KUMBA IRON ORE THABAZIMBI MINE

MOSTERT TUNNEL LEVEL CAVE (MTC)

Wachteenbietjesdraai 350 KQ and Kwaggashoek 345 KQ

Heritage Impact Report on proposed mining activities of project Phoenix

Issue Date: 15 August 2012

Revision No.: 1

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Declaration of Independence

The report has been compiled by PGS Heritage & Grave Relocation Consultants, an appointed Heritage Specialist for Shangoni Management Services. The views stipulated in this report are purely objective and no other interests are displayed during the decision making processes discussed in the Heritage Impact Assessment.

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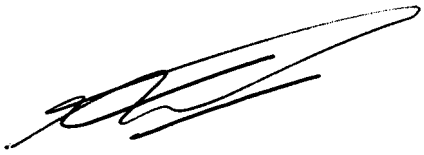

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EXECUTIVE SUMMARY

PGS Heritage & Grave Relocation Consultants (PGS) was appointed by Shangoni Management Services to undertake a Heritage Impact Assessment (HIA) to evaluate the possible impact of the Project Phoenix on the Mostert Tunnel Level MTC (MTC) situated on Wachteenbietjesdraai 350 KQ and Kwaggashoek 345 KQ, Thabazimbi Municipality, Limpopo Province.

The study utilised the specialist input covering specialist fields of archaeology, palaeontology and geology to evaluate the significance and require mitigation measures in the event that the MTC may be impacted by the mining activities of Project Phoenix.:

Archaeology

As the MTC was never open to human occupation and was only discovered in the late 1950's after an adit was mined into the Thabazimbi Mountain (Martini, 1986), no archaeological deposits was expected. During the visit to the MTC it was evident that no archaeological deposits or human access was possible in the MTC system, and subsequently no impact on archaeological resources is foreseen.

Palaeontology

There is no evidence of fossil or living creatures in the MTC. It is strongly recommended that this MTC is preserved and protected from the outside elements. Changing the atmosphere (airflow, moisture, light) will destroy the pristine aragonite and calcite crystals. Access to the MTC will have to be strictly controlled at all times (Bamford, 2012).

MTC geology and Speleothems

The MTC contains speleothems, notably aragonite frostwork, popcorn coralloids, polymineral multiaggregates and trays. In the opinion of the geologist (Cairncross, 2011), the aragonite frost and trays would qualify as rare geological specimens under the current NHRA (1999). Future mining operations make the continued existence of the MTC uncertain and local disturbances caused by surrounding mining activity may already be having an impact on the MTC's contents.

The following mitigation measures are proposed before mining commences (Cairncross, 2011):

- A selection of as many different types, varieties and sizes of the speleothems must be carefully and professionally collected. This requires specialist collecting techniques that minimize damage or, preferably, omits damage completely to the speleothems. They will need to be collected and properly handled and packed while in the MTC and then transported out of the area. NOTE: It is important to state here that due to (a) the hardness of the dolomite substrate and (b) the delicateness and fragility of the speleothems, most speleothems may be unsalvageable and best efforts will probably only yield a small percentage of the MTC's content. But this would be preferable to nothing. Furthermore, the relatively narrow opening at the entrance to the MTC precludes any salvaging of very large speleothems. Those collected, would have to be packed / laid in small open boxes lined with very soft material such as dry cleaning plastic. These small boxes would then be placed in large cardboard boxes also lined with soft material to buffer any potential damage. Boxes will have to remain open to avoid damage to the specimens. These boxes will then have to be lowered carefully down the metal stairs and loaded in vehicular transport parked at the steel door in the MTC. An inventory of specimens will be made and the samples then transported to a place of safekeeping until they can be dispersed to the relevant organisations.
- It is proposed that these specimens get donated to local museums, notably the Transvaal Museum in Pretoria and the Johannesburg Geology Museum in the Museum Africa complex, Johannesburg and any other museum with proper geological collection and curation protocols where the specimens can be properly housed and preserved. If sufficient speleothem specimens are collected then these could also be donated to local university geology departments for curation and preservation purposes, or similar institutions.
- A scientific article will be written and published on the MTC and its speleothems thereby documenting it for posterity as it will no longer be accessible or may even be destroyed.

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1 INTRODUCTION

PGS Heritage & Grave Relocation Consultants (PGS) was appointed by Shangoni Management Services to undertake a Heritage Impact Assessment (HIA) to evaluate the possible impact of the Project Phoenix on the Mostert Tunnel Level MTC (MTC) situated on Wachteenbietjesdraai 350 KQ and Kwaggashoek 345 KQ, Thabazimbi Municipality, Limpopo Province.

1.1 Scope of the Study

The aim of the study is to identify possible impacts and possible mitigation on the MTC by the proposed Project Phoenix mining activities of Thabazimbi Mine. The Heritage Impact Assessment aims to inform the EIA in the development of a comprehensive EMP and mitigation measures to assist the developer in managing the discovered heritage resources in a responsible manner, in order to protect, preserve, and develop them within the framework provided by the National Heritage Resources Act of 1999 (Act 25 of 1999) (NHRA).

1.2 Specialist Qualifications

This Heritage Impact Assessment was compiled by PGS Heritage & Grave Relocation Consultants (PGS).

The staff at PGS have a combined experience of nearly 40 years in the heritage consulting industry. PGS and its staff have extensive experience in managing HIA processes. PGS will only undertake heritage assessment work where the staff have the relevant expertise and experience to undertake that work competently.

Wouter Fourie, Principal Archaeologist and Heritage Specialist for this project, is registered with the Association of Southern African Professional Archaeologists (ASAPA) and have CRM accreditation within the said organisation.

Professor Marion Bamford, holds a PhD in Palaeobotany and has been employed since 1990 at the University of the Witwatersrand as a palaeontologist doing research, lecturing and supervising post graduate students. Her research involves much field work in Africa on a wide range of sediments of different ages. She has been doing environmental and heritage impact assessments since 1996 for diamond mining companies, uranium and coal

exploration, dam construction and urban development. The most recent project was along the Orange River where TranHex needed an assessment done before expanding their mining operations.

Professor Bruce Cairncross is head of the Department of Geology at the University of Johannesburg. Although a clastic sedimentologist specializing in coal sedimentology, Professor Cairncross is a recognized international authority on Southern African minerals, mineral localities and gemstones. He has published seven books on the subject and numerous articles. He was awarded the Geological Society of South Africa's Presidential Award in 2009 for his services rendered to the Johannesburg Geological Museum in preserving and promoting the museum's collections and he was a finalist in the National Science and Technology Forum annual prize winners for creating public awareness of science and technology. Cairncross is a Fellow of the Geological Society of South Africa (GSSA), past Vice-President of the International Association of Sedimentologists (1998-2002), and current Chairman of Johannesburg's Museum Africa's Geological Museum Association and Geological Consultative Committee.

1.3 Assumptions and Limitations

Not detracting in any way from the comprehensiveness of the fieldwork undertaken, it is necessary to realise that the evaluation of the impact on the heritage resources is based on the possible impact of mining from the Project Phoenix development. This based on the Geotechnical report completed for Project Phoenix and its findings (SRK Consulting, 2007).

1.4 Legislative Context

The identification, evaluation and assessment of any cultural heritage site, artefact or find in the South African context is required and governed by the following legislation:

i. National Environmental Management Act (NEMA), Act 107 of 1998
ii. National Heritage Resources Act (NHRA), Act 25 of 1999
iii. Mineral and Petroleum Resources Development Act (MPRDA), Act 28 of 2002
iv. Development Facilitation Act (DFA), Act 67 of 1995

The following sections in each Act refer directly to the identification, evaluation and assessment of cultural heritage resources.

i. National Environmental Management Act (NEMA) Act 107 of 1998
    a. Basic Environmental Assessment (BEA) – Section (23)(2)(d)
    b. Environmental Scoping Report (ESR) – Section (29)(1)(d)
    c. Environmental Impact Assessment (EIA) – Section (32)(2)(d)
    d. Environmental Management Plan (EMP) – Section (34)(b)
ii. National Heritage Resources Act (NHRA) Act 25 of 1999
    a. Protection of Heritage Resources – Sections 34 to 36; and
    b. Heritage Resources Management – Section 38
iii. Mineral and Petroleum Resources Development Act (MPRDA) Act 28 of 2002
    a. Section 39(3)
iv. Development Facilitation Act (DFA) Act 67 of 1995
    a. The GNR.1 of 7 January 2000: Regulations and rules in terms of the Development Facilitation Act, 1995. Section 31.

The NHRA stipulates that cultural heritage resources may not be disturbed without authorization from the relevant heritage authority. Section 34(1) of the NHRA states that, "no person may alter or demolish any structure or part of a structure which is older than 60 years without a permit issued by the relevant provincial heritage resources authority…" NHRA is utilized as the basis for the identification, evaluation and management of heritage resources and in the case of CRM those resources specifically impacted on by development as stipulated in Section 38 of NHRA, and those developments administered through NEMA, MPRDA and the DFA legislation. In the latter cases the feedback from the relevant heritage resources authority is required by the State and Provincial Departments managing these Acts before any authorizations are granted for development. The last few years have seen a significant change towards the inclusion of heritage assessments as a major component of Environmental Impacts Processes required by NEMA and MPRDA. This change requires us to evaluate the Section of these Acts relevant to heritage (Fourie, 2008):

The NEMA 23(2)(b) states that an integrated environmental management plan should, "…identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage".

A study of subsections (23)(2)(d), (29)(1)(d), (32)(2)(d) and (34)(b) and their requirements reveals the compulsory inclusion of the identification of cultural resources, the evaluation of the impacts of the proposed activity on these resources, the identification of alternatives and the management procedures for such cultural resources for each of the documents

noted in the Environmental Regulations. A further important aspect to be taken account of in the Regulations under NEMA is the Specialist Report requirements laid down in Section 33 of the regulations (Fourie, 2008).

MPRDA defines 'environment' as it is in the NEMA and therefore acknowledges cultural resources as part of the environment. Section 39(3)(b) of this Act specifically refers to the evaluation, assessment and identification of impacts on all heritage resources as identified in Section 3(2) of the National Heritage Resources Act that are to be impacted on by activities governed by the MPRDA. Section 40 of the same Act requires the consultation with any State Department administering any law that has relevance on such an application through Section 39 of the MPRDA. This implies the evaluation of Heritage Assessment Reports in Environmental Management Plans or Programmes by the relevant heritage authorities (Fourie, 2008).

Cairncross (2011), evaluated the significance of the MTC and its geological features and concluded that although the MTC and MTC systems are no longer protected under the NHRA, the uniqueness of the aragonite frost and trays qualify them as "rare geological specimens" under Section 32.1.(a) of NHRA (Cairncross, 2011).

The MTC is however protected under Chapter 10, Section 701 of the Limpopo Environmental Management Act 2003, Act 7 of 2003 (LEMA). The LEMA requires the permitting for access and sampling of material from a cave. This process will be run concurrent with the SAHRA process.

1.5 Terminology and Abbreviations

Archaeological resources

This includes:

i. material remains resulting from human activity which are in a state of disuse and are in or on land and which are older than 100 years including artefacts, human and hominid remains and artificial features and structures;
ii. rock art, being any form of painting, engraving or other graphic representation on a fixed rock surface or loose rock or stone, which was executed by human agency and which is older than 100 years, including any area within 10m of such representation;
iii. wrecks, being any vessel or aircraft, or any part thereof, which was wrecked in South Africa, whether on land, in the internal waters, the territorial waters or in the maritime culture zone of the republic as defined in the Maritimes Zones Act, and any cargo, debris or artefacts found or associated therewith, which is older than 60 years or which SAHRA considers to be worthy of conservation;
iv. features, structures and artefacts associated with military history which are older than 75 years and the site on which they are found.

Cultural significance

This means aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance

Development

This means any physical intervention, excavation, or action, other than those caused by natural forces, which may in the opinion of the heritage authority in any way result in a change to the nature, appearance or physical nature of a place or influence its stability and future well-being, including:

i. construction, alteration, demolition, removal or change in use of a place or a structure at a place;
ii. carrying out any works on or over or under a place;
iii. subdivision or consolidation of land comprising a place, including the structures or airspace of a place;
iv. constructing or putting up for display signs or boards;

v. any change to the natural or existing condition or topography of land; and

vi. any removal or destruction of trees, or removal of vegetation or topsoil

Early Stone Age

The archaeology of the Stone Age between 700 000 and 2 500 000 years ago.

Fossil

Mineralised bones of animals, shellfish, plants and marine animals. A trace fossil is the track or footprint of a fossil animal that is preserved in stone or consolidated sediment.

Heritage

That which is inherited and forms part of the National Estate (historical places, objects, fossils as defined by the National Heritage Resources Act 25 of 1999).

Heritage resources

This means any place or object of cultural significance

Holocene

The most recent geological time period which commenced 10 000 years ago.

Late Stone Age

The archaeology of the last 20 000 years associated with fully modern people.

Late Iron Age (Early Farming Communities)

The archaeology of the last 1000 years up to the 1800's, associated with iron-working and farming activities such as herding and agriculture.

Middle Stone Age

The archaeology of the Stone Age between 20-300 000 years ago, associated with early modern humans.

Palaeontology

Any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or trace.

Abbreviations	*Description*
AIA	Archaeological Impact Assessment
ASAPA	Association of South African Professional Archaeologists
CRM	Cultural Resource Management
DEA	Department of Environmental Affairs
DWA	Department of Water Affairs
EIA practitioner	Environmental Impact Assessment Practitioner
EIA	Environmental Impact Assessment
ESA	Early Stone Age
GPS	Global Positioning System
HIA	Heritage Impact Assessment
I&AP	Interested & Affected Party
LEMA	Limpopo Provincial Environmental Management Act
LSA	Late Stone Age
LIA	Late Iron Age
MSA	Middle Stone Age
MIA	Middle Iron Age
MTC	Mostert Tunnel MTC
NEMA	National Environmental Management Act
NHRA	National Heritage Resources Act
PHRA	Provincial Heritage Resources Authority
PSSA	Palaeontological Society of South Africa
SADC	Southern African Development Community
SAHRA	South African Heritage Resources Agency

Refer to **Appendix B** for further discussions on heritage management and legislative frameworks

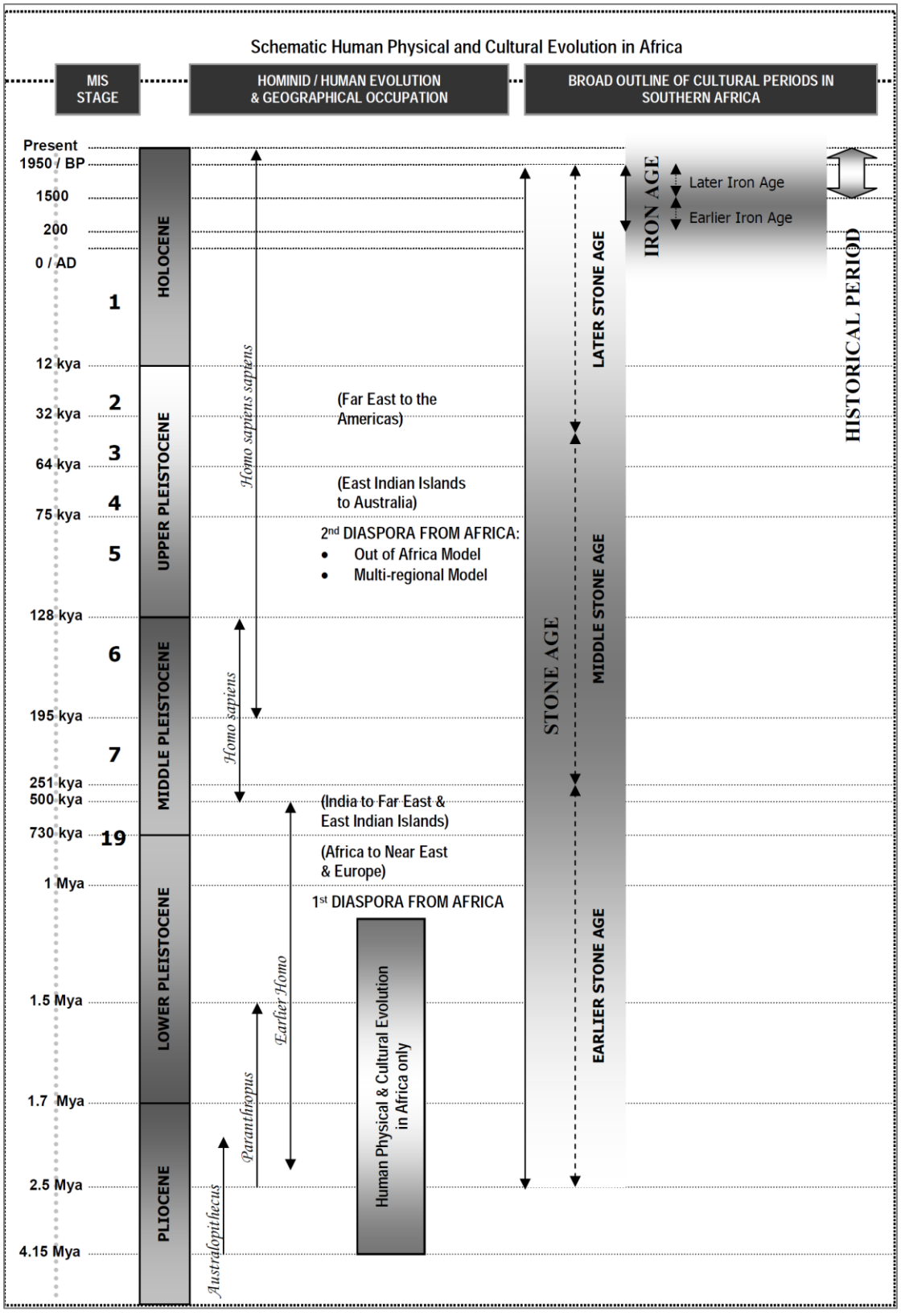

Figure 1 – Human and Cultural Timeline in Africa (Morris, 2008)

2 TECHNICAL DETAILS OF THE PROJECT

2.1 Site Location and Description

The MTC is situated on the property of the Kumba Iron Ore Thabazimbi Mine on the Thabazimbi Mountain just to the south of town (Figure 2).

Figure 2 – MTC Locality

2.2 Technical Project Description

The Life of Mine of the Thabazimbi mine is reaching its end in 2016. Kumba is investigating possibilities to extend the LOM by at least 20 years by exploiting the large low grade iron ore resources in the form of banded ironstone formations (BIF).

The above two factors give rise to the Phoenix Project.

- The current operational plant at Thabazimbi is not equipped to treat the banded ironstone earmarked for the Phoenix Plant.
- The Phoenix Project will ensure utilisation of material that has previously been classified as sub-standard material.

- Beneficiation of ore that has been classified as material that cannot be beneficiated by the existing plant or that has not been removed from the pit areas due to the nature of the material.

Phoenix Project was re-started in 2009. Project Phoenix involves the mining of banded ironstone and using improved processing technologies. All activities will take place within the existing mining right area.

- Project Phoenix exploration involves drilling and bulk sampling.
    - The exploration for Project Phoenix - in old underground tunnels & above ground.
    - Above ground exploration - drilling and a bulk sampling process whereby the material will be removed and treated in the pilot plants.

The bulk sample will be blasted and taken by means of conventional loading and hauling mining methods.

Approximately 750 000 tons of material (ore and waste rock) will be removed as a bulk sampling. This will take place in the Vanderbijl pit.

Two pilot plants namely JIG (crushing & screening) and a High Density Separation will be situated in the Donkerpoort area. The results from the pilot plants will be used to support final feasibility study for the Phoenix Project.

The MTC is approximately 200m outside the final mining pit shell as proposed in the original project Phoenix study **(Figure 3**). The proposed layout suggests that the MTC will not be mined out, but due to its proximity to the final pit shell, it will be exposed to ground vibrations from blasting and mining activities. This will furthermore have an effect on tourism activities to the MTC, as all employees/visitors within a 500m blasting radius have to be removed to a safe place as per the mine's safety procedure.

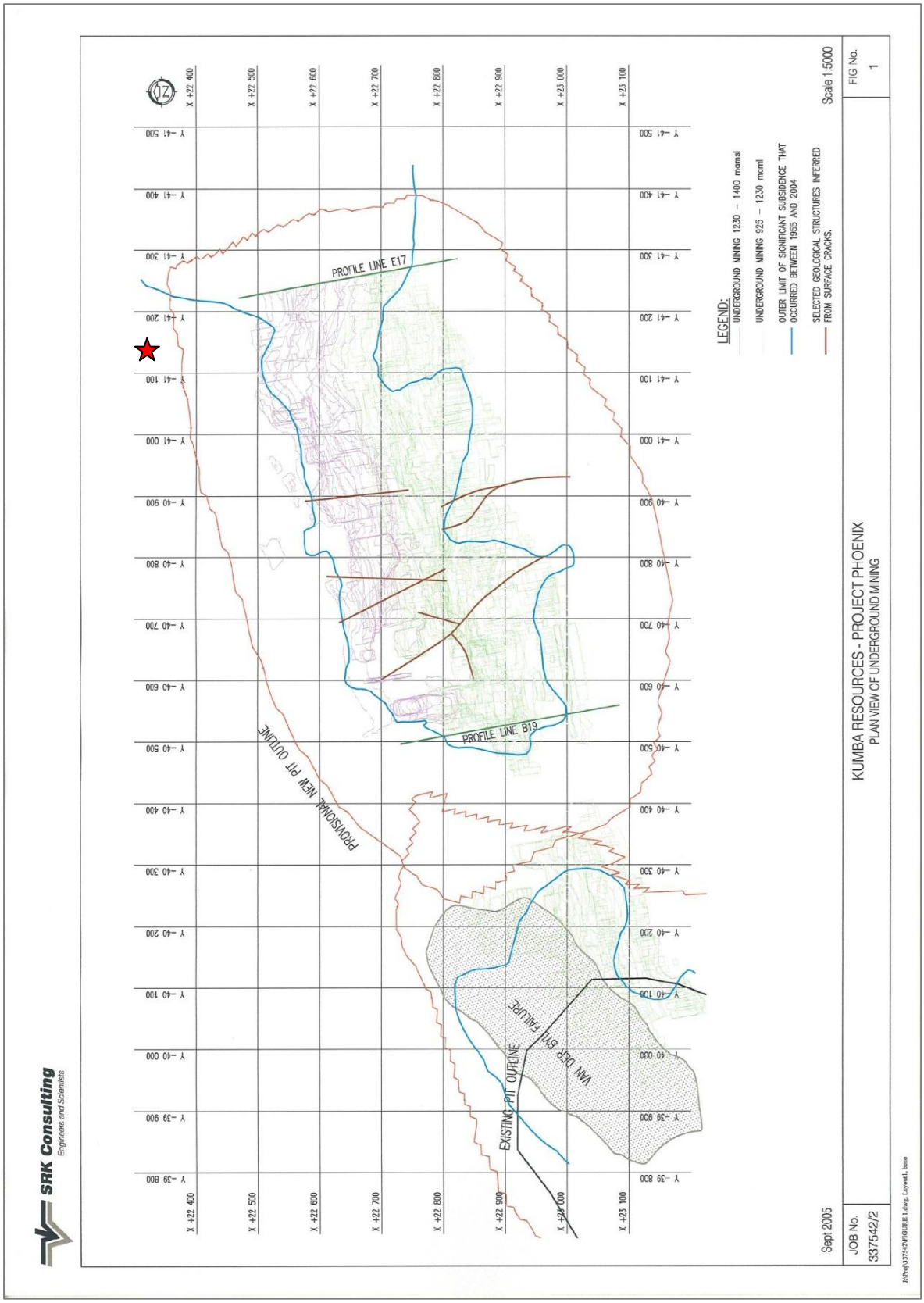

Figure 3 – Approximate position of MTC in relation to the proposed mining extent of Project Phoenix (SRK Consulting, 2007)

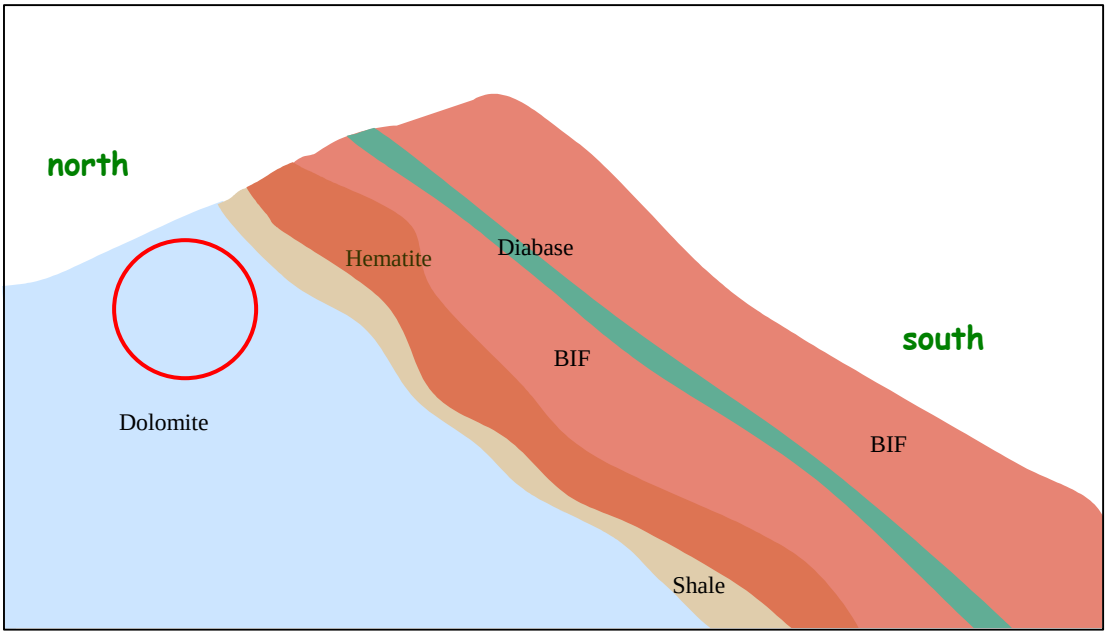

Figure 4 – Schematic Geological Section - Approximate position of MTC in relation to the geology and deposits targeted during Project Phoenix (SRK Consulting, 2007)

3 ASSESSMENT METHODOLOGY

The section below outlines the assessment methodologies utilised in the study.

3.1 Methodology for Assessing Heritage Site significance

This Heritage Impact Assessment (HIA) report was compiled by PGS Heritage and Grave Relocation Consultants (PGS) for the Mostert Tunnel Level MTC (MTC) project. The applicable maps, tables and figures, are included as stipulated in the NHRA (no 25 of 1999), the National Environmental Management Act (NEMA) (no 107 of 1998) and the Mineral and Petroleum Resources Development Act (MPRDA) (28 of 2002). The HIA process consisted of three steps:

Step I – Literature Review: The background information to the field survey relies greatly on the Heritage Background Research.

Step II – Physical Survey: A physical survey was conducted on foot through the proposed project area by qualified archaeologists (March 2012), aimed at locating and documenting sites falling within and adjacent to the proposed development footprint.

Step III – The final step involved the recording and documentation of relevant archaeological resources, the assessment of resources in terms of the HIA criteria and report writing, as well as mapping and constructive recommendations.

The significance of heritage sites was based on four main criteria:

- Site integrity (i.e. primary vs. secondary context),
- Amount of deposit, range of features (e.g., stonewalling, stone tools and enclosures),
- Density of scatter (dispersed scatter)
    - Low - <10/50m2
    - Medium - 10-50/50m2
    - High - >50/50m2
- Uniqueness; and
- Potential to answer present research questions.

Management actions and recommended mitigation, which will result in a reduction in the impact on the sites, will be expressed as follows:

A - No further action necessary;
B - Mapping of the site and controlled sampling required;
C - No-go or relocate development activity position;
D - Preserve site, or extensive data collection and mapping of the site; and
E - Preserve site.

Impacts on these sites by the development will be evaluated as follows:

Site Significance

Site significance classification standards prescribed by the SAHRA (2006) and approved by the ASAPA for the Southern African Development Community (SADC) region, were used for the purpose of this report.

Table 1: Site significance classification standards as prescribed by SAHRA.

FIELD RATING	GRADE	SIGNIFICANCE	RECOMMENDED MITIGATION
National Significance (NS)	Grade 1	-	Conservation; National Site nomination
Provincial Significance (PS)	Grade 2	-	Conservation; Provincial Site nomination
Local Significance (LS)	Grade 3A	High Significance	Conservation; Mitigation not advised
Local Significance (LS)	Grade 3B	High Significance	Mitigation (Part of site should be retained)
Generally Protected A (GP.A)	-	High / Medium Significance	Mitigation before destruction
Generally Protected B (GP.B)	-	Medium Significance	Recording before destruction
Generally Protected C (GP.A)	-	Low Significance	Destruction

3.2 Methodology for Impact Assessment

In order to ensure uniformity, a standard impact assessment methodology has been utilised so that a wide range of impacts can be compared. The impact assessment methodology makes provision for the assessment of impacts against the following criteria:

- Significance;
- Spatial scale;
- Temporal scale;
- Probability; and
- Degree of certainty.

A combined quantitative and qualitative methodology was used to describe impacts for each of the aforementioned assessment criteria. A summary of each of the qualitative descriptors along with the equivalent quantitative rating scale for each of the aforementioned criteria is given in **Table 2**.

Table 2: Quantitative rating and equivalent descriptors for the impact assessment criteria

RATING	SIGNIFICANCE	EXTENT SCALE	TEMPORAL SCALE
1	VERY LOW	*Isolated site*	Incidental
2	LOW	*Study area*	Short-term
3	MODERATE	*Local*	Medium-term
4	HIGH	*Regional / Provincial*	Long-term
5	VERY HIGH	*Global / National*	Permanent

A more detailed description of each of the assessment criteria is given in the following sections.

Significance Assessment

Significance rating (importance) of the associated impacts embraces the notion of extent and magnitude, but does not always clearly define these since their importance in the rating scale is very relative. For example, the magnitude (i.e. the size) of area affected by atmospheric pollution may be extremely large (1000 km^2) but the significance of this effect is dependent on the concentration or level of pollution. If the concentration is great, the significance of the impact would be HIGH or VERY HIGH, but if it is diluted it would be VERY LOW or LOW. Similarly, if 60 ha of a grassland type are destroyed, the impact would be VERY HIGH if only 100 ha of that grassland type were known. The impact would be VERY LOW if the grassland type was common. A more detailed description of the impact significance rating scale is given in

Table 3 below.

Table 3: Description of the significance rating scale

RATING		DESCRIPTION
5	VERY HIGH	Of the highest order possible within the bounds of impacts which could occur. In the case of adverse impacts: there is no possible mitigation and/or remedial activity which could offset the impact. In the case of beneficial impacts, there is no real alternative to achieving this benefit.
4	HIGH	Impact is of substantial order within the bounds of impacts which could occur. In the case of adverse impacts: mitigation and/or remedial activity is feasible but difficult, expensive, time-consuming or some combination of these. In the case of beneficial impacts, other means of achieving this benefit are feasible but they are more difficult, expensive, time-consuming or some combination of these.

3	MODERATE	Impact is real but not substantial in relation to other impacts, which might take effect within the bounds of those which could occur. In the case of adverse impacts: mitigation and/or remedial activity are both feasible and fairly easily possible. In the case of beneficial impacts: other means of achieving this benefit are about equal in time, cost, effort, etc.
2	LOW	Impact is of a low order and therefore likely to have little real effect. In the case of adverse impacts: mitigation and/or remedial activity is either easily achieved or little will be required, or both. In the case of beneficial impacts, alternative means for achieving this benefit are likely to be easier, cheaper, more effective, less time consuming, or some combination of these.
1	VERY LOW	Impact is negligible within the bounds of impacts which could occur. In the case of adverse impacts, almost no mitigation and/or remedial activity is needed, and any minor steps which might be needed are easy, cheap, and simple. In the case of beneficial impacts, alternative means are almost all likely to be better, in one or a number of ways, than this means of achieving the benefit. Three additional categories must also be used where relevant. They are in addition to the category represented on the scale, and if used, will replace the scale.
0	NO IMPACT	There is no impact at all - not even a very low impact on a party or system.

Spatial Scale

The spatial scale refers to the extent of the impact i.e. will the impact be felt at the local, regional, or global scale. The spatial assessment scale is described in more detail in **Table 4**.

Table 4: Description of the significance rating scale

RATING		DESCRIPTION
5	Global/National	The maximum extent of any impact.
4	Regional/Provincial	The spatial scale is moderate within the bounds of impacts possible, and will be felt at a regional scale (District Municipality to Provincial Level). The impact will affect an area up to 50 km from the proposed site.
3	Local	The impact will affect an area up to 5 km from the proposed site.
2	Study Area	The impact will affect a route corridor / site not exceeding the boundary of the site.
1	Isolated Sites / proposed site	The impact will affect an area no bigger than the site.

Duration Scale

In order to accurately describe the impact it is necessary to understand the duration and persistence of an impact in the environment. The temporal scale is rated according to criteria set out in **Table 5**.

Table 5: Description of the temporal rating scale

RATING		DESCRIPTION
1	Incidental	The impact will be limited to isolated incidences that are expected to occur very sporadically.
2	Short-term	The environmental impact identified will operate for the duration of the construction phase or a period of less than 5 years, whichever is the greater.
3	Medium term	The environmental impact identified will operate for the duration of life of the project.
4	Long term	The environmental impact identified will operate beyond the life of operation.
5	Permanent	The environmental impact will be permanent.

Degree of Probability

The probability or likelihood of an impact occurring will be described as shown in **Table 6** below.

Table 6: Description of the degree of probability of an impact occurring

RATING	DESCRIPTION
1	Practically impossible
2	Unlikely
3	Could happen
4	Very Likely
5	It's going to happen / has occurred

Degree of Certainty

As with all studies it is not possible to be 100% certain of all facts, and for this reason a standard "degree of certainty" scale is used, as discussed in **Table 7**. The level of detail for specialist studies is determined according to the degree of certainty required for decision-making. The impacts are discussed in terms of affected parties or environmental components.

Table 7: Description of the degree of certainty rating scale

RATING	DESCRIPTION
Definite	More than 90% sure of a particular fact.
Probable	Between 70 and 90% sure of a particular fact, or of the likelihood of that impact occurring.
Possible	Between 40 and 70% sure of a particular fact, or of the likelihood of an impact occurring.
Unsure	Less than 40% sure of a particular fact or the likelihood of an impact occurring.
Can't know	The consultant believes an assessment is not possible even with additional research.

Quantitative Description of Impacts

To allow for impacts to be described in a quantitative manner, in addition to the qualitative description given above, a rating scale of between 1 and 5 was used for each of the assessment criteria. Thus the total value of the impact is described as the function of significance, spatial and temporal scale as described below:

Impact Risk = (SIGNIFICANCE **+** *Spatial* **+** Temporal) X Probability

3 5

An example of how this rating scale is applied is shown below:

Table 8: Example of Rating Scale

IMPACT	SIGNIFICANCE	SPATIAL SCALE	TEMPORAL SCALE	PROBABILITY	RATING
	LOW	Local	Medium Term	Could Happen	
Impact to heritage	2	3	3	3	1.6

Note: The significance, spatial and temporal scales are added to give a total of 8, that is divided by 3 to give a criterion rating of 2.67. The probability (3) is divided by 5 to give a probability rating of 0.6. The criteria rating of 2.67 is then multiplied by the probability rating (0,6) to give the final rating of 1,6.

The impact risk is classified according to 5 classes as described in the table below.

Table 9:Impact Risk Classes

RATING	IMPACT CLASS	DESCRIPTION
0.1 – 1.0	1	Very Low
1.1 – 2.0	2	Low
2.1 – 3.0	3	Moderate
3.1 – 4.0	4	High
4.1 – 5.0	5	Very High

Therefore with reference to the example used for air quality above, an impact rating of 1.6 will fall in the Impact Class 2, which will be considered to be a low impact.

4 CURRENT STATUS QUO

4.1 Site Description

The MTC site is situated within the mining area of the Thabazimbi Mine (**Figure 2**) just south of the town of Thabazimbi. Access to the MTC site is through the Mostert Tunnel constructed during the underground mining of the Thabazimbi Mine during the 1950's (**Figure 5**).

Figure 5 – Entrance to the Mostert Tunnel (Cairncross, 2011)

Cairncross (2011) indicates that the MTC was discovered during the 1950's and only in the mid-1980, Martini (1986) documented the layout of the MTC (**Figure 9**) and made

recommendations for managing the conservation of the MTC. Since then the MTC and access was managed according to these recommendations. Small groups of visitors were escorted through the MTC at regular intervals. This practice was halted in the past 2 years due to safety concerns expressed by geotechnical experts. Refer to Appendix D for more details on the history of the MTC.

4.2 Findings

The following evaluation of the heritage significance of the MTC is based on visits done by Mr. Wouter Fourie (Archaeologist) (PGS heritage and Grave Relocation Consultants), Professor Marion Bamford (Palaeontologist) (Bernard Price Institute) and Professor Bruce Cairncross (Geologist)(University of Johannesburg), on three separate visits.

The aims of the visits were to evaluate the heritage significance of the MTC with regards to archaeology, palaeontology and geology.

4.2.1 Archaeology

A site visit was conducted by Mr. Wouter Fourie, an Accredited Professional Archaeologist from PGS Heritage and Grave Relocation consultants to evaluate the possible archaeological significance of the MTC.

As the MTC was never open to human occupation and was only discovered in the late 1950's after an adit was mined into the Thabazimbi Mountain (Martini, 1986), no archaeological deposits was expected. During the visit to the MTC it was evident that no archaeological deposits or human access was possible in the MTC system, and subsequently no impact on archaeological resources is foreseen.

Mitigation:
None required.

4.2.2 Palaeontology

The report on the palaeontological evaluation of the MTC is contained in **Appendix C**.

The findings of the study however indicated that there is no evidence of fossil or living creatures in the MTC.

Mitigation:

None required.

4.2.3 **MTC geology and Speleothems**

The evaluation of the geology and speleothems of the MTC has found that it contains speleothems that can be classified as:

- aragonite frostwork,
- popcorn coralloids,
- polymineral multiaggregates and trays

Figure 6 – Delicate in situ aragonite frostwork rising from the MTC floor. The main crystal cluster is 25 cm (Cairncross, 2011)

Figure 7 – In situ calcite and aragonite coating the MTC wall, partially stained by dust and iron oxides. Field of view is approximately 2m. (Cairncross, 2011)

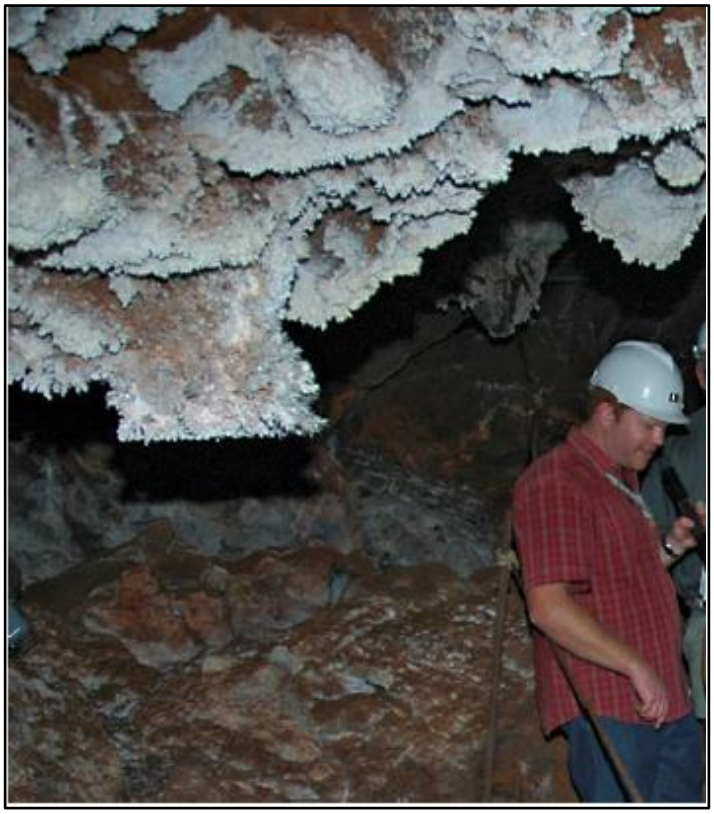

Figure 8 – Flat-bottomed in situ speleothem tray. The flat, horizontal lower surface typifies all of these tray formations, although the flat bases are at varying elevations in the MTC. (Cairncross, 2011)

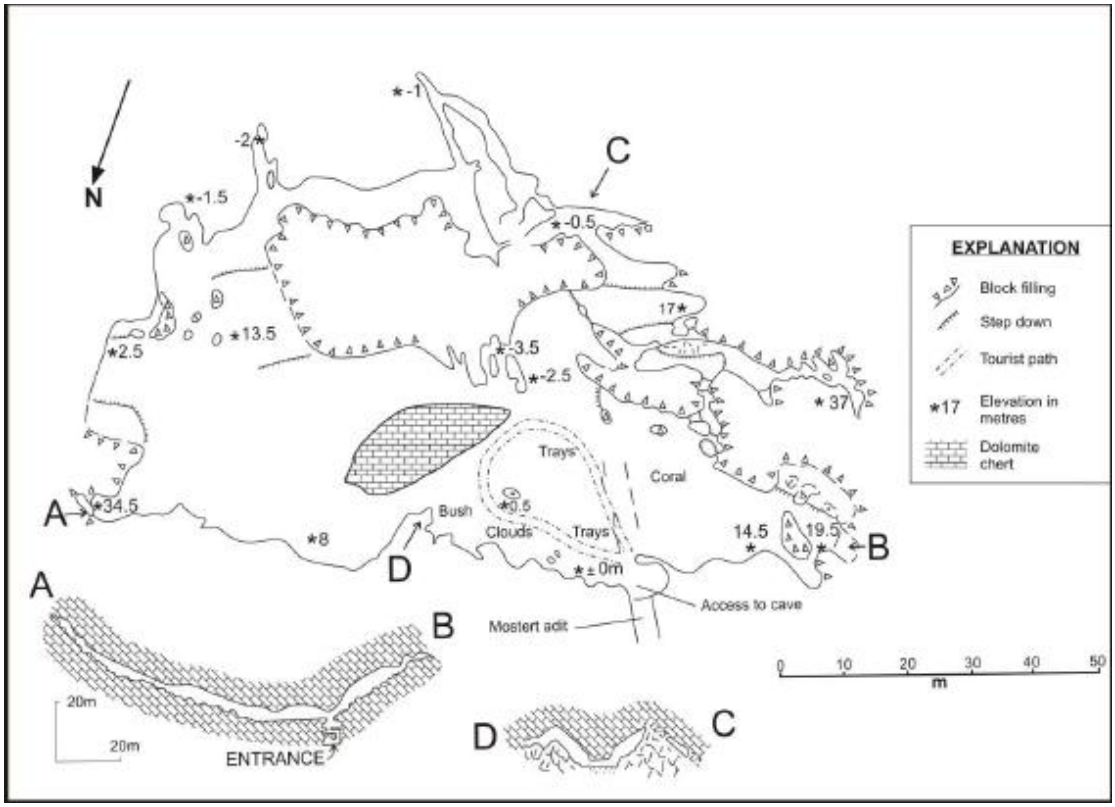

Figure 9 – Plan view of the Thabazimbi MTC and two cross-sections A-B and C-D. ((Cairncross, 2011) (Martini, 1986))

Mitigation:

Refer to Section 0 for detailed recommendation on mitigation measures.

5 IMPACT ASSESSMENT AND RECOMMENDATIONS

The proposed mining of Project Phoenix does pose the possibility of impacting on the MTC. The evaluation of the possibility is based on the work conducted in the Geotechnical Report completed for Project Phoenix (SRK Consulting, 2007).

The report identified seven (7) geotechnical zones (**Figure 10**)(**Table 10**) of importance for the project, of which Zone 1, described a dolomite (SRK Consulting, 2007) and dolomite/chert (Cairncross, 2011), containing the MTC.

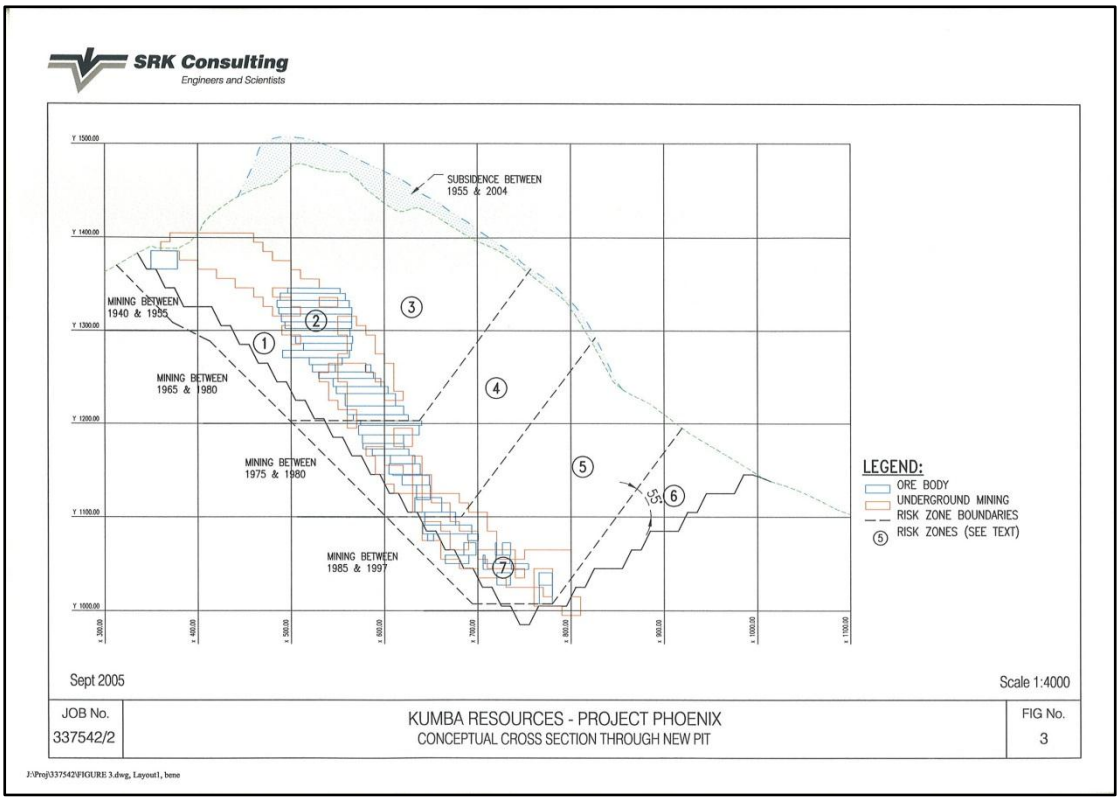

Figure 10 – Schematic Geological Section - Approximate position of MTC in relation to the geology and deposits targeted during Project Phoenix (SRK Consulting, 2007)

The SRK Report (2007) only evaluated the impact of older tunnels and cavities on the proposed mining activities and not the possible impact of mining on any MTC systems and therefore also not on the MTC. The report however does indicate that a possibility of tunnels collapse as a result of destressing during mining activities (**Table 10**) in the or close to Zone 1 (Dolomite) could occur.

It can also not be excluded that historical mining activities since the 1950's has not impacted on the MTC (Cairncross, 2011).

Table 10: Description of Geotechnical Zones (SRK Consulting, 2007)

Zone	Descriptor	Disturbance: Behaviour of Mining Blocks
1	Dolomite (footwall zone)	Intact: rock mass structure largely undisturbed De-stressed: normal stress reduced due to caving Opening on bedding planes as a result of destressing Some tunnel collapse as a result of destressing
2	Upper and central ore zone, including shale	Small block size & small voids from blasting Hang ups in draw points and cross cuts giving larger voids Degradation during draw
3	BIF (MTCd)	Mass movement into volume previously occupied by ore General disintegration of rock structure Small block size giving rise to small voids Particle degradation filling voids Low potential for large voids - compaction owing to mass movement. Larger blocks of hanging wall and footwall drawn into the zone
4	BIF (partly MTCd)	Totally de-stressed with rotation and translation of blocks Large displacements leaving spaces between blocks Block degradation, with voids increasingly filled with fines Surface expression of active caving cracks opening to several metres. Hang-ups on ore-BIF contact
5	BIF (unMTCd)	Not yet MTCd but dilation of the rock mass into open or loosely filled MTCd ore zone De-stressed and meta-stable Bedding parallel joints beginning to open Limited movement of blocks Translational movement towards ore zone Possibility of MTC back hang-up
6	BIF (intact)	No disturbance
7	Lower ore zone, including shale	MTC not well developed; hanging wall not yet MTCd Hang ups in draw points giving larger voids Waste from Zone 2 hanging wall draw down

More recent impacts on the MTC and the subsequent damage to some of the speleothems was the theft of the electrical cables providing electricity to the light that was placed inside the MTC to facilitate visits (Cairncross, 2011). This impact may be minimal such as dust disturbances to a total collapse of the MTC.

Envisaged impact of mining on MTC

IMPACT	SIGNIFICANCE	SPATIAL SCALE	TEMPORAL SCALE	PROBABILITY	RATING
	High	Study area	Permanent	Very likely	
Impact mining on MTC	4	2	5	4	2.9

Cairncross (2011), evaluated the significance of the MTC and its geological features and concluded that although the MTC and MTC systems are no longer protected under the NHRA, the uniqueness of the aragonite frost and trays qualify them as "rare geological specimens" under Section 32.1.(a) of NHRA (Cairncross, 2011). The difficulty in giving a heritage rating to MTC lies in the fact that the MTC as a structure is not protected under the NHRA, but the rare geological specimens contained inside the MTC are.

To this effect the speleothems is provisionally graded as Grade 1 and of National significance based on the evaluation by Professor Cairncross (2011) and protected under Section 32 of the NHRA as a heritage Object, "*particularly the aragonite frost and trays, would be acknowledged, within the South African context, to qualify as rare, based on their abundance in other known South African caves*."

Discussions with Archaeology, Palaeontology and Meteorite Unit (APM) of SAHRA indicated that the evaluation of the MTC must be submitted to the Unit and then further evaluation will be conducted from their side with regards to the way forward.

The following process is then proposed to implement the recommendations as made for the recovery of the rare geological specimens (Cairncross, 2011):

1. Submission and evaluation of this HIA to the APM Unit of SAHRA;
2. Evaluation and comments on legal position of the material and MTC by SAHRA

3. Handling of the recovery of the material permitting process as under Section 35 permitting of archaeological, palaeontological and meteorites.
4. Collection of materials as recommended by professor Cairncross (2011):
    a) *Selection of as many different types, varieties and sizes of the speleothems must be carefully and professionally collected. This requires specialist collecting techniques that minimize damage or, preferably, omits damage completely to the speleothems. They will need to be collected and properly handled and packed while in the cave and then transported out of the area.* ***NOTE:*** *It is important to state here that due to (a) the hardness of the dolomite substrate and (b) the delicateness and fragility of the speleothems, most speleothems may be unsalvageable and best efforts will probably only yield a small percentage of the cave's content. But this would be preferable to nothing. Furthermore, the relatively narrow opening at the entrance to the cave precludes any salvaging of very large speleothems. Those collected, would have to be packed / laid in small open boxes lined with very soft material such as dry cleaning plastic. These small boxes would then be placed in large cardboard boxes also lined with soft material to buffer any potential damage. Boxes will have to remain open to avoid damage to the specimens. These boxes will then have to be lowered carefully down the metal stairs and loaded in vehicular transport parked at the steel door in the Mostert Tunnel. An inventory of specimens will be made and the samples then transported to a place of safekeeping until they can be dispersed to the relevant organisations.*
    b) *It is proposed that these specimens get donated to local museums, notably the Transvaal Museum in Pretoria and the Johannesburg Geology Museum in the Museum Africa complex, Johannesburg and any other museum with proper geological collection and curation protocols where the specimens can be properly housed and preserved. If sufficient speleothem specimens are collected then these could also be donated to local university geology departments for curation and preservation purposes, or similar institutions.*
    c) *A scientific article will be written and published on the cave and its speleothems thereby documenting it for posterity as it will no longer be accessible or may even be destroyed.*

5. As the MTC as such is not protected under the NHRA, a destruction permit will not be required, however the collections permit under Points 3 and 4 inherently leads to the destruction of some of the material in the MTC.
6. A final destruction permit for any further material not salvaged will have to be issued to enable the Thabazimbi Mine to continue mining at their Project Phoenix section and preempt possible damage to the MTC and the material contained in it.

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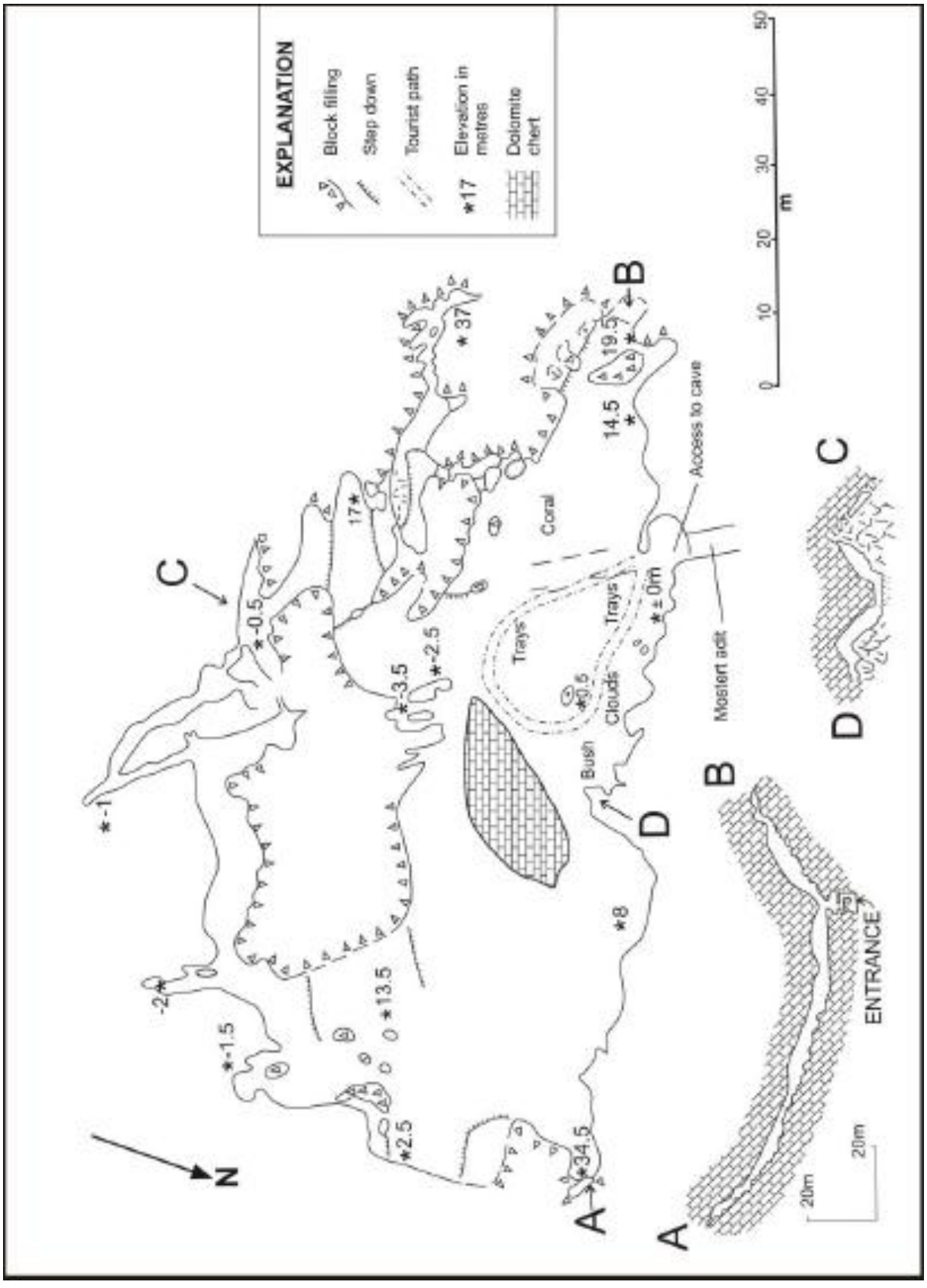
Appendix A

MTC LAYOUT



LEGISLATIVE REQUIREMENTS – TERMINOLOGY AND ASSESSMENT CRITERIA

3.1 General principles

In areas where there has not yet been a systematic survey to identify conservation worthy places, a permit is required to alter or demolish any structure older than 60 years. This will apply until a survey has been done and identified heritage resources are formally protected.

Archaeological and palaeontological sites, materials, and meteorites are the source of our understanding of the evolution of the earth, life on earth and the history of people. In the NHRA, permits are required to damage, destroy, alter, or disturb them. People who already possess material are required to register it. The management of heritage resources is integrated with environmental resources and this means that before development takes place heritage resources are assessed and, if necessary, rescued.

In addition to the formal protection of culturally significant graves, all graves, which are older than 60 years and are not in a formal cemetery (such as ancestral graves in rural areas), are protected. The legislation protects the interests of communities that have an interest in the graves: they should be consulted before any disturbance takes place. The graves of victims of conflict and those associated with the liberation struggle are to be identified, cared for, protected and memorials erected in their honour.

Anyone who intends to undertake a development must notify the heritage resource authority and if there is reason to believe that heritage resources will be affected, an impact assessment report must be compiled at the construction company's cost. Thus, the construction company will be able to proceed without uncertainty about whether work will have to be stopped if an archaeological or heritage resource is discovered.

According to the National Heritage Act (Act 25 of 1999 section 32) it is stated that:

An object or collection of objects, or a type of object or a list of objects, whether specific or generic, that is part of the national estate and the export of which SAHRA deems it necessary to control, may be declared a heritage object, including –

- objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects, meteorites and rare geological specimens;
- visual art objects;
- military objects;
- numismatic objects;
- objects of cultural and historical significance;
- objects to which oral traditions are attached and which are associated with living heritage;
- objects of scientific or technological interest;
- books, records, documents, photographic positives and negatives, graphic material, film or video or sound recordings, excluding those that are public records as defined in section 1 (xiv) of the National Archives of South Africa Act, 1996 (Act No. 43 of 1996), or in a provincial law pertaining to records or archives; and
- any other prescribed category.

Under the National Heritage Resources Act (Act No. 25 of 1999), provisions are made that deal with, and offer protection to, all historic and pre-historic cultural remains, including graves and human remains.

3.2 Graves and cemeteries

Graves younger than 60 years fall under Section 2(1) of the Removal of Graves and Dead Bodies Ordinance (Ordinance no. 7 of 1925) as well as the Human Tissues Act (Act 65 of 1983) and are under the jurisdiction of the National Department of Health and the relevant Provincial Department of Health and must be submitted for final approval to the Office of the relevant Provincial Premier. This function is usually delegated to the Provincial MEC for Local Government and Planning, or in some cases the MEC for Housing and Welfare. Authorisation for exhumation and reinterment must also be obtained from the relevant local or regional council where the grave is situated, as well as the relevant local or regional council to where the

grave is being relocated. All local and regional provisions, laws and by-laws must also be adhered to. In order to handle and transport human remains, the institution conducting the relocation should be authorised under Section 24 of Act 65 of 1983 (Human Tissues Act).

Graves older than 60 years, but younger than 100 years, fall under Section 36 of Act 25 of 1999 (National Heritage Resources Act) as well as the Human Tissues Act (Act 65 of 1983) and are under the jurisdiction of the South African Heritage Resource Agency (SAHRA). The procedure for Consultation Regarding Burial Grounds and Graves (Section 36(5) of Act 25 of 1999) is applicable to graves older than 60 years that are situated outside a formal cemetery administrated by a local authority. Graves in the category located inside a formal cemetery administrated by a local authority will also require the same authorisation as set out for graves younger than 60 years, over and above SAHRA authorisation.

If the grave is not situated inside a formal cemetery but is to be relocated to one, permission from the local authority is required and all regulations, laws and by-laws set by the cemetery authority must be adhered to.

Appendix C

PALAEONTOLOGICAL ASSESSMENT

Palaeontological Impact Assessment of the cave above Mostert Adit, Thabazimbi Mountain

by Prof Marion Bamford
Bernard Price Institute for Palaeontological Research
University of the Witwatersrand

04 May 2012

SUMMARY

The cave was visited by Prof Marion Bamford and Mrs Cynthia Kemp on 20 February 2012 under the guidance of Mr Gawie Goss and four Phoenix employees. The solution cavity which has been naturally enlarged by roof fall has extremely delicate and beautiful aragonite and calcite crystal formations covering much of the floor, walls and ceilings. There is only a very small opening to the outside through which air passes thus maintaining a near constant temperature and humidity but allowing for some evaporation. There is no evidence of fossil or living creatures in the cave. It is strongly recommended that this cave is preserved and protected from the outside elements. Changing the atmosphere (airflow, moisture, light) will destroy the pristine aragonite and calcite crystals. Access to the cave will have to be strictly controlled at all times.

INTRODUCTION

Details of the geology and formation of the cave have been provided by J Martini (1986) and will be updated by Prof Bruce Cairncross in 2011/2012 but a brief summary is provided here for background.

Thabazimbi is in the northern part of the Transvaal Basin and the rocks here are old and potentially non-fossiliferous although some evidence of early bacteria could possibly be found in the dolomites (Tayloe et al., 2009). Considering the oldest to the youngest rocks, exposed in the area are the Penge Formation banded ironstone (BIF) and Black Reef Formation of the Chuniespoort Group (approx 2500 – 2420 million years old. This group is overlain by the Pretoria Group but only three formations are present in the Thabazimbi area: the Rooihoogte Formation, Magaliesberg Formation and Steenkampsberg Formation which have various combinations of sandstone, shale and quartzite (see Figure 1 and Table). In parts the whole sequence is overlain by Quaternary alluvium, sand and calcrete.

Banded Iron formations are considered to be very early evidence of life on earth because oxygen released into the atmosphere by photosynthesizing micro-organisms such as blue green algae/bacteria and green algae was captured by iron and formed layers of iron oxides. There is some debate whether the process of iron formation was purely abiotic or biotic as there are other sediments included such as silica or chert bands (Beukes and Klein, 1990). Unlike in various stromatolites deposits there are no micro-organisms preserved in BIF. It is highly unlikely, therefore, that there would be any fossils in this area.

The cave was discovered in the 1950's when miners broke through into the cavern from the Mostert adit. In 1985 and 1986 members of the South African Speleological Association visited the cave, described the formations and recommended a management plan (Martini, 1986). With collapse of the roof the cave is up to 37m in height in places and approximately 70m long. The floor is very uneven and is covered with numerous large and small blocks. A demarcated pathway has rock chips added to infill some cavities and make it easier to walk along, and rope handrails. According to Mr Goss the accessible area is only one third of the cave. In this area most of the walls and roof and much of the floor are covered with delicate aragonite crystals of the coral, tray and popcorn types (Martini, 1986).

Access to the mining area is controlled by Kumba / Anglo American security. Access to the cave is restricted. There is a locked iron gate at the entrance of the Mostert adit, and another locked iron gate at the base of the chimney. A metal-clad wooden trapdoor seals the first chimney from the second, which opens out into the floor of the cave. Photography in the cave was prohibited.

OBSERVATIONS

Aragonite-calcite crystals were seen in abundance but no flowstone, stalacmites or stalactites. The four informal types of aragonite-calcite formations were seen; the clouds, trays and coral and popcorn. We could see patches on the walls and roof where there had been recent rockfalls and the dark red ironstone, grey dolomite and pale chert bands, all bare of white crystals, were visible. Crystals were re-growing on "newly" exposed surfaces but from one visit it is not possible to determine a timeframe. In a closed environment I assume it is a slow process for the crystals to form.

Near the trapdoor entrance to the cave there is some red dust covering the white aragonite crystals; farther away the surfaces are much cleaner. No algal growth was visible. Some cables for lights were visible but since some of the cabling has been stolen (Goss pers. comm.) no lights are left on in the cave.

We could find no evidence of an opening into the cave, past or present, other than the very slight draught of air. There was no evidence of bats in the cave. There were no fossils in the cave either, as was expected as there is no natural opening that is large enough to permit the entrance of living or dead plant or animal matter.

RECOMMENDATION

Although there is no palaeontological material in the cave I strongly recommend the <u>preservation and protection</u> of the cave for the following reasons:

1. By any standards the cave has incredibly beautiful aragonite and calcite crystal formations. These are extremely fragile.
2. To protect the contents of the cave the atmosphere must be maintained. The temperature and humidity should be kept at their natural level and not fluctuate. No new openings should be made and access by visitors should be kept to an absolute minimum. Human breath and air movement caused by moving bodies can upset the cave atmosphere.
3. The cave should be kept dark and sealed to prevent algal growth and dust being introduced.
4. Visitors should be carefully monitored so they do not wander off the designated path or touch or remove any crystals.

5. Access to the cave should be strictly controlled, firstly to limit the number of visitors and secondly from a safety point of view. Roof falls have occurred and no doubt will continue to occur naturally, and perhaps will increase from future mining activities in the area.

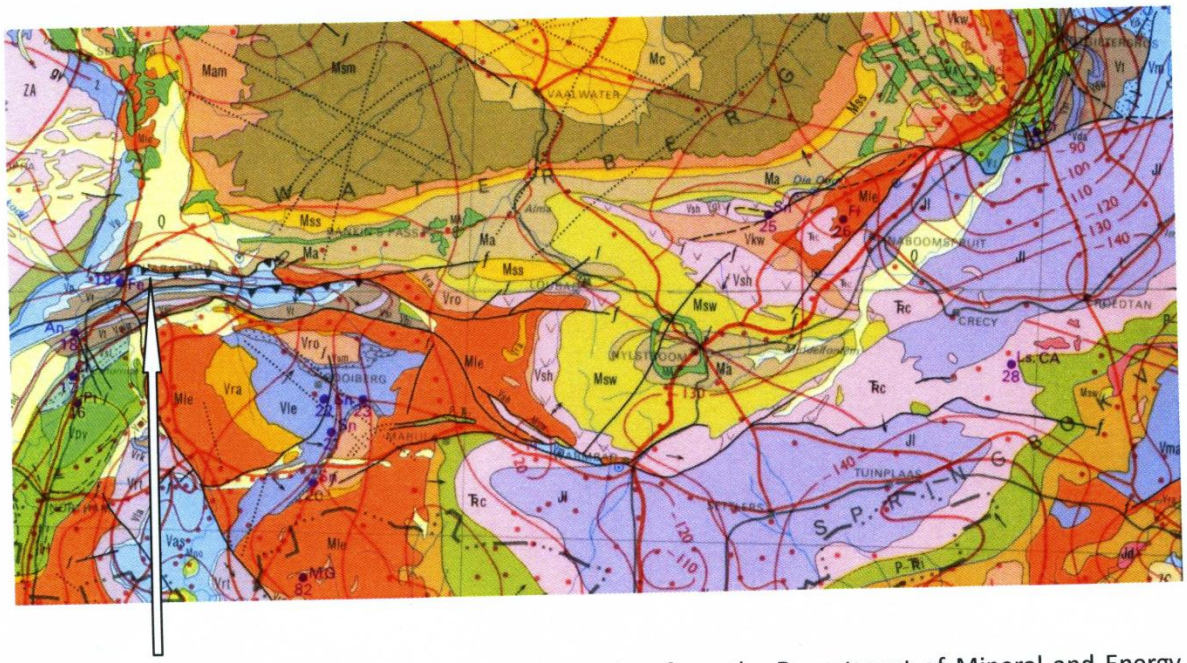


Figure 1: Geological map of the Thabazimbi Area taken from the Department of Mineral and Energy Affairs, Pretoria. Key for symbols in table below taken from the map and ages from Eriksson et al. 2006. Note that the sequence is not complete and only the relevant formations are listed. Arrow points to the mine.

Group	Symbol	Formation	Lithology	Approx Age (Ma)
Pretoria	Vst	Steenkampberg	quartzite	
	Vmg	Magaliesberg	quartzite	
	Vt	Rooihoogte	Shale, conglomerate, breccias, diamictite	2420
	Vb	Buffelsfontein	Volcanic rocks, sandstone	
Chuniespoort	Vp	Penge	BIF , shale	2500 - 2430
	Vbr	Black Reef	Quartzite, conglomerate, shale, basalt	2650
	Q	Quaternary	Alluvium, sand, calcrete	1.8 - 0

Table 1: legend for Figure 1.

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Appendix D

MTC GEOLOGY AND SPELEOTHEM ASSESSMENT