Decommissioning and Closure of Imerys Refractory Minerals' Anref Andalusite Mine

Ramotshere Moiloa Local Municipality, Ngaka Modiri Molema District Municipality, North West Province

Farm: Portion 12,13 and the Remainder of Portion 8,11 of Kleinfontein 260-JP; Portion 1 and former Portion 24,39,41,42 & 44 of Driefontein 259-JP; and Remainder of Portion 9 and Mineral Area 2 of Wonderfontein 258-JP

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Palaeontological Impact Assessment: Phase 1: Field Study

Facilitated by: Shangoni Management Services

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2018/10/19

Ref: NW 30/5/5/5/3/2/1/522 EM

SAHRA CaseID: 12760

B. Executive summary

Outline of the development project: Shangoni Management Services has facilitated the appointment of Dr H. Fourie, a palaeontologist, to undertake a Paleontological Impact Assessment (PIA), Phase 1: Field Study of the suitability of the Proposed Decommissioning and Closure of Imerys Refractory Minerals' Anref Andalusite Mine in the Ramotshere Moiloa Local Municipality, Ngaka Modiri Molema District Municipality within the North West Province

Farms: Portion 12,13 and the Remainder of Portion 8,11 of Kleinfontein 260-JP; Portion 1 and former Portion 24,39,41,42 & 44 of Driefontein 259-JP; and Remainder of Portion 9 and Mineral Area 2 of Wonderfontein 258-JP.

The applicant, Imerys Refractory Minerals (Pty) Ltd, proposes to Rehabilitate and Close Anref Andalusite Mine near Groot Marico.

The Project includes one Option (see google.earth image):
Option 1: An area indicated with yellow pins with the N4 to the south and plots of agricultural land to the east and west. The area is approximately 68 hectares. The decrease in demand for aluminium and low feasibility led to the closure of the mine.

Legal requirements:-

The **National Heritage Resources Act (Act No. 25 of 1999) (NHRA)** requires that all heritage resources, that is, all places or objects of aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance are protected. The Republic of South Africa (RSA) has a remarkably rich fossil record that stretches back in time for some 3.5 billion years and must be protected for its scientific value. Fossil heritage of national and international significance is found within all provinces of the RSA. South Africa's unique and non-renewable palaeontological heritage is protected in terms of the National Heritage Resources Act. According to this act, palaeontological resources may not be excavated, damaged, destroyed or otherwise impacted by any development without prior assessment and without a permit from the relevant heritage resources authority.

The main aim of the assessment process is to document resources in the development area and identify both the negative and positive impacts that the development brings to the receiving environment. The PIA therefore identifies palaeontological resources in the area to be developed and makes recommendations for protection or mitigation of these resources.

"palaeontological" means 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 traces.

For this study, resources such as geological maps, scientific literature, institutional fossil collections, satellite images, aerial maps and topographical maps were used. It provides an assessment of the observed or inferred palaeontological heritage within the study area, with recommendations (if any) for further specialist palaeontological input where this is considered necessary.

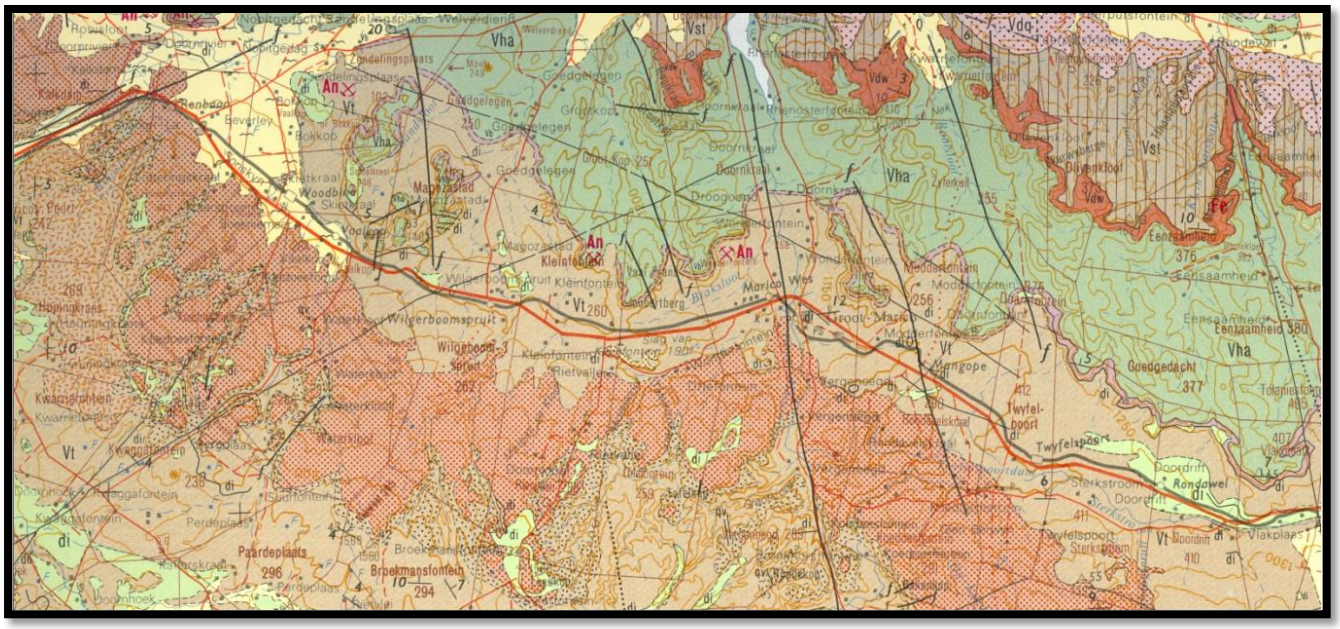
A Palaeontological Impact Assessment is generally warranted where rock units of LOW to VERY HIGH palaeontological sensitivity are concerned, levels of bedrock exposure within the study area are adequate; large scale projects with high potential heritage impact are planned; and where the distribution and nature of fossil remains in the proposed area is unknown. The specialist will inform whether further monitoring and mitigation are necessary.

Types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (Act No.25 of 1999):
(i) (i) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens.
This report adheres to the guidelines of Section 38 (1) of the National Heritage Resources Act (Act No. 25 of 1999).
Subject to the provisions of subsections (7), (8) and (9), any person who intends to undertake a development categorised as (a) the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length; (b) the construction of a bridge or similar structure exceeding 50 m in length; (c) any development or other activity which will change the character of a site (see Section 38); (d) the re-zoning of a site exceeding 10 000 m² in extent; (e) or any other category of development provided for in regulations by SAHRA or a PHRA authority.

This report aims to provide comment and recommendations on the potential impacts that the proposed development could have on the fossil heritage of the area and to state if any mitigation or conservation measures are necessary.

Outline of the geology and the palaeontology:
The geology was obtained from map 1:100 000, Geology of the Republic of South Africa (Visser 1984) and the 1:250 000 (2526) Geological Map of Rustenburg (Walraven1981).

Figure 3: The geology of the development area.



Legend to Map and short explanation.
di – Diabase (light green), Vaalian.
Vst– Slate, shale (medium brown //), Strubenkop Formation, Pretoria Group, Transvaal Supergroup.
Vdw – Ferruginous siltstone and sandstone (brown), Dwaalheuwel Formation, Pretoria Group, Transvaal Supergroup.
Vha – Volcanic rocks (green), Hekpoort Formation, Pretoria Group, Transvaal Supergroup.
Vt – Shale, siltstone, conglomerate in places, quartzite [::] (brown), Time Ball Hill Formation, Pretoria Group, Transvaal Supergroup.
---f--- – (black) Fault.

⊥ 12 - Strike and dip of bed.
An – Approximate position of development on Kleinfontein (in red on the Figure).

Mining Activities
An - Andalusite.

Summary of findings: The Palaeontological Impact Assessment: Phase 1: Field Study was undertaken in October in the summer in dry and hot conditions (Appendix 6 of Act, 1(d)), and the following is reported:

The mine is situated on the Time Ball Hill Formation of the Pretoria Group, Transvaal Supergroup. Faulting is present close to the property. The site has mine infrastructure on it, but is vacant at present. Some rehabilitation has already taken place with material found on site. The rehabilitation process will not use material from outside the boundaries of the fence of the mine property.

The Transvaal Supergroup fills an east-west elongated basin in the south-central part of the old Transvaal (now North – West, Gauteng and Mpumalanga) as far south as Potchefstroom. It is Vaalian in age, approximately 2600 Ma to 2100 Ma. A maximum thickness of the Transvaal Supergroup reaches 2000 m in the north-eastern section. The east-west elongated basin is filled with clastic, volcanic and chemical sedimentary rocks. Three groups based on lithological differences have been established: they are the Rooiberg, Pretoria and Chuniespoort Groups as well as other smaller groups (Kent 1980, Snyman 1996). It is the Bushveld Complex that is responsible for the tilting of the Transvaal sediments and the heat of its intrusion having created andalusite crystals (Norman and Whitfield 2006). This Supergroup is underlain by the Ventersdorp, Witwatersrand and Pongola Supergroups, and the Dominion Group. Three prominent ridges are present from the oldest to the youngest, the Time Ball Hill, Daspoort and Magaliesberg Formations (Norman and Whitfield 2006).

The Pretoria Group consists predominantly of quartzite and shale, together with a prominent volcanic unit, minor conglomerate, chemical and volcanic members. It comprises the Hekpoort Andesite, Dullstroom Basalt, Time Ball Hill, Silverton, and Magaliesberg Quartzite Formations as well as several smaller formations (in total 15) and overlies the Chuniespoort Group (Kent 1980). Both the shale and quartzite of the Pretoria Group are utilised in the building industry (Snyman 1996). The Time Ball Hill shale Formation is known to contain 'algal microfossils' diagenetic in origin. Stromatolites as they are known are preserved in the subordinate carbonate rocks (Kent 1980). The Pretoria Group is clastic sedimentary in nature (Eriksson 1999). The pile of sedimentary rocks, mainly mudstones and quartzites with some basalt can collectively reach a thickness of up to 5 km (Visser 1989).

Andalusite (Al_2SiO_5) crystals occur in hornfels. These anhydrous aluminium silicates are used in the field of neutral refractories and electrical purposes. They are found in nearly all rocks that have suffered intrusion by large igneous masses, or in the oldest sedimentary rocks that have been altered by heat and pressure. Large exposures of andalusite-bearing slates are known, particularly in the Marico district (Department of Mines 1936).

Fossils in South Africa mainly occur in rocks of sedimentary nature and not in rocks from igneous or metamorphic nature. Therefore, if there is the presence of sedimentary rocks the palaeontological sensitivity can generally be LOW to VERY HIGH, and here locally **HIGH** for the Pretoria Group (SG 2.2 SAHRA APMHOB, 2012).

Recommendation:
The impact of the development on fossil heritage is **HIGH** and therefore a Phase 1: Field Survey or further mitigation or conservation measures were necessary for this development (according to SAHRA protocol) as fossils may be found during rehabilitation.

Table 2: Criteria used (Fossil Heritage Layer Browser/SAHRA).

Rock Unit	Significance/vulnerability	Recommended Action
Pretoria Group	High	Desktop study is required and based on the outcome of the desktop study, a field assessment is likely

The Project includes one Option (see google.earth image):
Option 1: An area indicated with yellow pins with the N4 to the south and plots of agricultural land to the east and west. The area is approximately 68 hectares. The decrease in demand for aluminium and low feasibility led to the closure of the mine.

Concerns/threats (1g,1ni,1nii,1o,1p) to be added to the EMPr:

1. Threats are earth moving equipment/machinery (front end loaders, excavators, graders, dozers) during construction, digging of foundations, the sealing-in, disturbance, damage or destruction of the fossils by development, vehicle traffic and human disturbance.
2. The overburden and inter-burden must be surveyed for fossils during construction. Special care must be taken during the digging, drilling, blasting and excavating of foundations, trenches, channels and footings and removal of overburden during construction not to intrude fossiliferous layers.

Recommendations:

3. Mitigation will not be necessary.
4. No consultation with parties is necessary.
5. Alternatives will not be feasible.
6. The rehabilitation and closure may go ahead, it is not likely that a fossil will be found.

Stakeholders: Developer – Imerys Refractory Minerals (Pty) Ltd, Sanlameerzicht, 259 West Street, Centurion, 0157.
Environmental – Shangoni Management Services, P.O. Box 74726, Lynwood Ridge, 0040, Tel. 012 807 7036.
Mineral and Surface Right – Imerys Refractory Minerals (Pty) Ltd.

C. Table of Contents

D. Background information on the project

Report

This report is part of the environmental impact assessment process under the National Environmental Management Act, as amended (Act No. 107 of 1998) (NEMA) and includes Appendix 6 (GN R38282 of 4 December 2014) of the Environmental Impact Assessment Regulations (see Appendix 2).

Outline of development

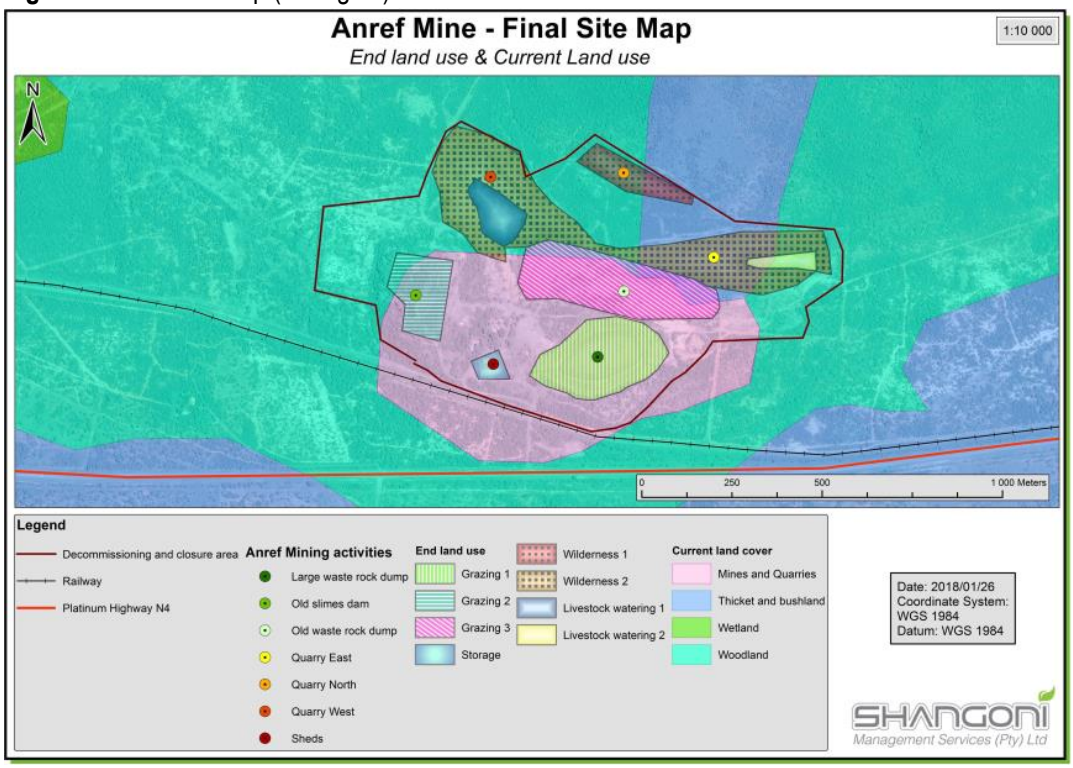
This report discusses and aims to provide the developer with information regarding the location of palaeontological material that will be impacted by the development. In the pre-construction phase it may be necessary for the developer to apply for the relevant permit from the South African Heritage Resources Agency (SAHRA / PHRA).

Anref was an andalusite mine situated west from the town of Groot Marico. The mine has not been operational since 2008. Concurrent rehabilitation has been implemented since operations have ceased, and the mine management plans to commence with decommissioning.

The waste rock dumps (WRD) have been shaped and seeded, while vegetation establishment on the slimes dams took place. The majority of rehabilitation activities were completed in 2017. Access roads will also be rehabilitated as well as the opencast quarries.

The project is focused on the decommissioning and closure, no development will take place.

Figure 1: Final Site Map (Shangoni).



The following infrastructure is present:

1. Roads,
2. Buildings (2x sheds),
3. Reservoir,

4. North, east and west quarries,
5. Two waste rock dumps (WRD),
6. One slimes dam,
7. And associated infrastructure such as electricity lines.

The Project includes one Option (see google.earth image):
Option 1: An area indicated with yellow pins with the N4 to the south and plots of agricultural land to the east and west. The area is approximately 68 hectares. The decrease in demand for aluminium and low feasibility led to the closure of the mine.

Rezoning/ and or subdivision of land: No.
Name of Developer and Environmental Consultant: Imerys Refractory Minerals (Pty) Ltd and Shangoni Management Services.
Terms of reference: Dr H. Fourie is a palaeontologist commissioned to do a palaeontological impact assessment to ascertain if any palaeontological sensitive material is present in the development area. This study will advise on the impact on fossil heritage mitigation or conservation necessary, if any.
Dr Fourie obtained a Ph.D from the Bernard Price Institute for Palaeontological Research (now ESI), University of the Witwatersrand. Her undergraduate degree is in Geology and Zoology. She specialises in vertebrate morphology and function concentrating on the Therapsid Therocephalia. For the past ten years she carried out field work in the Eastern Cape, Northern Cape, North West, Limpopo, Mpumalanga, Gauteng and Free State Provinces. Dr Fourie has been employed at the Ditsong: National Museum of Natural History in Pretoria (formerly Transvaal Museum) for 24 years.
Legislative requirements: South African Heritage Resources Agency (SAHRA) for issue of permits if necessary. National Heritage Resources Act (Act No. 25 of 1999). An electronic copy of this report must be supplied to SAHRA.

E. Description of property or affected environment
Location and depth:
The Proposed Decommissioning and Closure of Imerys Refractory Minerals' Anref Andalusite Mine in the Ramotshere Moiloa Local Municipality, Ngaka Modiri Molema District Municipality, North West Province is situated on Portion 12,13 and the Remainder of Portion 8,11 of Kleinfontein 260-JP; Portion 1 and former Portion 24,39,41,42 & 44 of Driefontein 259-JP; and Remainder of Portion 9 and Mineral Area 2 of Wonderfontein 258-JP.

The development will provide much needed grazing in the area.

Depth is determined by the related infrastructure.

The Project includes one Option (see google.earth image):
Option 1: An area indicated with yellow pins with the N4 to the south and plots of agricultural land to the east and west. The area is approximately 68 hectares. The decrease in demand for aluminium and low feasibility led to the closure of the mine.

Figure 2: Google.earth image showing location (Shangoni).

The site is underlain by the Transvaal Supergroup rocks.

F. Description of the Geological Setting

Description of the rock units:

The Transvaal Supergroup fills an east-west elongated basin in the south-central part of the old Transvaal (now North – West, Gauteng and Mpumalanga) as far south as Potchefstroom. It is Vaalian in age, approximately 2600 Ma to 2100 Ma. A maximum thickness of the Transvaal Supergroup reaches 2000 m in the northeastern section. The east-west elongated basin is filled with clastic, volcanic and chemical sedimentary rocks. Three groups based on lithological differences have been established: they are the Rooiberg, Chuniespoort, and Pretoria Groups as well as other smaller groups (Kent 1980, Snyman 1996). It is the Bushveld Complex that is responsible for the tilting of the Transvaal sediments and the heat of its intrusion having created andalusite crystals (Norman and Whitfield 2006). This Supergroup is underlain by the Ventersdorp, Witwatersrand and Pongola Supergroups, and the Dominion Group. Three prominent ridges are present from the oldest to the youngest, the Time Ball Hill, Daspoort and Magaliesberg Formations (Norman and Whitfield 2006).

The Pretoria Group consists predominantly of quartzite and shale, together with a prominent volcanic unit, minor conglomerate, chemical and volcanic members. It comprises the Hekpoort Andesite, Dullstroom Basalt, Time Ball Hill, Silverton, and Magaliesberg Quartzite Formations as well as several smaller formations (in total 15) and overlies the Chuniespoort Group (Kent 1980). Both the shale and quartzite of the Pretoria Group are utilised in the building industry (Snyman 1996). The Pretoria Group is clastic sedimentary in nature (Eriksson 1999). The pile of sedimentary rocks, mainly mudstones and quartzites with some basalt can collectively reach a thickness of up to 5 km. The Silverton shale Formation is the thickest of all the shale formations of the Pretoria Group (300 – 3000 m). It forms wide valleys and when changed to hornfels can be used for roof coverings (Visser 1989). The Time Ball Hill shale Formation is known to contain 'algal microfossils' diagenetic in origin. Stromatolites as they are known are preserved in the subordinate carbonate rocks (Kent 1980).

The Hekpoort Andesite Formation is usually well developed, except for the Mokopane and Thabazimbi regions (Visser 1989) and can be up to 500 m thick with andesite, basalt and pyroclasts. These sheets are massive with

an amygdaloidal crust on top (Snyman 1996). It is rich in green hornblende with an age between 2,224 ± 21 Ma (2626 Wes Rand sheet info). The Dwaalheuwel Formation is only present in the Mokopane area, above the Hekpoort Formation. In the east it is grouped with the Strubenkop Formation and the Daspoort Formation. The Strubenkop Formation is fairly thin (20-80 m) in the east, but thicker towards its central part, up to 130 m thick towards the west. It is enriched with iron in the vicinity of Pretoria (Visser 1989).

Figure 3: The geology of the development area (Walraven 1981).

Legend to Map and short explanation.
di – Diabase (green), Vaalian.
Vst– Slate, shale (medium brown //), Strubenkop Formation, Pretoria Group, Transvaal Supergroup.
Vdw – Ferruginous siltstone and sandstone (brown), Dwaalheuwel Formation, Pretoria Group, Transvaal Supergroup.
Vha – Volcanic rocks (green), Hekpoort Formation, Pretoria Group, Transvaal Supergroup.
Vb – Quartzite, grit (lilac), Boshoek Formation, Pretoria Group, Transvaal Supergroup.
Vt – Shale, siltstone, conglomerate in places, quartzite [::] (brown), Time Ball Hill Formation, Pretoria Group, Transvaal Supergroup.
---f--- – (black) Fault.
⊥ 12 - Strike and dip of bed.
An on kleinfontein – Approximate position of development (in red on the Figure).

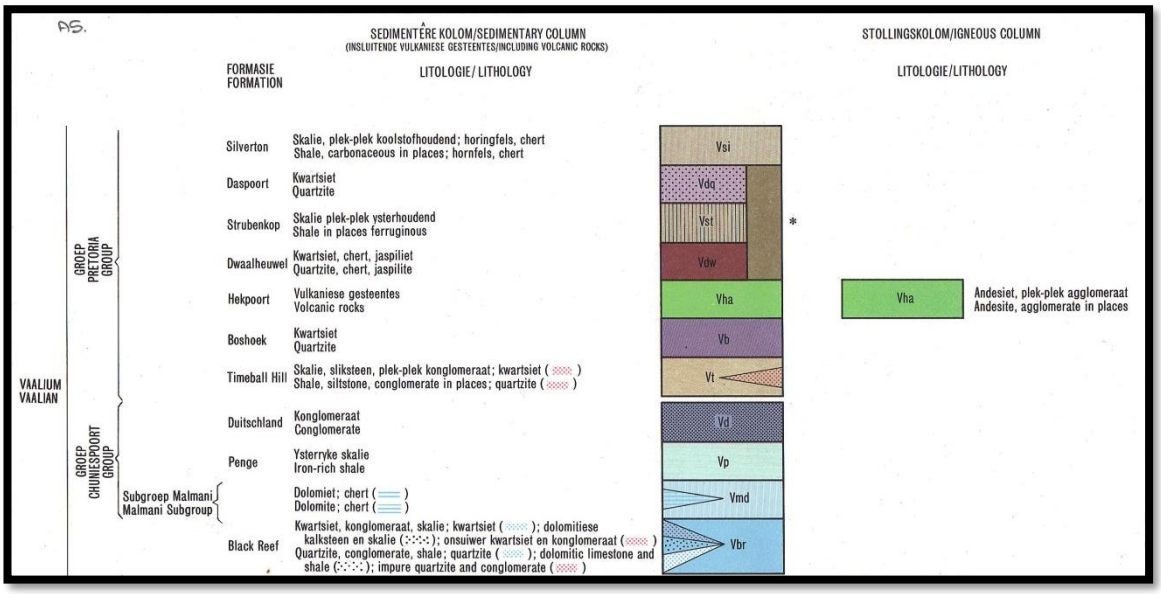
Vaalian to post-Mokolian diabase (di) intrusions occur throughout the area in the form of plates, sills and dykes. These plates are common in the Transvaal Supergroup and when present in the Pretoria Group they are referred to as the Transvaal diabase (Kent 1980, Visser 1989). The diabase sills of Bushveld age (Norman and Whitfield 2006) is typically fine-grained, green-grey with plagioclase and pyroxenes (Visser 1989).

The Time Ball Hill Formation is present here in the development area. Nixon *et al.* (1988) described the black shales south-west of Potchefstroom as consisting of overlapping laminated basal mounds which are stromatolitic as well as spheroidal possible planktonic fossil algae. These can range in size from 3.5 - 17 mm in height and up to 10 mm in diameter and can be present in the development area.

The Project includes one Option (see google.earth image):

Option 1: An area indicated with yellow pins with the N4 to the south and plots of agricultural land to the east and west. The area is approximately 68 hectares. The decrease in demand for aluminium and low feasibility led to the closure of the mine.

Figure 4: Lithostratigraphic column of the geology of the site (Walraven 1978).



Field Observations:

The entire area to be rehabilitated is disturbed with mining activities. The rehabilitation material will be taken from what is currently inside this perimeter, therefore not intruding in the Time Ball Hill Formation. The saved stockpile dump consists of soil only. Some areas have already been shaped and seeded.

Figure 5: Overview of property from area next to slimes dam.

Figure 6: View towards quarry west. Rehabilitation can be seen. The shaped and seeded WRD can be seen.

Figure 7: This is on top of the slimes dam, trees and grass have reclaimed this area.

Figure 8: View of quarry west showing the Time Ball Hill range in the background.

Figure 9: View of remainder of quarry north, rehabilitation has begun.

Figure 10: Plan of Mining Activities (Shangoni).

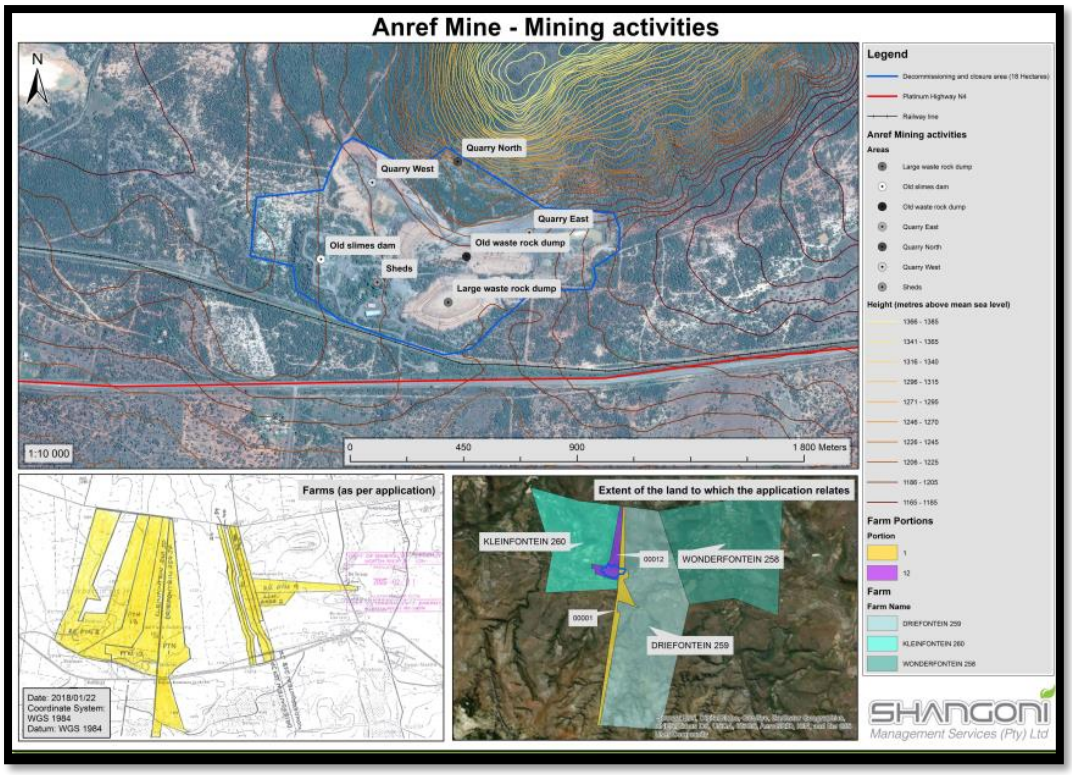
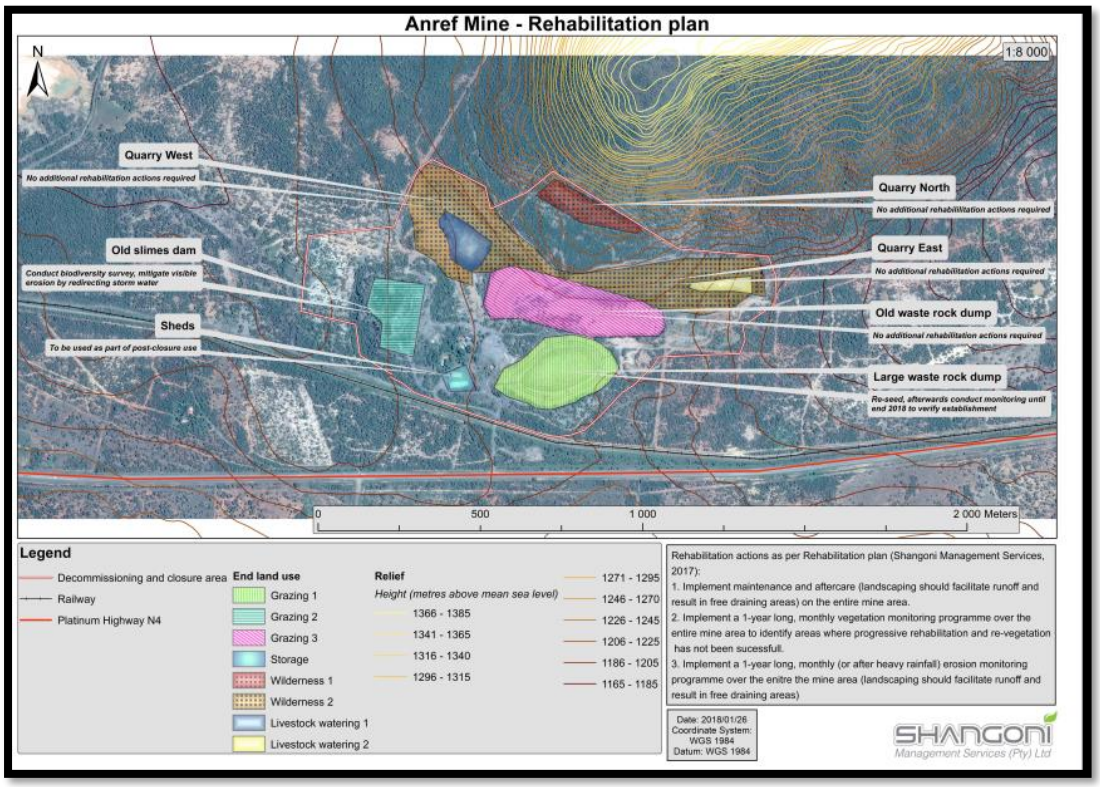


Figure 11: Rehabilitation Plan (Shangoni).



It is recommended to wait for the response from SAHRA on the (this report) Field Study. Alternatives will be not be feasible.

G. Background to Palaeontology of the area

Summary: When rock units of moderate to very high palaeontological sensitivity are present within the development footprint, a desk top and or field scoping (survey) study by a professional palaeontologist is usually warranted. The main purpose of a field scoping (survey) study would be to identify any areas within the development footprint where specialist palaeontological mitigation during the construction phase may be required (SG 2.2 SAHRA AMPHOB, 2012).

Chemical sediments such as fine grained limestone and dolomite is made up of deposits of organically derived carbonate shells, particles or precipitate. Dolomite is magnesium-rich limestone formed from algal beds and stromatolites. These Early Proterozoic Transvaal stromatolitic dolomites formed and released free oxygen at around 2900 – 2400 Ma. Stromatolites are common in the Malmani dolomites, accepted to be the fossil remnants of the simplest single-celled organisms. They are finely layered, concentric, mound-like structures formed by microscopic algal organisms (Norman and Whitfield 2006).

Figure 12: Example of a stromatolite present in dolomite (Photograph: E. Butler).

Stromatolites are significant indicators of palaeoenvironments and provide evidence of algal growth between 2640 and 2432 million years ago (Groenewald and Groenewald 2014). Caves in the Malmani dolomite (Vmd) of the Transvaal Supergroup provided a refuge for man's distant ancestors (Norman and Whitfield 2006). These caves are also home to Middle and Late Stone Age cultures. The cave breccia in the Cradle of Humankind, near Johannesburg, yielded internationally renowned hominins such as *Australopithecus africanus and robustus* and extinct mammals and other fauna. The caves are actively being researched and excavated and this has led to many international collaborations. The caves are filled with sediments from the Kalahari Group.

In the rocks overlying the Black Reef Formation there is evidence for life on an abundant scale as cyanobacteria came to dominate the shallow sea forming stromatolites of varying shapes. Large, elongate stromatolite domes can be seen at Boetsap in the North West Province (McCarthy and Rubidge 2005) and the algal microfossils reported from the Time Ball Hill Formation shales are probably of diagenetic origin (Eriksson 1999).

The Time Ball Hill Formation is present here in the rehabilitation area. Nixon *et al.* (1988) described the black shales south-west of Potchefstroom as consisting of overlapping laminated basal mounds which are stromatolitic as well as spheroidal possible planktonic fossil algae. These can range in size from 3.5 - 17 mm in height and up to 10 mm in diameter and can be present in the development area.

Table 1: Taken from Palaeotechnical Report (Groenewald and Groenewald 2014).

Subgroup/ sequence	Group	Formation	Fossil Heritage	Comment
Transvaal Supergroup	Pretoria	Time Ball Hill (Vt)	Stromatolites.	Marine mudrocks with minor carbonates, volcanic rocks. Probably also contain microfossils. This may also apply to carbonaceous mudrocks.

Fossils in South Africa mainly occur in rocks of sedimentary nature and not in rocks from igneous or metamorphic nature. Therefore, if there is the presence of sedimentary rock strata the palaeontological sensitivity is generally LOW to VERY HIGH, but here locally **HIGH** for the Pretoria Group, Transvaal Supergroup.

Table 2: Criteria used (Fossil Heritage Layer Browser/SAHRA).

Rock Unit	Significance/vulnerability	Recommended Action
Pretoria Group	High	Desktop study is required and based on the outcome of the desktop study, a field assessment is likely

Databases and collections: Ditsong: National Museum of Natural History.
Impact: **HIGH** for the Pretoria Group, Transvaal Supergroup. There are significant fossil resources that may be impacted by the development and if destroyed are no longer available for scientific research or other public good.

H. Description of the Methodology (1e)

The palaeontological impact assessment field study was undertaken in October 2018. The walk through of the affected portion was done and photographs (in 20 mega pixels) were taken of the site with a digital Canon camera (PowerShot SX620HS). A Global Positioning System (GPS) can be used (Garmin eTrex 10) to record outcrops if not covered with topsoil, subsoil, overburden, and vegetation. A literature survey is included and the study relied on literature, geological maps, google.maps and google.earth images.

Assumptions and Limitations (Appendix 6 of Act 1i):-
The accuracy and reliability of the report may be limited by the following constraints:

1. Most development areas have never been surveyed by a palaeontologist or geophysicist.
2. Variable accuracy of geological maps and associated information.
3. Poor locality information on sheet explanations for geological maps.
4. Lack of published data.
5. Lack of rocky outcrops.
6. Insufficient data from developer and exact lay-out plan for all structures.

A Phase 1 Palaeontological Impact Assessment: Field Study will include:

1. Recommendations for the future of the site.
2. Background information on the project.
3. Description of the property of affected environment with details of the study area.
4. Description of the geological setting and field observations.
5. Background to palaeontology of the area.
6. Field Rating.
7. Stating of Significance (Heritage Value).

A Phase 2 Palaeontological Impact Assessment: Mitigation will include:

1. Recommendations for the future of the site.
2. Description of work done (including number of people and their responsibilities).
3. A written assessment of the work done, fossils excavated, not removed or collected and observed.
4. Conclusion reached regarding the fossil material.
5. A detailed site plan.
6. Possible declaration as a heritage site or Site Management Plan.

The National Heritage Resources Act No. 25 of 1999 further prescribes.

Act No. 25 of 1999. National Heritage Resources Act, 1999.
National Estate: 3 (2) (f) archaeological and palaeontological sites,
(i)(1) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens,
Heritage assessment criteria and grading: (a) Grade 1: Heritage resources with qualities so exceptional that they are of special national significance;
(b) Grade 11: Heritage resources which, although forming part of the national estate, can be considered to have special qualities which make them significant within the context of a province or a region; and (c) Grade 111: Other heritage resources worthy of conservation.
SAHRA is responsible for the identification and management of Grade 1 heritage resources.
Provincial Heritage Resources Authority (PHRA) identifies and manages Grade 11 heritage resources.
Local authorities identify and manage Grade 111 heritage resources.

No person may damage, deface, excavate, alter, remove from its original position, subdivide or change the planning status of a provincially protected place or object without a permit issued by a heritage resources authority or local authority responsible for the provincial protection.
Archaeology, palaeontology and meteorites: Section 35.
(2) Subject to the provisions of subsection (8) (a), all archaeological objects, palaeontological material and meteorites are the property of the State.
(3) Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.

Mitigation involves planning the protection of significant fossil sites, rock units or other palaeontological resources and/or excavation, recording and sampling of fossil heritage that might be lost during development, together with pertinent geological data. The mitigation may take place before and / or during the construction phase of development. The specialist will require a Phase 2 mitigation permit from the relevant Heritage Resources Authority before a Phase 2 may be implemented.

The Mitigation is done in order to rescue representative fossil material from the study area to allow and record the nature of each locality and establish its age before it is destroyed and to make samples accessible for future research. It also interprets the evidence recovered to allow for education of the public and promotion of palaeontological heritage.

Should further fossil material be discovered during the course of the development (*e. g.* during bedrock excavations), this must be safeguarded, where feasible *in situ,* and reported to a palaeontologist or to the Heritage Resources authority. In situations where the area is considered palaeontologically sensitive (*e. g.* Karoo Supergroup Formations, ancient marine deposits in the interior or along the coast) the palaeontologist might

need to monitor all newly excavated bedrock. The developer needs to give the palaeontologist sufficient time to assess and document the finds and, if necessary, to rescue a representative sample.

When a Phase 2 palaeontological impact study is recommended, permission for the development to proceed can be given only once the heritage resources authority has received and approved a Phase 2 report and is satisfied that (a) the palaeontological resources under threat have been adequately recorded and sampled, and (b) adequate development on fossil heritage, including, where necessary, *in situ* conservation of heritage of high significance. Careful planning, including early consultation with a palaeontologist and heritage management authorities, can minimise the impact of palaeontological surveys on development projects by selecting options that cause the least amount of inconvenience and delay.

Three types of permits are available; Mitigation, Destruction and Interpretation. The specialist will apply for the permit at the beginning of the process (SAHRA 2012).

I. Description of significant fossil occurrences (1f)
Details of the location and distribution of all significant fossil sites or key fossiliferous rock units are often difficult to determine due to thick topsoil, subsoil, overburden and alluvium. Depth of the overburden may vary a lot.

Stromatolites are likely to be present in the area. These structures range from a centimetre to several tens of metres in size. They are the result of algal growth in shallow water, indicating a very rich growth that would have caused an enrichment in the amount of oxygen in the atmosphere (Groenewald and Groenewald 2014).

Figure 13: Thin section of a stromatolite (De Zanche and Mietto 1977).

The threats are:- earth moving equipment/machinery (front end loaders, excavators, graders, dozers) during construction, the sealing-in or destruction of fossils by development, vehicle traffic, and human disturbance. See Description of the Geological Setting (F) above.

J. Recommendation (1j,1l)
a. There is no objection (see Recommendation B) to the development, and it is not necessary to request a Phase 2 Palaeontological Impact Assessment: Mitigation to determine whether the development will affect fossiliferous outcrops. The palaeontological sensitivity is **HIGH,** but caution is not recommended. A Phase 2 Palaeontological Mitigation will not be required as fossils will not be found during rehabilitation.
b. This project may benefit the economy, the growth of the community and social development in general.
c. Preferred choice: The impact on the palaeontological heritage is **HIGH.**

d. The following should be conserved: if any palaeontological material is exposed during digging, excavating, drilling or blasting SAHRA must be notified. All construction activities must be stopped and a palaeontologist should be called in to determine proper mitigation measures.

Sampling and collecting (1m,1k):
Wherefore a permit is needed from the South African Heritage Resources Agency (SAHRA / PHRA).

a. Objections: Cautious. See heritage value and recommendation.
b. Conditions of development: See Recommendation.
c. Areas that may need a permit: No.
d. Permits for mitigation: SAHRA/PHRA.

K. Conclusions

a. All the land involved in the rehabilitation was assessed and none of the property is unsuitable for rehabilitation (see Recommendation B).
b. All information needed for the Field Study was provided by the Environmental Consultant. All technical information was provided by Shangoni.
c. Areas that would involve mitigation and may need a permit from the South African Heritage Resources Agency are discussed.
d. The following should be conserved: if any palaeontological material is exposed during digging, excavating, drilling or blasting, SAHRA must be notified. All development activities must be stopped and a palaeontologist should be called in to determine proper mitigation measures. Especially shallow caves, but this is unlikely.
e. Condition in which development may proceed: It is further suggested that a Section 37(2) agreement of the Occupational, Health and Safety Act 85 of 1993 is signed with the relevant contractors to protect the environment and adjacent areas as well as for safety and security reasons.

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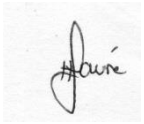
Declaration / Disclaimer (1b)

I, Heidi Fourie, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed development project for which I was appointed to do a palaeontological assessment. There are no circumstances that compromise the objectivity of me performing such work.

I accept no liability, and the client, by receiving this document, indemnifies me against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by the use of the information contained in this document.

It may be possible that the desktop study may have missed palaeontological resources in the Project Area as the presence of outcrops are not known and may only be found once development commences.

This report may not be altered in any way and any parts drawn from this report must make reference to this report.



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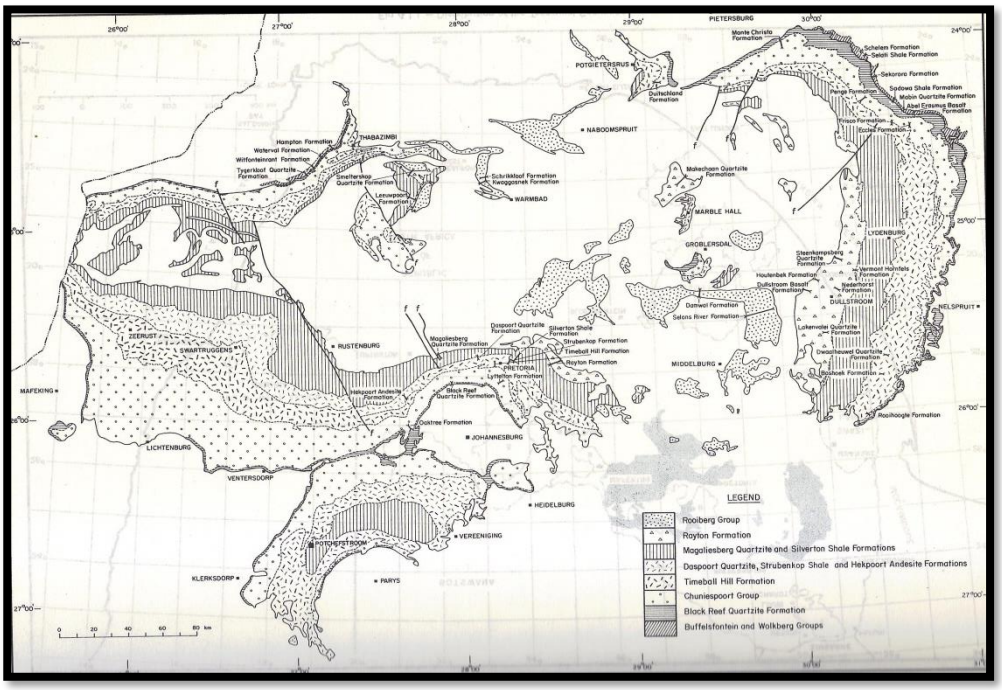
Heidi Fourie
2018/10/19

Appendix 1: Geology of the Transvaal Supergroup (Kent 1980).



Appendix 2:

Table 3: Listing points in Appendix 6 of the Act and position in Report.

Section	Point in Act	Heading
B	1(c)	Outline of development project
	1(d)	Summary of findings
	1(g)	Concerns/threats:
	1(n)i	"
	1(n)ii	"
	1(o)	"
	1(p)	"
D	1(h)	Figures
	1(a)i	Terms of reference
H	1(e)	Description of Methodology
	1(i)	Assumptions and Limitations
I	1(f)	Heritage value
J	1(j)	Recommendation
	1(l)	"
	1(m)	Sampling and collecting
	1(k)	"
Declaration	1(b)	Declaration
Appendix 1	1(k)	Protocol for finds
	1(m)	"
	1(q)	"

Appendix 3: Protocol for Chance Finds and Management Plan.

This section covers the recommended protocol for a Phase 2 Mitigation process as well as for reports where the Palaeontological Sensitivity is **LOW;** this process guides the palaeontologist / palaeobotanist / ECO on site and should not be attempted by the layman / developer. The developer needs to employ an Environmental Control Officer (ECO) to oversee the construction activities so that when a fossil is unearthed they can notify the relevant department and specialist to further investigate. The ECO should familiarise him- or herself with the applicable

formations and its fossils. Miners or construction workers should be informed that fenced-off areas are no-go areas. The Evolutionary Studies Institute, University of the Witwatersrand has good examples of fossils.

The developer must survey the areas affected by the development and then indicate on plan where the construction / development / mining will take place. Trenches have to be dug to ascertain how deep the sediments are above the bedrock (can be a few hundred metres). This will give an indication of the depth of the topsoil, subsoil, and overburden, if need be trenches should be dug deeper to expose the interburden.

Mitigation will involve recording, rescue and judicious sampling of the fossil material present in the layers sandwiched between the geological / coal layers. It must include information on number of taxa, fossil abundance, preservational style, and taphonomy. This can only be done during excavations. In order for this to happen, in case of mining operations, the process will have to be closely scrutinised by a professional palaeontologist / palaeobotanist to ensure that only the coal layers are mined and the interlayers (siltstone and mudstone) are surveyed for fossils or representative sampling of fossils are taking place.

The palaeontological impact assessment process presents an opportunity for identification, access and possibly salvage of fossils and add to the few good plant localities. Mitigation can provide valuable onsite research that can benefit both the community and the palaeontological fraternity.

A Phase 2 study is very often the last opportunity we will ever have to record the fossil heritage within the development area. Fossils excavated will be stored at a National Repository.

A Phase 2 Palaeontological Impact Assessment: Mitigation will include (SAHRA) -

1. Recommendations for the future of the site.
2. Description and purpose of work done (including number of people and their responsibilities).
3. A written assessment of the work done, fossils excavated, not removed or collected and observed.
4. Conclusion reached regarding the fossil material.
5. A detailed site plan and map.
6. Possible declaration as a heritage site or Site Management Plan.
7. Stakeholders.
8. Detailed report including the Desktop and Phase 1 study information.
9. Annual interim or progress Phase 2 permit reports as well as the final report.
10. Methodology used.

Three types of permits are available; Mitigation, Destruction and Interpretation. The specialist will apply for the permit at the beginning of the process (SAHRA 2012).

The Palaeontological Society of South Africa (PSSA) does not have guidelines on excavating or collecting, but the following is suggested:

1. The developer needs to clearly stake or peg-out (survey) the areas affected by the mining / construction / development operations and dig representative trenches and if possible supply geological borehole data.
2. Fossils likely to occur; see Report, or any other fossiliferous layer ranked **VERY HIGH or HIGH**.
3. When clearing topsoil, subsoil or overburden and hard rock (outcrop) is found, the contractor needs to stop all work. The area needs to be fenced off.
4. A Palaeontologist / Palaeobotanist (contact SAHRIS for list) / ECO must then inspect the affected areas and trenches for fossiliferous outcrops / layers. The contractor / developer may be asked to move structures, and put the development on hold.

5. If the Palaeontologist / Palaeobotanist / ECO are satisfied that no fossils will be destroyed or have removed fossils, development and removing of the topsoil can continue.
6. After this process the same Palaeontologist / Palaeobotanist / ECO will have to inspect and offer advice through the Phase 2 Mitigation Process. Bedrock excavations for footings may expose, damage or destroy previously buried fossil material and must be inspected.
7. When permission for the development is granted, the next layer can be removed, if this is part of the Vryheid Formation, then with the removal of each layer of sediment, the Palaeontologist / Palaeobotanist / ECO must do an investigation (a minimum of once every week).
8. At this stage the Palaeontologist / Palaeobotanist / ECO in consultation with the developer / mining company must ensure that a further working protocol and schedule is in place. Onsite training should take place, followed by an annual visit by the Palaeontologist / Palaeobotanist.

Fossil excavation if necessary during Phase 2:

1. Photography of fossil / fossil layer and surrounding strata.
2. Once a fossil has been identified as such, the task of extraction begins.
3. It usually entails the taking of a GPS reading and recording lithostratigraphic, biostratigraphic, date, collector and locality information.
4. Using Paraloid (B-72) as an adhesive and protective glue, parts of the fossil can be kept together (not necessarily applicable to plant fossils).
5. Slowly chipping away of matrix surrounding the fossil using a geological pick, brushes and chisels.
6. Once the full extent of the fossil / fossils is visible, it can be covered with a plaster jacket (not necessarily applicable to plant fossils).
7. Chipping away sides to loosen underside.
8. Splitting of the rock containing palaeobotanical material will reveal any fossils sandwiched between the layers.

This document forms part of the Environmental Monitoring Programme. For practical reasons a palaeontologist may only be required to be on site once a month. If any fossil material is discovered then a Phase 2 rescue operation might be necessary, and a permit will be needed.

SAHRA has the following documents in place:
Guidelines to Palaeontological Permiting policy.
Minimum Standards: Palaeontological Component of Heritage Impact Assessment reports.
Guidelines for Field Reports.
Palaeontological Heritage Reports (All Provinces).