

**Palaeontological Impact Assessment for the
opencast mining right application on Farm
Makganyene 667, northwest of Postmasburg,
Northern Cape Province**

Desktop Study (Phase 1)

Subcontracted by

Beyond Heritage (Pty) Ltd

26 August 2025

Prof Marion Bamford

Palaeobotanist

P Bag 652, WITS 2050

Johannesburg, South Africa

Marion.bamford@wits.ac.za

1. Executive Summary

A Palaeontological Impact Assessment was requested for the opencast mining right application (MRA) by Assmang (Pty) Ltd on portions of Farm Makganyene 667, northwest of Postmasburg, Northern Cape Province. SAHRA Case id: 24503.

To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development.

The proposed site lies on the non-fossiliferous Makganyene Formation (Postmasburg Group) diamictites and partly on moderately sensitive Gordonia Formation sands. No fossils have been reported from this area. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no further palaeontological impact assessment is required unless fossils are found by the contractor, environmental officer or other designated responsible person once excavations, drilling or mining activities have commenced. Since the impact will be low, as far as the palaeontology is concerned, the project should be authorised.


ASPECT	SCREENING TOOL SENSITIVITY	VERIFIED SENSITIVITY	OUTCOME STATEMENT/ PLAN OF STUDY	RELEVANT SECTION MOTIVATING VERIFICATION
Palaeontology	Moderate	Low	Palaeontological Impact Assessment	Section 7.2. SAHRA Requirements

2. Declaration of independence and summary of expertise.

a. Declaration

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Beyond Heritage (Pty) Ltd, Modimolle, South Africa. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision-making process for the Project.

Specialist: Prof Marion Bamford

Signature: 

b. Expertise

The Palaeontologist Consultant: Prof Marion Bamford

Qualifications: PhD (Wits Univ, 1990); FRSSAf, mASSAf, PSSA

Experience: 36 years research and lecturing in Palaeontology; over 28 years PIA studies and over 450 projects completed.

c. Specialist declaration of independence and statement of objectivity for the assessment.

Declaration of Independence

I, Marion Bamford, declare that –

General declaration:

- I act as the independent palaeontology practitioner in this application,
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant,
- I declare that there are no circumstances that may compromise my objectivity in performing such work,
- I have expertise in conducting palaeontological impact assessments, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation,
- I will take into account, to the extent possible, the matters listed in section 38 of the NHRA when preparing the application and any report relating to the application,
- I have no, and will not engage in, conflicting interests in the undertaking of the activity,
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority,
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties

and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application,

- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not
- All the particulars furnished by me in this form are true and correct,
- I will perform all other obligations as expected from a heritage practitioner in terms of the Act and the constitutions of my affiliated professional bodies; and
- I realise that a false declaration is an offence in terms of regulation 71 of the Regulations and is punishable in terms of section 24F of the NEMA.

Disclosure of Vested Interest

- I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Regulations.

d. Summary of the specialist's expertise

I, Marion Bamford, am a professional Palaeontologist with a PhD in Palaeontology (Wits University, 1990). I have more than 35 years of experience in palaeontological research and have published over 190 papers in peer-reviewed journals and published more than 14 scholarly book chapters. I review manuscripts for international and local journals and also review funding proposals for international funding bodies. Currently I am the Director of the Evolutionary Studies Institute, the only palaeontological institute in Southern Africa.

I have completed more than 450 palaeontological impact assessments (desktop and site visit studies) in the last 28 years for a variety of projects (solar energy projects, wind energy projects, powerlines, roads, infrastructure, housing and retail projects and from all over South Africa. I have been subcontracted by over 30 different companies. From my own projects and training provided by me and other staff in the ESI for Palaeontological Impact Assessments, I am familiar with the legislation.

Table of Contents

1.	Executive Summary	i
2.	Declaration of independence and summary of expertise.....	1
3.	Project Background.....	4
4.	Methods and Terms of Reference.....	7
5.	Geology and Palaeontology.....	7
i.	Project location and geological context	7
ii.	Palaeontological context.....	9
6.	Impact assessment	11
7.	Assumptions and uncertainties.....	16
8.	Recommendation.....	16
9.	References	17
10.	Chance Find Protocol	18
11.	Appendix A – Examples of fossils	18
	Figure 1: Google Earth map of the general area to show the relative land marks.	6
	Figure 2: Google Earth Map of the proposed development	6
	Figure 3: Geological map of the area around the project site.....	7
	Figure 4: SAHRIS palaeosensitivity map for the site	9
	Figure 5: DFFE screening map for palaeosensitivity.....	10
	Table 1: NEMA and EIA Regulations	4
	Table 2: List of abbreviations for geology map	8
	Tables 3a-k: Impact Assessment criteria	12

3. Project Background

Greenmined Environmental (Pty) Ltd has been appointed by Assmang (Pty) Ltd to conduct an Environmental Authorisation (EA) Application for the proposed mining opencast activities on 1 549.61 ha that extends over portion 2 (portion of portion 1), remainder portion of portion 1 and portion 3 of the farm Makganyene No 667 in the Tsantsabane Local Municipality, Northern Cape Province (Figures 1-2).

A desktop palaeontological impact assessment was completed in 2019 (Bamford, Nov 2019) but SAHRA has requested an updated report (Case Id: 24053).

A Palaeontological Impact Assessment was requested for the Makganyene 667 mining right application project. To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development and is reported herein.

Table 1: National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and Environmental Impact Assessment (EIA) Regulations, 2014 (as amended) - Requirements for Specialist Reports (Appendix 6). Includes the requirements from GNR Appendix 6 of GN 326 EIA Regulation 2017.

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	Relevant section in report
ai	Details of the specialist who prepared the report,	Section 2
a ii	The expertise of that person to compile a specialist report including a curriculum vitae	Section 2
b	A declaration that the person is independent in a form as may be specified by the competent authority	Section 2
c	An indication of the scope of, and the purpose for which, the report was prepared	Section 3
ci	An indication of the quality and age of the base data used for the specialist report: SAHRIS palaeosensitivity map accessed – date of this report	Yes
c ii	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 6
d	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
e	A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 4
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 6

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	Relevant section in report
g	An identification of any areas to be avoided, including buffers	N/A
h	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 7
j	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 8
k	Any mitigation measures for inclusion in the EMPr	Section 10, Appendix A
l	Any conditions for inclusion in the environmental authorisation	N/A
m	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 10, Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 8
nii	If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Sections 8, 10
o	A description of any consultation process that was undertaken during the course of carrying out the study	N/A
p	A summary and copies of any comments that were received during any consultation process	N/A
q	Any other information requested by the competent authority.	N/A
2	Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/A

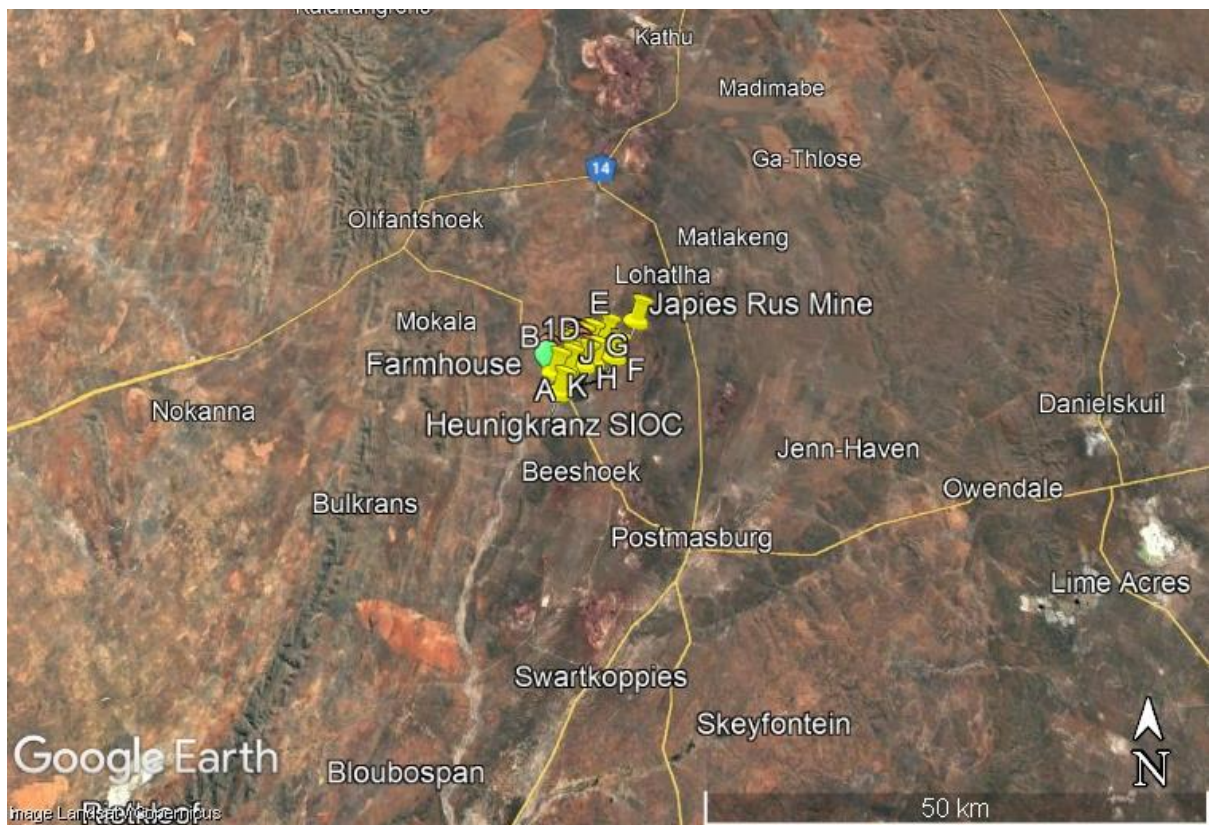


Figure 1: Google Earth map of the general area to show the relative land marks. The Makganyene PRA project area is shown by the yellow pins.

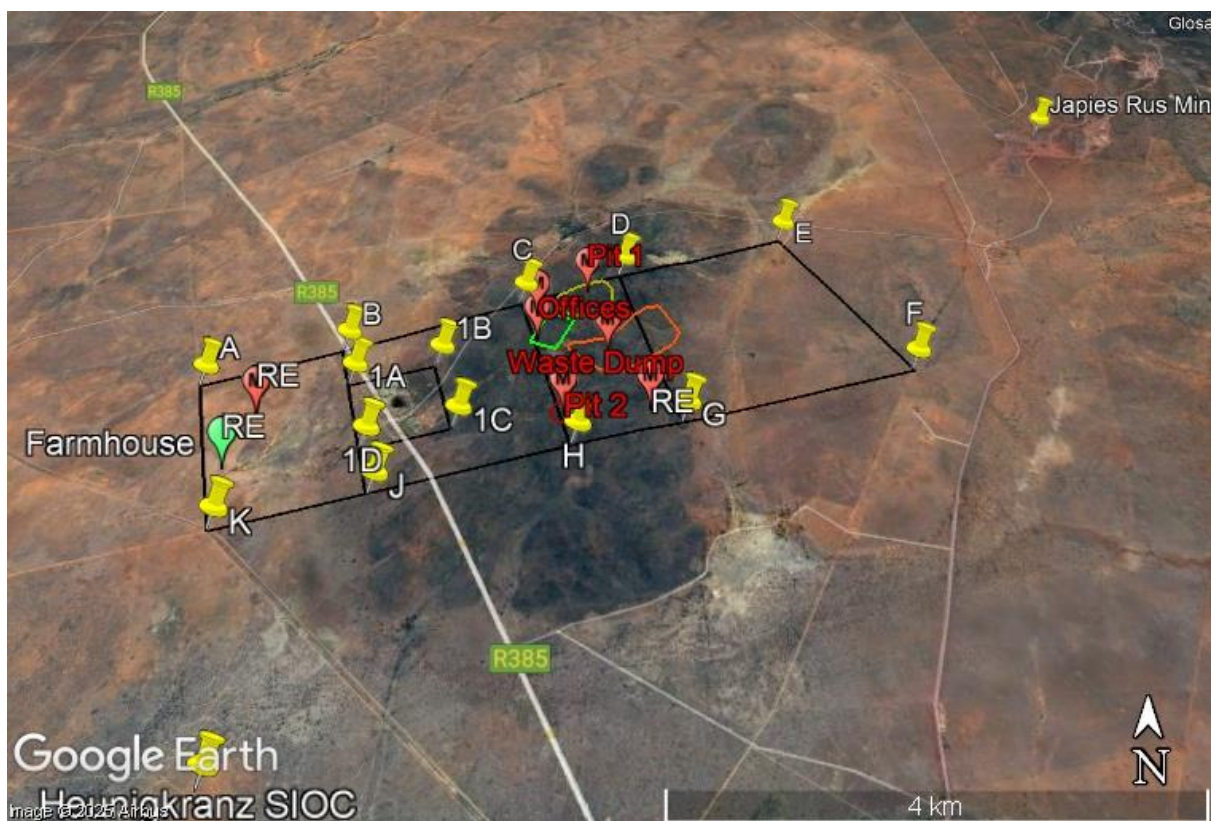


Figure 2: Google Earth Map of the proposed MRA on Farm for Makganyene 667 and planned infrastructure.

4. Methods and Terms of Reference

The Terms of Reference (ToR) for this study were to undertake a PIA and provide feasible management measures to comply with the requirements of SAHRA.

The methods employed to address the ToR included:

1. Consultation of geological maps, literature, palaeontological databases, published and unpublished records to determine the likelihood of fossils occurring in the affected areas. Sources include records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases; eg <https://sahris.sahra.org.za/map/palaeo>
2. Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance (*not applicable to this assessment*);
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*not applicable to this assessment*); and
4. Determination of fossils' representativity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (*not applicable to this assessment*).

5. Geology and Palaeontology

i. Project location and geological context

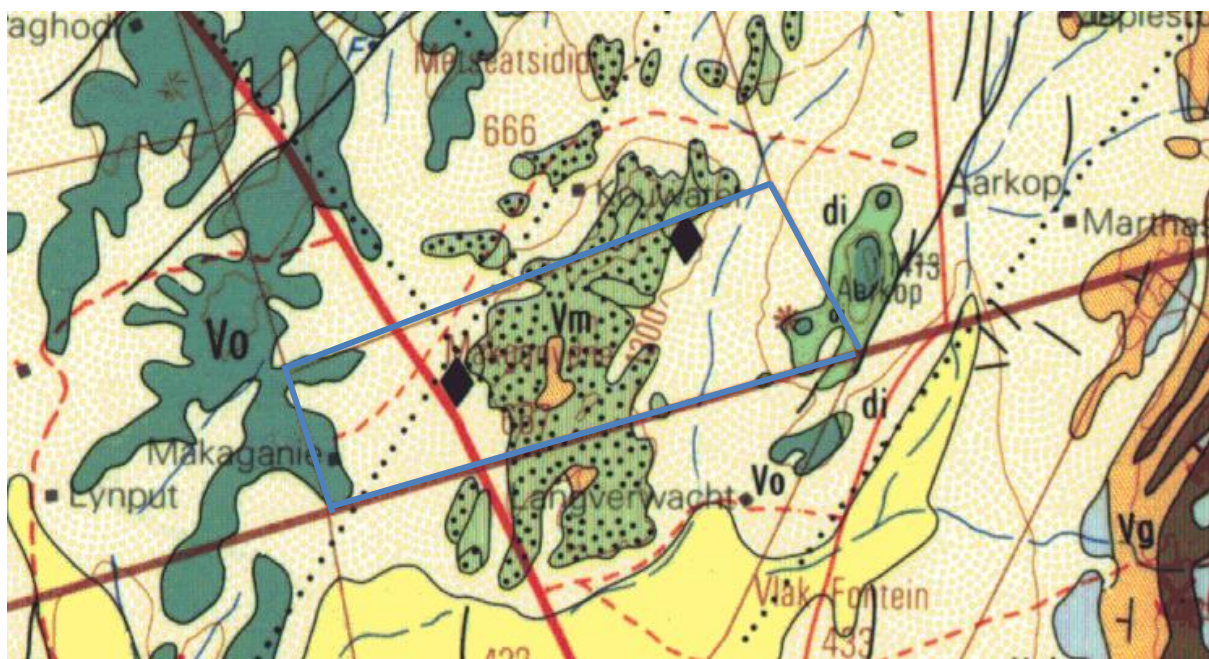


Figure 3: Geological map of the area around the Farm Makganyene 667 with the MRA area shown within the blue outline. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2822 Postmasburg.

Table 2: Explanation of symbols for the geological map and approximate ages (Eriksson et al., 2006; Partridge et al., 2006). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Qs	Kalahari Group	Windblown sands and sand dunes	Quaternary, ca 2,5 Ma to present
Ql	Kalahari Group	Surface limestone	Quaternary, ca 2,5 Ma to present
VI	Lucknow Fm, Olifantshoek SG	White quartzite and shale with subordinate dolomite and conglomerate	Palaeoproterozoic Ca 1893 Ma
Vv	Voelwater Fm, Postmasburg Group	Banded Iron, jasper, dolomite	Palaeoproterozoic < 2222 Ma
Vo	Ongeluk Fm, Postmasburg Group	Basaltic andesitic lava	2222 Ma
Vm	Makganyane Fm, Postmasburg Group	Diamictites of glacial origin	Ca 2420 – 2222 Ma
Vg	Gamagara Fm, Postmasburg Group	Shale, flagstone, quartzite, conglomerate	Ca 2420 – 2222 Ma

The project lies in the Kalahari Basin where young windblown sands overlie much older rocks of the Olifantshoek and Transvaal Supergroups (Figure 3).

The Late Archaean to early Proterozoic Transvaal Supergroup is preserved in three structural basins on the Kaapvaal Craton (Eriksson et al., 2006). In South Africa are the Transvaal and Griqualand West Basins, and the Kanye Basin is in southern Botswana. The Griqualand West Basin is divided into the Ghaap Plateau sub-basin and the Prieska sub-basin. Sediments in the lower parts of the basins are very similar but they differ somewhat higher up the sequences. Several tectonic events have greatly deformed the south western portion of the Griqualand West Basin between the two sub-basins

Above the basal Ghaap Group that has extensive iron and manganese deposits, is the upper Postmasburg Group that is divided from the base upwards, into the Makganyene, Ongeluk, Hotazel and Mooidraai Formations (Eriksson et al., 2006; Schröder et al., 2016). Lying above the Asbestos Hills Subgroup is the Makganyene Formation that has diamictites and shales from glacial conditions. Disconformably overlying these are the Ongeluk Formation basaltic andesitic lavas. According to Cornell et al. (1996) and Schroder et al. (2016) the Ongeluk Formation is equivalent to the lavas of the Hekpoort Formation in the Transvaal Basin.

QUATERNARY

There were two large basins dominating southern Africa during the Cenozoic, with the Kalahari Basin to the west and the Bushveld basin to the east. Both basins are bounded along their southern extent by the more or less west-east trending Griqualand-Transvaal Axis (Partridge et al., 2006). These sediments are not easy to date but recent attempts are gradually filling in the history of the sands, sand dunes and inter-dunes (Botha, 2021).

Quaternary Kalahari sands cover large parts of the rocks in this region, especially to the west. This is the largest and most extensive palaeo-erg in the world (Partridge et al., 2006) and is composed of extensive aeolian and fluvial sands, sand dunes, calcrete, scree and colluvium. Periods of aridity have overprinted the sands, and calcrete and silcrete are common. Most geological maps indicate these sands simply descriptively (aeolian sand, gravelly sand, calcrete) or they are lumped together as the Gordonia Formation because

the detailed regional lithostratigraphic work has not been done, Nonetheless, these sands have eroded from the interior and have been transported by wind or water to fill the basin. Reworking of the sands or stabilisation by vegetation has occurred. Probable ages of dune formation are around 100 kya (thousand years), 60 kya, 27-23 kya and 17-10 kya (in Botha, 2021).

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figures 4-5. The project area is in the moderately sensitive Makganyene Formation diamictites and the Quaternary Kalahari sands, probably the Gordonia Formation.

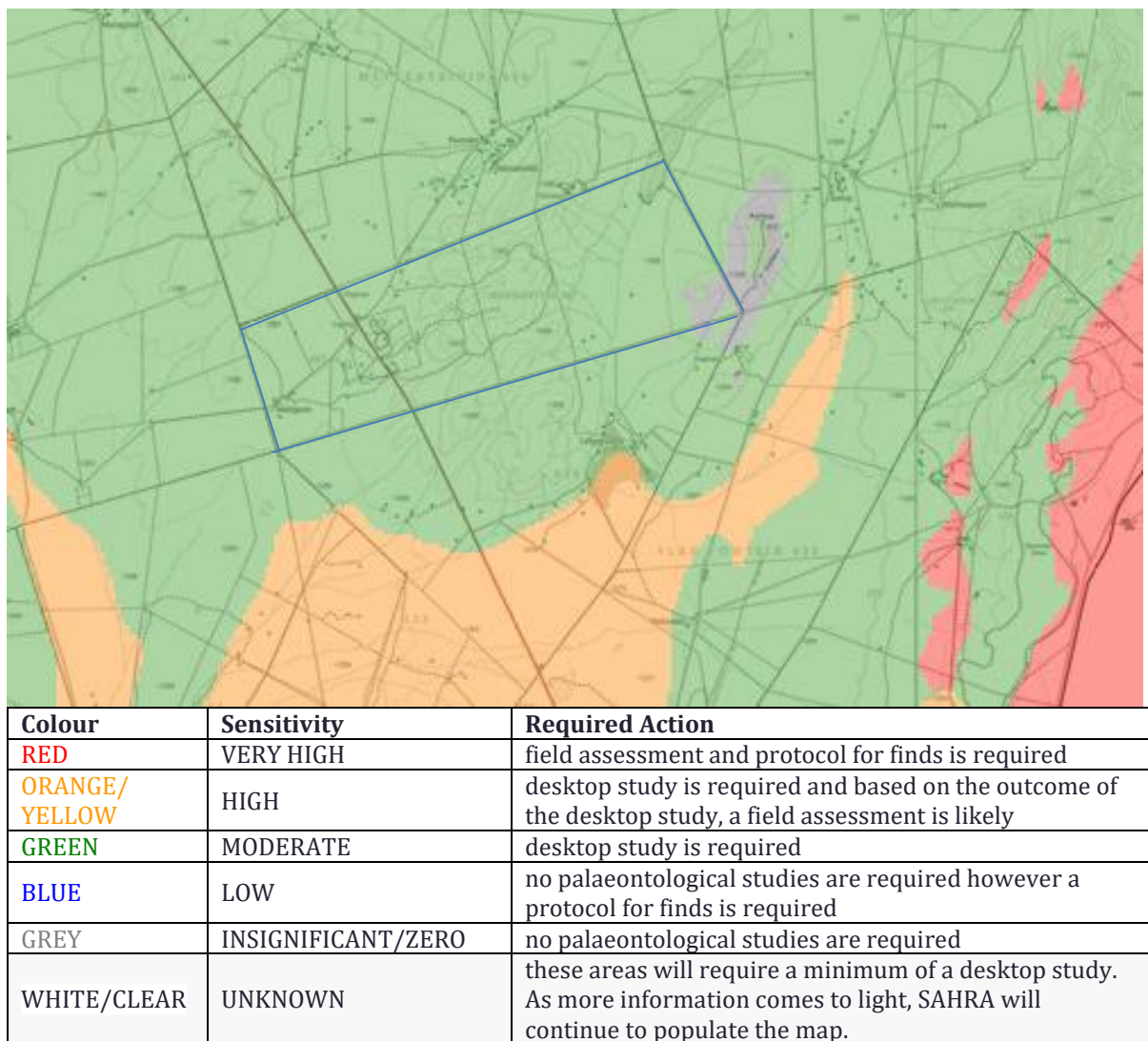


Figure 4: SAHRIS palaeosensitivity map for the site for the Makganyene MRA project shown within the blue outline.

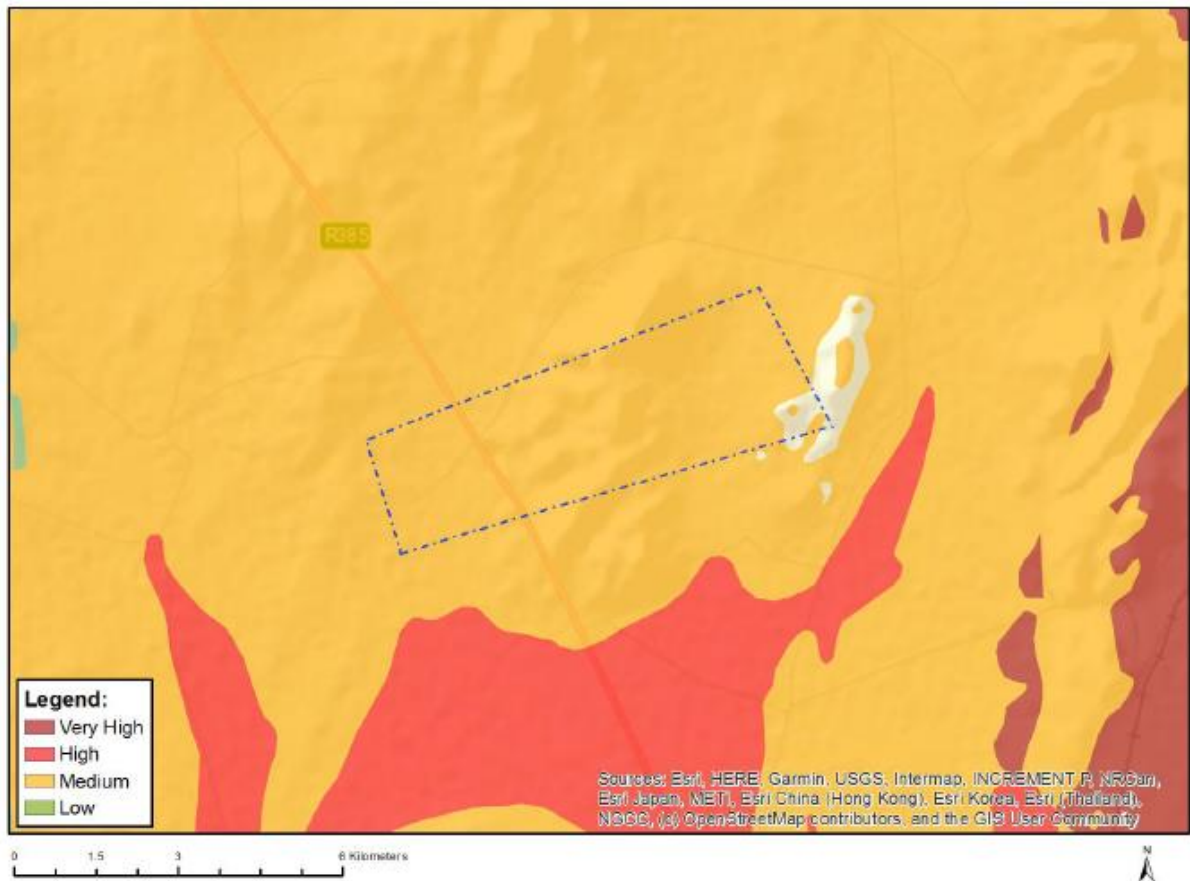


Figure 5: DFFE screening map for palaeosensitivity.

From the SAHRIS and DFFE maps above the area is indicated moderately sensitive (green) that correctly applies to the windblown sand and sand dunes of the Kalahari sands but questionably to the Makganyene Formation. The latter formation is included in the moderately sensitive section BUT this formation is composed of diamictites of glacial origin and banded jasper (Eriksson et al., 2006, p. 253). Such diamictites are the deposition of debris that has been dropped when the glaciers melted but are too old to have incorporated any fossil material as they predate the origin of body fossils. They should be indicated as having zero palaeosensitivity.

Windblown sands and sand dunes have been transported from another area and do not preserve fossils in primary context. Occasionally fragments of more durable fossils, such as bones or silicified wood, can be entrained by the sands but these not of scientific interest because they have been transported. In addition, no fossil traps such as palaeopans or palaeo-springs are visible in the satellite imagery, so it is very unlikely that any fossil fragments occur in the project area.

6. Impact assessment

Method for the assessment of the potential environmental, social and cultural impacts

DEFINITIONS AND CONCEPTS

Environmental Significance

The concept of significance is at the core of impact identification, evaluation and decision-making. The concept remains largely undefined and there is no international consensus on a single definition. The following common elements are recognized from the various interpretations:

- Environmental significance is a value judgment
- The degree of environmental significance depends on the nature of the impact
- The importance is rated in terms of both biophysical and socio-economic values
- Determining significance involves the amount of change to the environment perceived to be acceptable to affected communities.

Significance can be differentiated into impact magnitude and impact significance.

Impact magnitude is the measurable change (i.e. intensity, duration and likelihood). Impact significance is the value placed on the change by different affected parties (i.e. level of acceptability) (DEAT (2002) Impact Significance, Integrated Environmental Management, Information Series 5).

The concept of risk has two dimensions, namely the consequence of an event or set of circumstances, and the likelihood of particular consequences being realised (Environment Australia (1999) Environmental Risk Management).

Impact

The positive or negative effects on human well-being and / or the environment.

Consequence

The intermediate or final outcome of an event or situation OR it is the result, on the environment, of an event.

Likelihood

A qualitative term covering both probability and frequency.

Frequency

The number of occurrences of a defined event in a given time or rate.

Probability

The likelihood of a specific outcome measured by the ratio of a specific outcome to the total number of possible outcomes.

Environment

Surroundings in which an organisation operates, including air, water, land, natural resources, flora, fauna, humans and their interrelation (ISO 14004, 1996).

Methods that will be used

The environmental significance assessment method is based on the following determination:

Environmental Significance = Overall Consequence x Overall Likelihood

Determination of Overall Consequence

Consequence analysis is a mixture of quantitative and qualitative information, and the outcome can be positive or negative. Several factors can be used to determine consequence. For the purpose of determining the environmental significance in terms of consequence, the following factors were chosen: Severity/Intensity, Duration and Extent/Spatial Scale. Each factor is assigned a rating of 1 to 5, as described in the tables below.

Determination of Severity / Intensity

Severity relates to the nature of the event, aspect or impact to the environment and describes how severe the aspects impact on the biophysical and socio-economic environment.

Table 1: Table to be used to obtain an overall rating of severity, taking into consideration the various criteria.

TYPE OF CRITERIA	RATING				
	1	2	3	4	5
Quantitative	0-20%	21-40%	41-60%	61-80%	81-100%
Qualitative	Insignificant / Non-harmful	Small / Potentially harmful	Significant/ Harmful	Great/ Very harmful	Disastrous Extremely harmful
Social/ Community response	Acceptable / I&AP satisfied	Slightly tolerable / Possible objections	Intolerable/ Sporadic complaints	Unacceptable / Widespread complaints	Totally unacceptable / Possible legal action
Irreversibility	Very low cost to mitigate/ High potential to mitigate impacts to level of insignificance/ Easily reversible	Low cost to mitigate	Substantial cost to mitigate/ Potential to mitigate impacts/ Potential to reverse impact	High cost to mitigate	Prohibitive cost to mitigate/ Little or no mechanism to mitigate impact Irreversible
Biophysical (Air quality, water quantity and quality, waste production, fauna and flora)	Insignificant change / deterioration or disturbance	Moderate change / deterioration or disturbance	Significant change / deterioration or disturbance	Very significant change / deterioration or disturbance	Disastrous change / deterioration or disturbance

Determination of Duration

Duration refers to the amount of time that the environment will be affected by the event, risk or impact, if no intervention e.g. remedial action takes place.

Table 3b: Criteria for the rating of duration.

RATING	DESCRIPTION
--------	-------------

1	Up to ONE MONTH
2	ONE MONTH to THREE MONTHS (QUARTER)
3	THREE MONTHS to ONE YEAR
4	ONE to TEN YEARS
5	Beyond TEN YEARS

Determination of Extent/Spatial Scale

Extent or **spatial scale** is the area affected by the event, aspect or impact.

Table 2: Criteria for the rating of extent / spatial scale.

RATING	DESCRIPTION
1	Immediate, fully contained area
2	Surrounding area
3	Within Business Unit area of responsibility
4	Within the farm/neighbouring farm area
5	Regional, National, International

Determination of Overall Consequence

Overall consequence is determined by adding the factors determined above and summarized below, and then dividing the sum by 3.

Table 3: Example of calculating overall consequence.

CONSEQUENCE	RATING
Severity	Example 4
Duration	Example 2
Extent	Example 4
SUBTOTAL	10
TOTAL CONSEQUENCE: (Subtotal divided by 3)	3.3

Determination of Likelihood

The determination of likelihood is a combination of Frequency and Probability. Each factor is assigned a rating of 1 to 5, as described below.

Determination of Frequency

Frequency refers to how often the specific activity, related to the event, aspect or impact, is undertaken.

Table 4: Criteria for the rating of frequency.

RATING	DESCRIPTION
1	Once a year or once/more during operation
2	Once/more in 6 Months
3	Once/more a Month
4	Once/more a Week
5	Daily

Determination of Probability

Probability refers to how often the activity or aspect has an impact on the environment.

Table 5 Criteria for the rating of probability.

RATING	DESCRIPTION
1	Almost never / almost impossible
2	Very seldom / highly unlikely
3	Infrequent / unlikely / seldom
4	Often / regularly / likely / possible
5	Daily / highly likely / definitely

Overall Likelihood

Overall likelihood is calculated by adding the factors determined above and summarized below, and then dividing the sum by 2.

Table 6: Example of calculating overall likelihood.

CONSEQUENCE	RATING
Frequency	Example 4
Probability	Example 2
SUBTOTAL	6
TOTAL LIKELIHOOD (Subtotal divided by 2)	3

Determination of Overall Environmental Significance

The multiplication of overall consequence with overall likelihood will provide the environmental significance, which is a number that will then fall into a range of **LOW**, **LOW-MEDIUM**, **MEDIUM**, **MEDIUM-HIGH** or **HIGH**, as shown in the table below.

Table 7: Determination of overall environmental significance.

SIGNIFICANCE OR RISK	LOW	LOW-MEDIUM	MEDIUM	MEDIUM-HIGH	HIGH
Overall Consequence X Overall Likelihood	1 - 4.9	5 - 9.9	10 - 14.9	15 - 19.9	20 - 25

Qualitative description or magnitude of Environmental Significance

This description is qualitative and is an indication of the nature or magnitude of the Environmental Significance. It also guides the prioritizations and decision making process associated with this event, aspect or impact.

Table 8: Description of environmental significance and related action required.

SIGNIFICANCE	LOW	LOW-MEDIUM	MEDIUM	MEDIUM-HIGH	HIGH
Impact Magnitude	Impact is of very low order and therefore	Impact is of low order and therefore	Impact is real, and potentially substantial	Impact is real and substantial in relation to	Impact is of the highest order possible.

SIGNIFICANCE	LOW	LOW-MEDIUM	MEDIUM	MEDIUM-HIGH	HIGH
	likely to have very little real effect. Acceptable.	likely to have little real effect. Acceptable.	in relation to other impacts. Can pose a risk to company	other impacts. Pose a risk to the company. Unacceptable	Unacceptable. Fatal flaw.
Action Required	Maintain current management measures. Where possible improve.	Maintain current management measures. Implement monitoring and evaluate to determine potential increase in risk. Where possible improve	Implement monitoring. Investigate mitigation measures and improve management measures to reduce risk, where possible.	Improve management measures to reduce risk.	Implement significant mitigation measures or implement alternatives.

Based on the above, the significance rating scale has been determined as follows:

HIGH Of the highest order possible within the bounds of impacts which could occur. In the case of negative impacts, there would be no possible mitigation and / or remedial activity to offset the impact at the spatial or time scale for which it was predicted. In the case of positive impacts, there is no real alternative to achieving the benefit.

MEDIUM-HIGH Impacts of a substantial order. In the case of negative impacts, mitigation and / or remedial activity would be feasible but difficult, expensive, time-consuming or some combination of these. In the case of positive impacts, other means of achieving this benefit would be feasible, but these would be more difficult, expensive, time-consuming or some combination of these.

MEDIUM Impact would be real but not substantial within the bounds of those, which could occur. In the case of negative impacts, mitigation and / or remedial activity would be both feasible and fairly easily possible, In case of positive impacts; other means of achieving these benefits would be about equal in time, cost and effort.

LOW-MEDIUM Impact would be of a low order and with little real effect. In the case of negative impacts, mitigation and / or remedial activity would be either easily achieved or little would be required, or both. In case of positive impacts alternative means for achieving this benefit would likely be easier, cheaper, more effective, less time-consuming, or some combination of these.

LOW Impact would be negligible. In the case of negative impacts, almost no mitigation and or remedial activity would be needed, and any minor steps, which might be needed, would be easy, cheap, and simple. In the case of positive impacts, alternative means would almost all likely be better, in one or a number of ways, than this means of achieving the benefit.

INSIGNIFICANT There would be a no impact at all – not even a very low impact on the system or any of its parts.

Table 3k: Calculations for the Makganyene MRA pre-mitigation and post-mitigation

Criteria	Pre-mitigation	Post-mitigation (removal of any fossils in footprint)
Severity (from table 3a) (S)	1	1
Duration (D)	5	1
Extent (E)	1	1
CONSEQUENCE (C) = S+D+E / 3	7/3 = 2.3	3/3 = 1
Frequency (F)	1	1
Probability (P)	2	1
LIKELIHOOD (L) = F+P / 2	3/2 = 1.5	2/2 = 1
Environmental Significance = C x L	2.3x1.5 = 3.4 LOW	1x1 = 1 LOW
Impact magnitude	Low	Low to insignificant
Action required	Fossil chance find protocol to be followed so any fossils found during mining must be removed, kept safe and SAHRA notified.	

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the target rocks are much too old and/or the wrong kind to contain fossils. Furthermore, the material to be mined is metamorphosed and this does not preserve fossils. Since there is a small chance that fossils from the Gordonia Formation may be disturbed a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is low.

7. Assumptions and uncertainties

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the banded iron, jasper, dolomites, sandstones, shales and sands are typical for the country and only some might contain fossil plant, insect, invertebrate and vertebrate material. The sands of the Quaternary period would not preserve fossils.

8. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the overlying aeolian sands or soils of the Quaternary. There is a very small chance that transported, fragmented fossils may occur below the sand cover in fossil traps such as palaeo-pans or palaeo-springs although so no such features are visible in the satellite imagery. The rocks of the Postmasburg Group (Transvaal supergroup) that will be mined for iron and/or manganese are ancient and have been metamorphosed do they do not preserve any

fossils. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the environmental officer, or other responsible person once excavations have commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample. The impact on the palaeontological heritage would be low, as far as the palaeontology is concerned, so the project should be authorised.

ASPECT	SCREENING TOOL SENSITIVITY	VERIFIED SENSITIVITY	OUTCOME STATEMENT/ PLAN OF STUDY	RELEVANT SECTION MOTIVATING VERIFICATION
Palaeontology	Moderate	Low	Palaeontological Impact Assessment	Section 7.2. SAHRA Requirements

9. References

Anderson, J.M., Anderson, H.M., 1985. Palaeoflora of Southern Africa: Prodromus of South African megafloras, Devonian to Lower Cretaceous. A.A. Balkema, Rotterdam. 423 pp.

Eriksson, P.G., Altermann, W., Hartzer, F.J., 2006. The Transvaal Supergroup and its precursors. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. pp 237-260.

Johnson, M.R., van Vuuren, C.J., Visser, J.N.J., Cole, D.I., Wickens, H.deV., Christie, A.D.M., Roberts, D.L., Brandl, G., 2006. Sedimentary rocks of the Karoo Supergroup. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 461 – 499.

Moen, H.F.G., 2006. The Olifantshoek Supergroup. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 319-324.

Partridge, T.C., Botha, G.A., Haddon, I.G., 2006. Cenozoic deposits of the interior. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 585-604.

Plumstead, E.P., 1969. Three thousand million years of plant life in Africa. Geological Society of southern Africa, Annexure to Volume LXXII. 72pp + 25 plates.

10. Fossil Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations / drilling / mining activities begin.

1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations/mining commence.
2. When excavations begin the rocks and discard must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (plants, insects, bone or coal) should be put aside in a suitably protected place. This way the project activities will not be interrupted.
3. Photographs of similar fossils must be provided to the developer to assist in recognizing the fossil plants, vertebrates, invertebrates or trace fossils in the shales and mudstones (for example see Figure 6). This information will be built into the EMP's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. If there is any possible fossil material found by the developer/environmental officer/miners then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
7. If no good fossil material is recovered then no site inspections by the palaeontologist will be necessary. A final report by the palaeontologist must be sent to SAHRA once the project has been completed and only if there are fossils.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

11. Appendix A – Examples of fossils from the Quaternary



Figure 6: Photographs of robust but fragmented fossils that could be found below the aeolian sands in traps such as palaeo-pans or palaeo-springs.