this is done by the selective adsorption of metals onto resins or use of organic immiscible solvents.

### 2.1.4 PYROMETALLURGY

Pyrometallurgy refers to the process where metals or other elements are recovered and refined through smelting processes. Pyrometallurgical methods include:

- Roasting – oxidation of ores.
- Reduction furnaces – for the extraction of metals from oxides.
- Smelters – for the refining of metals and production of alloys.

# 3. IMPACT ASSESSMENT OF STEMMING MATERIAL

The following possible impacts of stemming material on the plant processes are evaluated:

- Physical material characteristics that influences crushing, screening, milling, classification and/or material handling.
- Recoverability of stemming material during ore separation and the subsequent impact of recover stemming material on product qualities.
- Chemical impacts that influence flotation, flocculation and/or hydrometallurgical processes.

It is important to note that the stemming material is diluted during the blasting and hauling process. Further, dilution occurs with the addition of process water. This assessment includes estimates on the dilution factor in order to obtain a realistic impact assessment.

The potential impact is classified as follows:

- N/A – not applicable where there is no impact anticipated.
- Low – some impact is expected but it is anticipated to be negligible.
- Medium –some measurable impact is expected that will possibly affect the process. This will require further work to establish significance of the impact.
- High – a high probability of a significant impact on the process. Further work will be required to confirm the impact and to establish mitigation measures.

# 4. ROCK FILLA – ASSESSMENT

## 4.1 KEY PRODUCT INFORMATION

| Item | Description |
|---|---|
| **Solubility of cured PU** | Zero, no leachate |
| **Density of cured PU** | 0.017±0.005t/m$^3$ |
| **Porosity of cured PU** | High |
| **Dilution** | Between 7.3 and 8.6 kg PU per 190 tonne blast<br>(Calculated as follows: 22-26 holes per can PU,<br>mass of one can PU is 900g, 210 holes per 190 tonne blast) |

## 4.2 ASSESSMENT

| Commodity | Processing Step | Element | Possible Impact | Threshold Value | Measured Value | Dilution Factor | Expected Process Value | Likelihood of Impact | Comments |
|---|---|---|---|---|---|---|---|---|---|
| All | Crushing | PU foam | None expected | N/A | N/A | N/A | 38 to 45 g PU/t ore | N/A | |
| All | Screening | PU foam | None expected | N/A | N/A | N/A | 38 to 45 g PU/t ore | N/A | |
| All | Comminution | PU foam | None expected | N/A | N/A | N/A | 38 to 45 g PU/t ore | N/A | |
| All | Hydro classification & pumping | PU foam | Blocking of pumps and cyclones | N/A | N/A | N/A | 38 to 45 g PU/t ore | Low | This will only occur due to large pieces of PU foam ending in sumps and pumps. If used as stemming material the changes of intact pieces of foam ending at plant is small. Downstream use will however increase this possibility significantly. |
| Coal, iron ore, chromite & manganese | Dense Medium Separation | PU Foam | None expected | N/A | N/A | N/A | 38 to 45 g PU/t ore | N/A | Concentration is insignificantly low compared to bulk commodity. |
| PGE Recovery | Flotation | PU Foam | None expected | N/A | N/A | N/A | 38 to 45 g PU/t ore | N/A | Low concentration. No indication of PU acting as reagent consumer. PU reports to froth thus not depressing PGE recovery. |
| PGE Recovery | Smelting | PU Foam | None expected | N/A | N/A | N/A | Unknown | N/A | PU is flammable and will completely burn-off |
| Gold Recovery | Leaching | PU Foam | None expected for carbon poisoning | N/A | N/A | N/A | 38 to 45 g PU/t ore | N/A | Low concentration. PU is insoluble thus does not poison carbon. |
| Gold Recovery | Leaching | PU Foam | Pregnant solution robbing | N/A | N/A | N/A | 39 to 45 g PU/t ore | Low | Low concentration. PU may act as a pregnant solution robber similar to wood chips. No current work available to establish possible threshold values. |
| Gold Recovery | Leaching | PU Foam | None expected for impacting pH | N/A | N/A | N/A | 40 to 45 g PU/t ore | N/A | Low concentration. PU is insoluble thus does not impact pH. |

# 5. CONCLUSIONS

The following are the main conclusions:

i. If the Rock Filla is used as stemming material there is no measurable impact expected in the processing of the ore.

ii. Downstream use of Rock Filla for other applications may result in pump or cyclone blockages.