Classification Report

NOKENG FLUOROSPAR MINE (RF) (PTY) LTD

WASTE STREAM:

ASH SAMPLES

September 2019

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The sample mentioned in this report were analysed as received by the laboratory. UIS Organic laboratory takes no responsibility for sample/s prior to submission: this includes sampling, sample container, storage, information supplied regarding the sample and shipping to our testing facility. The sample is analysed per customer request.

The information contained in this report is based upon data considered to be accurate at the time of preparation. UIS Organic Laboratory (Pty) Ltd, has taken reasonable care in the preparation of this report, however it assumes no responsibility or liability to the accuracy as well as the suitability of the information, for both the intended purpose of this waste stream or any consequences of its use. Since regulatory standards and guideline recommendations are revised on a continues basis, UIS Organic Laboratory cannot insure that the information contained in this report will be current at the time of use.

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Storage Conditions in the Laboratory: Fridge @ <6 ^{0}C

Abbreviations:

UTD – Unable to Determine

NR – Not Requested

BDL – Below Detection Limit (Please note that if the results for an analyte is below our detection limit, it does not indicate that the sample is clean or that the analyte result is equal to zero.)

TOM – Total Organic Matter

TOC – Total Organic Carbon

LD50 - Lethal Dose, 50% kill

NOEC – No Observed Effect Concentration

CCOHS - Canadian Centre for Occupational Health and Safety

Executive Summary

The ash sample were submitted by Nokeng Fluorspar mine (RF) (Pty) Ltd to UIS Organic Laboratory (Pty) Ltd for Waste Classification. The sample were registered on 19 August 2019.

The samples were analysed per customer request. To determine the sample composition XRF and XRD were used, no other analysis. Waste assessment were also not done prior to the classification. The physical hazards were tested, but the health and aquatic hazards were estimated from the sample composition.

The SANS10234 classification showed that the waste stream has a carcinogenic risk if the dust is inhaled, due to the quartz (crystalline silica) content. Due to the quartz the waste stream also has a carcinogenic risk.

A safety net classification was used for the aquatic hazards. The waste stream is classified as a category 4 chronic hazard.

Further analysis that could be done; Bio-Elution and Transformation/Dissolution analysis. No organic analytes are suspected in the ash sample.

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Introduction

UIS Organic Laboratory was appointed to do Waste Assessment (not part of this report), Classification and compile an SDS (not part of this report). This was performed using mainly the following standards and/or regulations. Please note that the report contains various quotes or copied section, directly from the following regulations.

- GN R. 634: Waste Classification and Management Regulations (National Environmental Management: Waste Act, 2008 (Act no.59 of 2008))
- GN R. 635: National Norms and Standards for the Assessment of Waste for Landfill Disposal (National Environmental Management: Waste Act, 2008 (Act no.59 of 2008))
- GN R. 636: National Norms and Standards for Disposal of Waste to Landfill (National Environmental Management: Waste Act, 2008 (Act no.59 of 2008))
- Globally Harmonised System of Classification and Labelling of Chemicals (GHS); SANS 10234:2008.

The Waste Classification and Management regulations were published on 23 August 2013. This were published in conjunction with two other acts, GN R. 635 and GN R.636. The purpose of these regulations is as follow;

1. Regulates the classification and management of waste.
2. Establish a mechanism and procedure for the listing of waste management activities that do not require a Waste Management Licence.
3. Prescribe requirement for the disposal of waste to landfill.
4. Prescribe requirements and timeframes for the management of certain wastes.
5. Prescribe general duties of waste generators, transporters and managers.
6. Prescribe the requirements for the assessment of waste prior to disposal to landfill.
7. Determine the requirements for the disposal of waste to landfill.

In terms of the Waste Classification and Management Regulations of 23 August 2013, Section 4 (2) states;

All waste generators must ensure that the waste they generate is classified in accordance with SANS 10234 within one hundred and eighty (180) day of generation.

These regulations also state in Section 5 (1);

That generators of hazardous waste must ensure that a safety data sheet for the hazardous waste is prepared in accordance with SANS 10234.

According to SANS 10234:2008, the classification criteria includes the following hazards;

1. Physical Hazards
2. Health Hazards
3. Environmental Hazards

The following data bases were mainly used to source information;

The Health Hazards and Environmental Hazards were determined using ECHA, CLP Inventory; https://echa.europa.eu/information-on-chemicals/cl-inventory-database.

The RTECS database from Canada's National Occupational Health & Safety Resource (CCOHS) were also used; http://ccinfoweb.ccohs.ca/rtecs/search.html.

1 Waste Classification

1.1 Waste Material

Solid sample, Ash were submitted for analysis.

1.2 Legal Framework

The standard used for waste classification is the; Globally Harmonised System of Classification and Labelling of Chemicals (GHS); SANS 10234:2008.

1.3 Methodology

Classification consist of three Hazard Classes, as seen in table 1.1.

Table 1.1: Hazard Classes and associated methods.

Hazard Class	**Methods**
Physical Hazards	All 14 Physical Hazard categories has different methods specified by SANS 10234.
Health Hazards	Bio-Elution analysis; Gastric Extraction, Intestinal fluid, Alveolar fluid and Sweat. As well as estimates using the ingredients.
Aquatic Hazards	Acute Toxicity: Fish species *P. reticulata* (Guppy), OECD 203; Crustacea species *D. magna* (Water flea), OECD 202; Aquatic Plant Species *S. polyrhiza* (Duckweed), OECD 201.

1.4 Results and Lab Analysis

XRF and XRD analysis were done as the only measure to determine the sample composition. This is usually sufficient for mine mineral waste such discard dumps and waste rock. The hazards contained in is this report is based on estimations from the sample composition. According to SANS 10234, the following criteria (cut-off values) is used to determine if a compound should be included in both an SDS and Classification report.

- If a compound is ≥ 1 % and this compound contributes to; Acute Toxicity, Skin Corrosion, Skin irritation, Serious eye damage or eye irritation, respiratory sensitisation, skin sensitivity, Mutagenicity – Category 2, target organ toxicity or if its hazardous to the aquatic environment.

- If a compound is ≥ 0.1 % and this compound contributes to; Mutagenicity – Category 1, Carcinogenicity or reproductive toxicity.

Table 1.2 shows the composition for this waste stream.

Table 1.2: The composition of the waste stream

Element	Cas No	XRF (%)	XRD (%)
Iron (Fe)	7439-89-6	6.66	N/A
Silicon (Si)	7440-21-3	19.86	6.21
Aluminum (Al)	7429-90.5	10.42	5.36
Potassium (K)	7440-09-7	0.60	N/A
Phosphorus (P)	7723-14-0	0.53	N/A
Manganese (Mn)	7439-96-5	0.07	N/A
Calcium (Ca)	7440-70-2	8.44	0.04
Magnesium (Mg)	7439-95-4	1.77	N/A
Titanium (Ti)	7440-32-6	0.79	N/A
Barium (Ba)	7440-39-3	0.17	N/A
Strontium (Sr)	7440-24-6	0.19	N/A
Sulfur (S)	7704-34-9	3.83	N/A
Oxide		46.49	11.88
Other Parameters			
Moisture (H_2O)	18.88	% g/g	
Total Organic Matter	39.70	% g/g	
Volatiles	6.54	% g/g	
Ash	63.287	%	

The total oil and grease analysis were below the laboratory's detection limit of 1 mg/L (ppm). Therefore, no oils, grease or waxes is suspected that hydrocarbon, plant or animal derived.

Table 1.2 shows the elemental composition from the XRD scan, but the scan picked up the following mineral composition. Only 23.5% of the sample is in crystalline form therefore the amorphous fraction is 76.5%.

- Quartz 9.3%
- Mullite 14.1%
- Calcite 0.1%

1.4.1 Physical Analysis

1.4.1. A. Explosive

Not Explosive, Division 1.6: Extremely insensitive article that does not present an explosion hazard and the probability of accidental initiation or propagation is negligible.

1.4.1. B. Flammable Gasses

N/A. No flammable gas produced

1.4.1. C. Flammable Aerosols

N/A

1.4.1. D. Oxidising Gasses

N/A. No oxidizable gas produced

1.4.1. E. Gasses under Pressure

N/A

1.4.1. F. Flammable Liquids (Up to 93 ºC)

N/A

1.4.1. G. Flammable Solids

Not Flammable

1.4.1. H. Self-Reactive Substances and Mixture

Not self-reactive. Type G.

1.4.1. I. Pyrophoric Substances

Not pyrophoric.

1.4.1. J. Self-Heating Substance and Mixtures

Not self-heat

1.4.1. K. Substances and mixture that on contact with water emits flammable gasses

No flammable gas emitted.

1.4.1. L. Oxidising substances and Mixtures

Not Oxidising, 3b.

1.4.1. M. Organic Peroxides

Not a peroxide

1.4.1. N. Corrosive to Metals

Not corrosive

1.4.2. Health Hazards

The health hazards are determine using acute toxicity estimates (ATE's) for the constitutes of the waste stream, sourced from the Internet, mainly RTECS and ECHA CLP online.

1.4.2. A. Acute Toxicity

According to SANS 10234:2008, chemical substances can be allocated to one of five hazard categories, based on acute toxicity by oral, dermal or inhalation route of exposure.

Acute toxicity estimates (ATE) are used to determine the toxicity. According to SANS 10234:2008 you only need to calculate the ATE's for compounds that exceeds either 0.1% or 1% as per the above explanation under section 1.4. However, in this report all the compound with a concertation above 0.1% and a LC50 values of less than 2000 mg/kg were used. Table 1.3 summarises the acute toxicity hazard. Extrapolation were not used between other routes or animals.

Table1.3: Acute toxicity hazards of Ash

	Oral Toxicity (mg/kg)	Dermal Toxicity (mg/kg)	Inhalation Toxicity (mg/l)
Calculated LC50:	>5000 mg/kg	>5000 mg/kg	>20 mg/l
Acute Toxicity Category:	Not Classified	Not Classified	Not Classified
Symbol:	N/A	N/A	N/A
Signal Word:	N/A	N/A	N/A
Hazard Statement:	N/A	N/A	N/A

Table 1.4 shows the available LC_{50} data used in the acute toxicity classification. In some instances, the element is used to source LD_{50} and in other instances salts are used.

Table 1.4: LC_{50} values obtained from databases.

Compound	Oral	Inhalation	Dermal
Iron	98,6 g/kg	< 250 mg/m3	No Data
Aluminium	> 15900mg/kg	6.1 mg/l/4h	> 5000 mg/kg
Calcium	> 2000 mg/kg	No Data	No Data
Silicon	3160 mg/kg	No Data	No Data
Magnesium	> 2000 mg/kg	No Data	> 2000 mg/kg
Sulphur	2000 mg/kg	> 5.43 g/m3/4h	2000 mg/kg
Quartz	No Data	No Data	No Data
Mullite	2000 mg/kg	6 mg/m^3	2000 mg/kg

The most likely route of exposure to the waste stream would be inhalation of dust. In general, inhaling dust may cause coughing and mild temporary irritation.

According to CCOHS, chronic exposure to aluminium dust can lead to the following temporary lung effects; pneumonia, granuloma and alveolar proteinosis. According to animal studies no scaring of the lungs were observed (pulmonary fibrosis).

Prolonged or repeated exposure to crystalline silica dust, such as quartz dust, is harmful to the respiratory system. Exposure to crystalline silica can lead to silicosis, which can be complicated by the bacterial disease, tuberculosis.

1.4.2. B. Skin corrosion and skin irritation

According to SANS 10234:2008, a substance can be classified as a skin corrosive or irritant based on hazards of its constituents. SANS 10234:2008 also states that if the substance has a pH ≤ 2 or ≥ 11.5, the substance is an eye and/or skin corrosive, unless there is data to indicate that the statement is false.

According to the CCOHS, crystalline silica lodged under the skin as a result of a physical injury may cause granulomas. This reaction can be delayed for weeks or even years after the accident.

Sulphur is a skin irritant, but it is not corrosive as tested on rabbit skin. Based on the sulphur concentration from the XRF results this waste stream should be a category 3 skin irritant. However not all the sulphur reported by the XRF scan will be bio available. This has not been tested, but bio-elution analysis can be done to determine how bio available the metals in the waste stream are.

Due to the above this waste stream is not classified as either a skin irritant or corrosive to skin.

1.4.2. C. Serious eye damage and eye irritation

None of the constituents of the waste stream is classified as an eye irritant.

Dust from the waste stream can irritate the eyes, as a foreign object in the eyes.

1.4.2. D. Respiratory sensitization and skin sensitization

According to SANS 10234:2008, respiratory sensitization is when a substance induces specific respiratory hypersensitivity of the airways following inhalation. Examples of this is asthma, rhinitis (conjunctivitis) and alveolitis. Skin sensitization is an allergic reaction after skin contact.

This waste stream is not classified as a respiratory or skin sensitizer.

1.4.2. E. Germ cell mutagenicity

According to SANS 10234, this hazard class are for substances that cause mutations in the germ cells of humans and that can be transferred to the progeny.

Mutation is a heritable genetic change that can manifest at phenotypic level and to underlying DNA modifications, such as base pare changes and chromosomal translocations. The term mutagenic and mutagen are used for substances that increases the incidents of mutations in populations of cells or the whole organism.

Genotoxic and genotoxicity applies to substances that alter DNA structure or information, such as interfering with normal replication. Genotoxicity test results are used as indications for mutagenic effects.

According to the RTECS database ingestion of nanoparticles aluminium oxide in rats showed positive results. However larger particles 50 – 200 micron showed negative results. The positive results obtained were numerical chromosome aberrations in bone morrow and bone morrow micronuclei. In cultured mammalian cells both positive and negative results were obtained, rendering it inconclusive.

This waste stream is not classified as a germ cell mutagen, based on its constituents.

1.4.2. F. Carcinogenicity

According to SANS 10234:2008, the carcinogenicity of a substance is based on the inherent properties of the substance. It does not provide information on the level of human cancer risk, which use of the substance may lead to.

According to the Canadian Centre for Occupational Health and Safety (CCOHS), the International Agency for Research on Cancer (IARC) has concluded that crystalline silica in the form of quartz or cristobalite dust is a human carcinogen.

Under SANS 10234:2008 Quartz dust is a Carcinogen, Category 1A.

Since the waste stream is a fine material, it is very likely that dust may be created which contains quartz. For this reason, the waste stream will need to be classified. However, if it's not in dust form or in conditions that creates dust this is not necessary. Table 1.5 shows the carcinogenic classification.

Table 1.5: Carcinogenic Classification

	Category 1A
Symbol	
Signal Word	Danger
Hazard Statement	H350: May Cause Cancer, due to inhalation.

1.4.2. G. Reproductive Toxicity (Teratogenicity in MRHW)

According to SANS 10234:2008, reproductive toxicity can refer to impairment of sexual function, fertility or developmental toxicity.

Effects on sexual function and fertility include, alterations to reproductive systems, the onset of puberty, gamete production and transport, sexual behaviour, fertility, the ability to give birth, premature aging or any other effect dependant on the reproductive system.

ECHA Reach dossier list one (1) human study, sourced from Gilbert-Barness et al. (1998). A four (4) month old girl were diagnosed with severe mental retardation. At nine (9) years of age her autopsy reveals the following; CNS cortical atrophy, small basal ganglia and hypomyelination of the spinal cord, cerebral cortex, sub cortex and cerebellar white matter. It was later found that the mother took Maalox tablets during pregnancy, which contains 200 mg of aluminium hydroxide per tablet. Later studies suggest that the high aluminium intake by the mother during the critical stages of foetus brain development, caused neurological damage to the infant. The link between aluminium and mental retardation were not proven.

There is no evidence that any of the constitutes causes any teratogenic effects.

This waste stream does not need to be classified, in terms of reproductive toxicity.

1.4.2. H. Specific target organ toxicity – Single exposure (STOT-SE)

For a substance to be classified as a STOT-SE reliable evidence of the following is necessary; consistent identifiable toxic effects in humans and test animals, the toxicological effect should be significant bringing change to the function and morphology of tissue and/or organs, thus there should be serious changes to the biochemistry or haematology of the organism. Human data should be the primary source for classification, considering all the changes that occurred to various organs.

Based on the constituents of this waste stream, it's not considered to be a STOT-SE.

1.4.2. I. Specific target organ toxicity – Repeated exposure (STOT-RE)

The criteria for classification as a STOT-RE is the same as that for STOT-SE, with the exception that the effect only occur after repeated exposure.

Quartz dust is a Category 1 STOT RE. Table 1.6 shows the STOR RE classification for the ash waste stream. Occupational exposure to crystalline silica dust can lead to the development of silicosis and pulmonary tuberculosis. There are three types of silicosis, 1) chronic which is the results of 10 or more years exposure, 2) accelerated silicosis as a result of exposure to high concentrations for 5 to 10 years and lastly 3) acute silicosis. Acute silicosis develops within a few weeks to 5 years from exposure to very high concentrations of crystalline silica.

It is also suspected that crystalline silica influences the kidneys and urinary tract as well as the liver. The CCOHS indicates that there is some evidence of this, but it has not been studied in dept.

Table 1.6: STOT RE Classification

	Category 1
Symbol	
Signal Word	Danger
Hazard Statement	H372: Causes damage to lungs through prolonged or repeated exposure via inhalation.

1.4.2. J. Aspiration Hazard

According to SANS 10234:2008 this is a substance that causes severe acute effects, such as chemical pneumonia, pulmonary injury or death after aspiration. Aspiration is initiated from the moment of inhalation.

There is no aspiration data, on the constituents of ash waste .

1.4.3. Hazards to the Aquatic Environment

To determine if a substance is hazardous to the aquatic environment, the following elements are looked at; acute toxicity, bioaccumulation, degradation and chronic toxicity.

The constituents of the sample are used to determine the toxicity.

1.4.3. A. Acute Aquatic Toxicity

Acute toxicity is determined by the following three (3) species. A fish population for 96 h to determine the LC_{50} using OECD 203. A crustacea (daphnia, water flea) species for 48 h to determine the EC_{50}, using OECD 202. Lastly an algae species or an aquatic plant species for 72 h or 96 h to determine ErC_{50} using OECD 201. The acute hazard categories are summarised in Table 1.7 below.

Table 1.7: Acute toxicity categories for substances hazardous to the aquatic environment, from SANS 10234:2008.

Hazard Category of Acute Toxicity	**Classification Criteria**	**Values**
1	96 h LC_{50} (For Fish) 48 h EC_{50} (For Crustacea) 72 h or 96 h ErC50 (For Algae or aquatic plant)	≤ 1 mg/l ≤ 1 mg/l ≤ 1 mg/l
2	96 h LC_{50} (For Fish) 48 h EC_{50} (For Crustacea) 72 h or 96 h ErC50 (For Algae or aquatic plant)	>1 to ≤ 10 mg/l and/or >1 to ≤ 10 mg/l and/or >1 to ≤ 10 mg/l
3	96 h LC_{50} (For Fish) 48 h EC_{50} (For Crustacea) 72 h or 96 h ErC50 (For Algae or aquatic plant)	>10 to ≤ 100 mg/l and/or >10 to ≤ 100 mg/l and/or >10 to ≤ 100 mg/l

The acute toxicity was calculated from the available data. Not all constituents have data for three (3) trophic levels. If the XRF/XRD data is used this waste stream will be classified as a category 3 acute hazard. Since its unlikely that the amount of metals that will leach out in the aquatic environment is the same as by XRF/XRD, this waste stream is not classified as an aquatic acute hazard.

If further is data is required a Transformation/Dissolution analysis should be done.

1.4.3. B. Chronic Aquatic Toxicity

Table 1.8 below shows the classification criteria for chronic aquatic toxicity.

Table 1.8: Hazards categories of chronic toxicity for substances hazardous to the aquatic environment, from SANS 10234:2008.

Hazard Category	**Classification Criteria**
1	a) 96 h LC_{50} (For Fish) ≤ 1mg/L; and/or b) 48 h EC_{50} (For Crustacea) ≤ 1mg/L; and/or c) 72 h or 96 h ErC50 (For Algae or aquatic plant) ≤ 1mg/L; and d) The substance is not rapidly degradable; and/or e) The log K_{ow} ≥ 4 (unless the experimentally determined BCF < 500)
2	a) 96 h LC_{50} (For Fish) > 10 to ≤ 100 mg/L; and/or b) 48 h EC_{50} (For Crustacea) > 10 to ≤ 100 mg/L; and/or c) 72 h or 96 h ErC50 (For Algae or aquatic plant) > 10 to ≤ 100 mg/L; and

	d) The substance is not rapidly degradable; and/or e) The log K_{ow} ≥ 4 (unless the experimentally determined BCF < 500) and f) Unless the chronic NOECs are > 1mg/L
3	a) 96 h LC_{50} (For Fish) > 1 to ≤ 10 mg/L; and/or b) 48 h EC_{50} (For Crustacea) > 1 to ≤ 10 mg/L; and/or c) 72 h or 96 h ErC50 (For Algae or aquatic plant) > 1 to ≤ 10 mg/L; and d) The substance is not rapidly degradable; and/or e) The log K_{ow} ≥ 4 (unless the experimentally determined BCF < 500) and f) Unless the chronic NOECs are > 1mg/L
4	Poorly soluble substances for which no acute toxicity is recorded at levels up to the water solubility, that are not rapidly degradable and have a log Kow ≥ 4, indicating a potential to bioaccumulate are to be classified in this category, unless other scientific evidence shows classification to be unnecessary. Such evidence would include an experimentally determined BCF < 500, or a chronic toxicity NOECs >1 mg/L, or evidence of rapid degradation in the environment.

From the XRD/XRF data this waste stream should be classified as a category 3 aquatic hazard. However, the metal concentrations indicated by the XRD/XRF analysis will not be available in the aquatic ecosystem. Since the waste stream consist of small particles and dust the surface area are large, a safety net classification will be used. This waste stream is also not expected to rapidly degrade. Figure 1.9 indicates the chronic hazard.

Dissolution/Transformation analysis should be conducted to confirm the classification.

Table 1.9: Chronic Aquatic Hazard Classification

	Category 4
Symbol	None
Signal Word	None
Hazard Statement	H413: May cause long lasting harmful effects to aquatic life.

1.5. Conclusion

Table 1.10 summarised the classification of the waste stream, according to SANS 10234:2008.

Table 1.10: Summary of the Physical, Health and Aquatic Hazards of Ash .

Hazard Class	Hazard Category	Hazard Statement
Physical Hazard		
Explosives	No data	None
Flammable Gasses	N/A	None
Flammable Aerosols	N/A	None
Oxidising Gasses	N/A	None
Gasses under Pressure	N/A	None
Flammable Liquids (Up to 93 ^{0}C)	N/A	None
Flammable solids	No data	None
Self-Reactive Substances and Mixture	No data	None
Pyrophoric Substances	No data	None
Self-Heating Substance and Mixtures	No data	None
Substances and mixture that on contact with water emits flammable gasses	No data	None
Oxidising substances and Mixtures	No data	None
Organic Peroxides	No data	None
Corrosive to Metals	No data	None
Health Hazards		
Acute Toxicity: Oral	Not Classified	None
Acute Toxicity: Dermal	Not Classified	None
Acute Toxicity: Inhalation	Not Classified	None
Skin corrosion and irritation	Not Classified	None
Serious Eye Damage and Irritation	Not Classified	None
Respiratory sensitization and skin sensitization	Not Classified	None
Germ Cell Mutagenicity	Not Classified	None
Carcinogenicity	Category 1 A	H350: May Cause Cancer, due to inhalation
Reproductive Toxicity	Not Classified	None
STOT-SE	Not Classified	None

STOT-RE	Category 1	H372: Causes damage to lungs through prolonged or repeated exposure via inhalation
Aspiration hazard	Not Classified	None
Aquatic Hazards		
Acute Aquatic Toxicity	Not Classified	None
Chronic Aquatic Toxicity	Category 4	H413: May cause long lasting harmful effects to aquatic life.

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