Palaeontological Impact Assessment for the proposed Eskom Chemie-Foskor project, near Phalaborwa, Limpopo Province

Desktop Study

For

Landscape Dynamics

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Expertise of Specialist

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Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 30 years research; 20 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Landscape Dynamics, South Africa. The views expressed in this report are entirely those of the author and Landscape Dynamics and no other interest was displayed during the decision making process for the project.

Specialist: …….. Prof Marion Bamford……..

Signature: ……. 

Executive Summary

The desktop Palaeontological Impact Assessment for the area in and around Phalaborwa for the proposed upgrade of power supply by Eskom to Chemie-Foskor has been compltd.Most of the rocks in the area are ancient gneisses of the Murchison Greenstone Belt which do not contain fossils. The rocks of the Phalaborwa Complex are volcanic in origin and do not contain fossils either. Older greenstone rocks of the Barberton greenstone Belt, namely the Onverwacht and Kromberg Formations, contain very rare fossil microbes so although it is extremely unlikely, there is a very small chance that similar fossil microbes could be found in this area. These fossils are microscopic so it is unlikely that they would be visible but the organic-rich black layers might be. Therefore a chance find protocol should be added to the EMPr. It is concluded that the project may continue as far as the palaeontology is concerned and no further impact assessments are required.

Palaeontological Impact Assessment for the proposed Eskom Chemie-Foskor Project, near Phalaborwa, Limpopo Province

1. Background

Eskom has contracted Landscape Dynamics to perform the Environmental Impact Assessment of their proposed project to improve the supply of power to the area near Phalaborwa.

Project components

Preferred Route Alternative (green routes)

- New Chemie Substation site as per the attached map
- A new single 132kV power line will be constructed from the new Chemie Substation to where it will connect to the existing 132kV Chemie-Selati Line to the direct east of the proposed Chemie Substation. The Chemie-Selati Line connects to the Phala-Traction Line further south. This new line is approximately 2.2km in length.
- A new LILO power line will be constructed from the new Chemie Substation to where it will connect to the existing 132kV to the Foskor-Chemie 2 Line south of the proposed Chemie Substation. This new line is approximately 2.8km in length.

Decommissioning of existing power line

- Approximately 2km of the existing 132kV Foskor-Chemie 2 Line will be decommissioned. The line to be decommissioned runs from the existing Chemie Substation to the new connection point as explained above.

Alternative route

- Alternative substation site as per attached map.
- A new LILO power line will be constructed from the new Chemie Substation to where it will connect to the existing 132kV to the Foskor-Chemie 2 Line south of the proposed Chemie Substation. This line will be approximately 3km in length.

A desktop palaeontological impact assessment has been requested by SAHRA for this project and is presented here.

The National Heritage Resources Act (Act 25 of 1999) and the National Environmental Management Act (Act 107 of 1998) requires that the proposed development must be preceded by the relevant impact assessment, in this case for palaeontology.

This report complies with the requirements of the NEMA and environmental impact assessment (EIA) regulations (GNR 982 of 2014). The table below provides a summary of the requirements, with cross references to the report sections where these requirements have been addressed.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (2014)

A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain:	**Relevant section in report**
Details of the specialist who prepared the report	Prof Marion Bamford
The expertise of that person to compile a specialist report including a curriculum vitae	Palaeontologist (PhD Wits 1990) CV attached
A declaration that the person is independent in a form as may be specified by the competent authority	Page 2
An indication of the scope of, and the purpose for which, the report was prepared	Section 1, page 3
The date and season of the site investigation and the relevance of the season to the outcome of the assessment	n/a Seasons make no difference to fossils
A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2, page 4
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	See table 2
An identification of any areas to be avoided, including buffers	n/a
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
A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 6, page 11
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Both options viable
Any mitigation measures for inclusion in the EMPr	Chance find p 12
Any conditions for inclusion in the environmental authorisation	n/a
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	n/a
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised and	n/a
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	n/a
A description of any consultation process that was undertaken during the course of carrying out the study	Section 3 page5
A summary and copies if any comments that were received during any consultation process	n/a
Any other information requested by the competent authority.	n/a

2. Methods and Terms of Reference

1. In order to determine the likelihood of fossils occurring in the affected area geological maps, literature, palaeontological databases and published and unpublished records have been consulted.

2. If fossils are likely to occur then a site visit must be made by a qualified palaeontologist to locate and assess the fossils and their importance.

3. Unique or rare fossils should either be collected (with the relevant South African Heritage Resources Agency (SAHRA) permit) and removed to a suitable storage and curation facility, for example a Museum or University palaeontology department, or protected on site.

4. Common fossils can be sacrificed if they are of minimal or no scientific importance but a representative collection could be made if deemed necessary.

The published geological and palaeontological literature, unpublished records of fossil sites, catalogues and reports housed in the Evolutionary Studies Institute, University of the Witwatersrand, and SAHRA databases were consulted to determine if there are any records of fossils from the sites and the likelihood of any fossils occurring there.

3. Consultation Process

No consultations were carried out during the palaeontological desktop study.

4. Geology and Palaeontology

Project location and geological setting

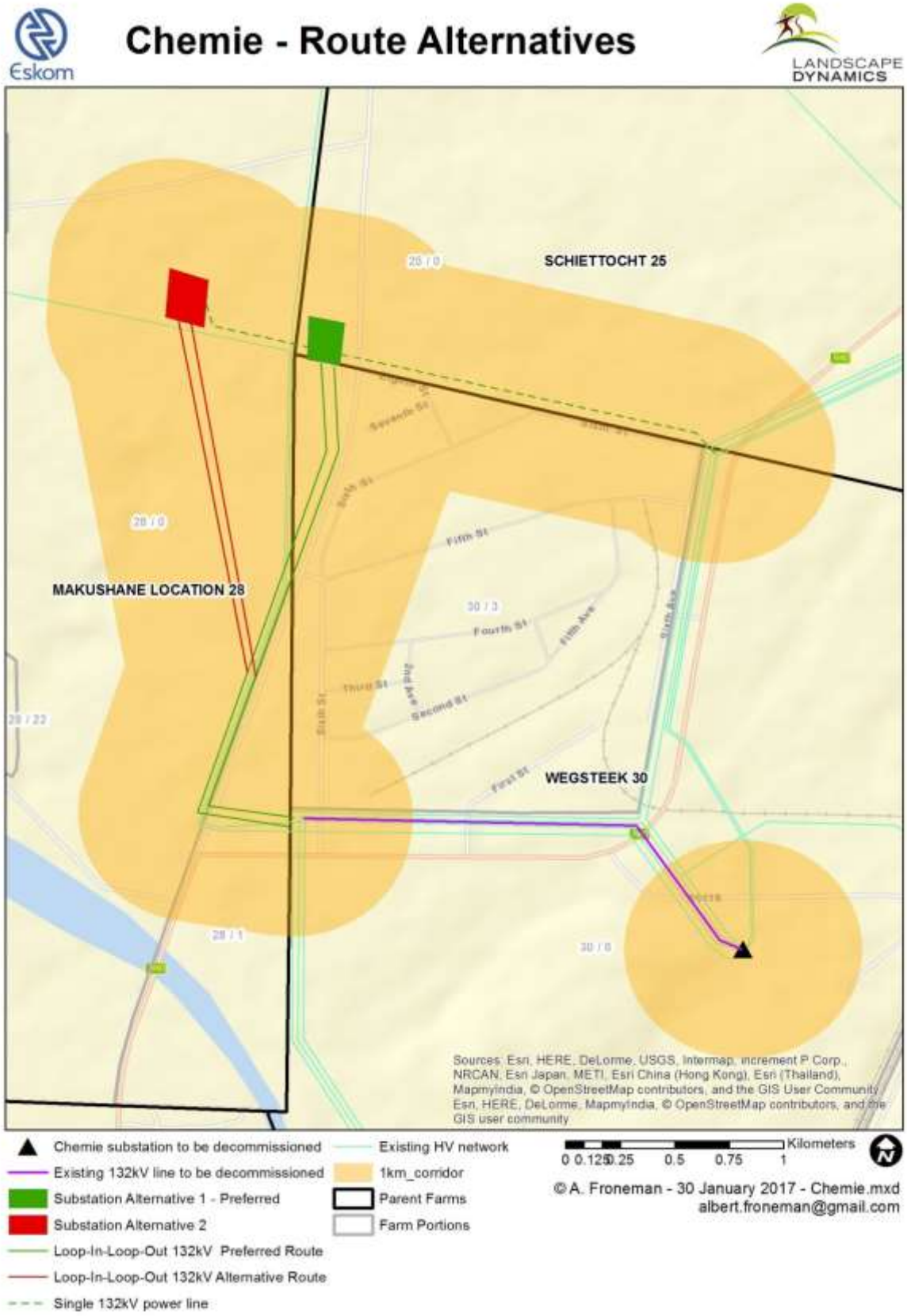

Figure 1: Details of the Route Alt 6 for the proposed Chemie-Foskor Project to replace substations and powerlines around Phalaborwa, Limpopo Province. Map supplied by Landscape Dynamics.

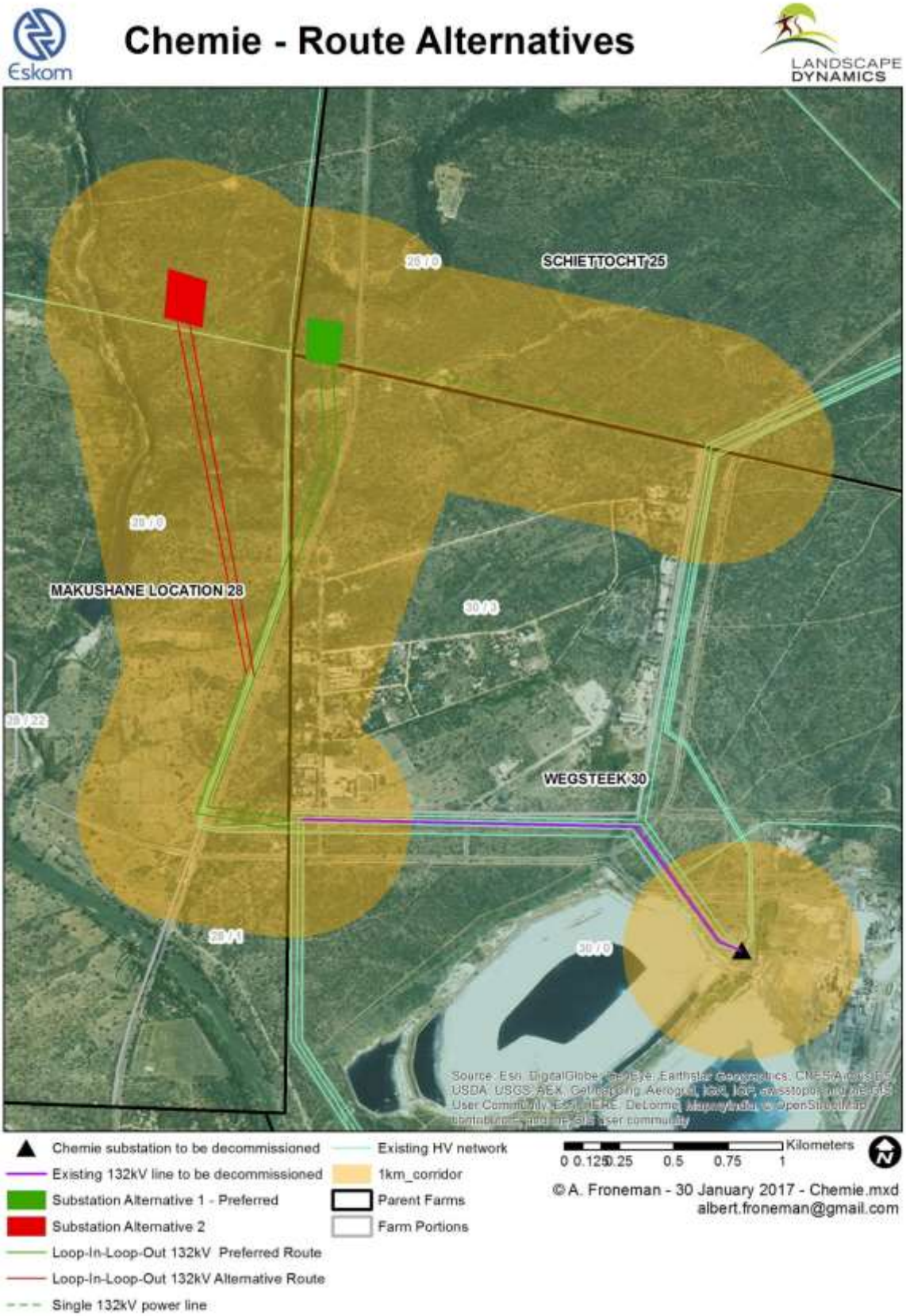

Figure 2: Details of the Route Alt 6 overlain on the Google Earth map showing the terrain for the proposed Chemie-Foskor project, around Phalaborwa, Limpopo Province. Map supplied by Landscape Dynamics.

Geology

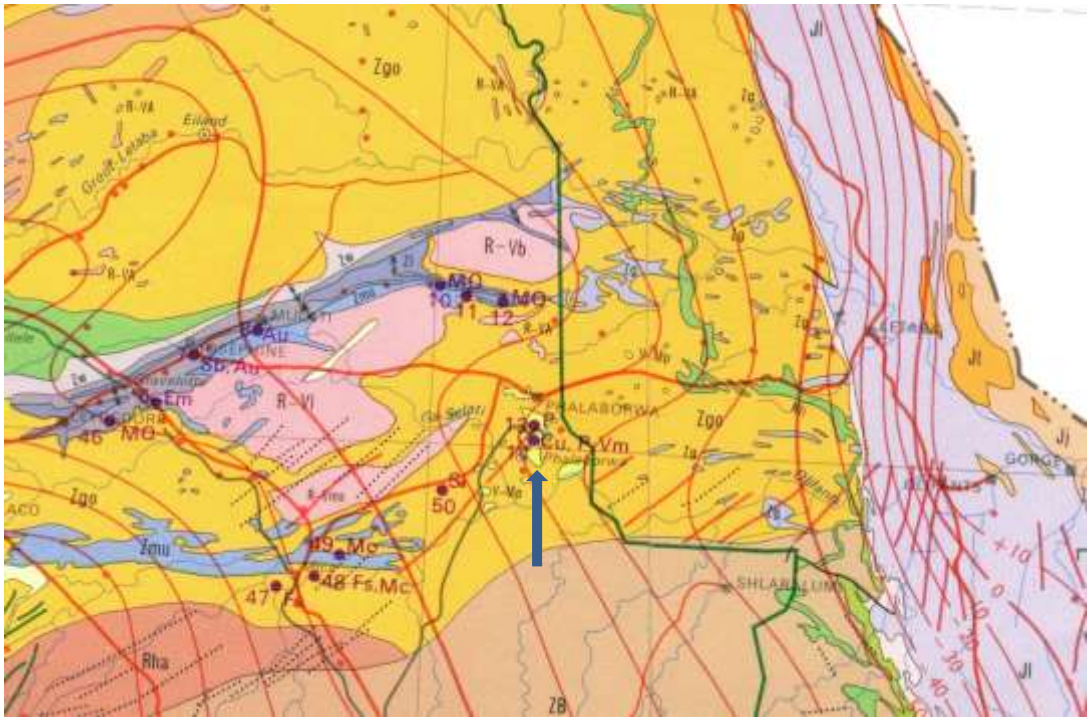

Figure 3: Geological map of the area around Phalaborwa where the Chemie-Foskor project is planned, as indicated by the blue arrow. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 1 000 000 map 1984.

Table 2: Explanation of symbols for the geological map and approximate ages (Brandl et al., 2006; Duncan and Marsh, 2006; Robb et al., 2006; Vervoerd and du Toit, 2006). SG = Supergroup; Fm = Formation.

Symbol	Group/Formation	Lithology	Approximate Age
Jt	Tshokwane Granophyre	Granophyre	
Jl	Letaba Fm, Lebombo Subgroup	Basalt	Ca 180 - 170 Ma
V-Mp	Phalaborwa Complex	Pyroxenite, dunite, carbonatite, syenite	2200-2100 Ma
R-Vb	Baderoukwe Granite	Biotite-muscovite granite	3018 Ma
R-Vms	Mashishimale Suite	Biotite-hornblende granite	2698 Ma
R-Vl	Lekkersmaak Granite	Biotite-muscovite granite	2690 Ma
Zg	Gravelotte Group, Murchison Greenstone Belt,	Ultramafic and mafic lavas, schist	Early Archean 2848 Ma
Zmu	Mulati Fm	Ultramafic and mafic lavas	
Zgo	Goudplaats Gnesiss	Migmatite, banded gneiss, leucogranite	3333 – 3274 Ma

Some of the oldest rocks of the earth's crust are to be found in this area, the Early Archean granitic gneisses with infolded greenstone belts or greenstone belt, remnants, of the Kaapvaal Craton (Brandl et al., 2006). The granitic gneisses (tonalities, trondhjemites or granodiorites) are the dominant ones in these regions and the greenstones are comprised mainly of extrusive mafic, ultramafic and felsic rocks, sometimes with sedimentary rocks in the upper parts (ibid). Contact between these two types of rocks is generally either tectonic or intrusive. The Gravelotte Group is divided into four units with the basal Mulati Unit being exposed far to the northwest and northeast. Intruding into these igneous rocks in the Phalaborwa area is the older Goudplaats-Hout River Gneiss which comprises tonalite gneiss and magmatic tonalite gneiss dated to between 3333 and 3274 M (Robb et al., 2006). The proposed project is on the Goudplaats Gneiss and possibly on the Phalaborwa Complex. This complex has been interpreted as the deeply eroded root zone of an ultramafic carbonatite-type volcano with very rich deposits of phosphate (apatite) and vermiculite, as well as magnetite, zirconia, sulphuric acid, uranium, nickel, gold, silver and platinum (Verwoerd and du Toit, 2006).

Far to the east are the much younger, but still igneous, basalts of the Letaba Formation of the Lebombo Group and the granophyres of the Tshokwane Granophyre (Duncan and Marsh, 2006).

Palaeontology

These early crustal and igneous rocks are mostly too old for body fossils. The earliest microbes have been recorded from rocks in the Barberton Greenstone Belt at ca 3500 Ma but they are very rare (Altermann, 2001; Kremer and Kazmierczak, 2017) and have not been recorded from the Murchison Greenstone Belt which is younger, at 3180-2953 Ma (Brandl et al., 2006). Both the Murchison and Barberton greenstone belts probably formed in oceanic settings with island arc development caused by some primitive form of Archean plate tectonic processes (Brandl et al., 2006). It is possible that these and other greenstone belts in southern Africa amalgamated to form the early Kaapvaal Craton, accompanied by the intrusion of various granitoid intrusions to form the stable Kaapvaal Craton by 2600 Ma (ibid). With such a history of tectonism and metamorphism it is surprising that the microbes in the Barberton Greenstone Belt survived at all.

As shown in the SAHRIS palaeosensitivity map, (Fig 4) the Phalaborwa area is grey indicating insignificant to zero chance of fossils occurring there. The desktop Palaeontological Impact assessment confirms this. The rocks are too old for preserving any body fossils of any kind. Microfossils have not been reported from this geological formation. This applies to both route alternatives.

Microfossils have been reported from an older but similar greenstone belt, the Barberton Greenstone belt and in particular from the Kromberg Formation. Since there is an extremely small chance of finding microfossils when the ground surface areas are excavated for powerlines, access roads and foundations for the new power station, a chance find protocol has been added to the report.

Figure 4: SAHRIS palaeosensitivity map. The proposed site for the Chemie-Foskor project is within the oval outline. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

5. Impact assessment

Using the criteria in the table below, the impact of the proposed new substation and powerlines and decommmisioning of old infrastructure near Phalaborwa for the Chemie-Foskor project, the impact on any palaeontological record has been assessed.

TABLE 3: CRITERIA FOR ASSESSING IMPACTS

PART A: DEFINITION AND CRITERIA		
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the	**L**	Localised - Within the site boundary.

SPATIAL SCALE of impacts	**M**	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national
PROBABILITY (of exposure to impacts)	**H**	Definite/ Continuous
	M	Possible/ frequent
	L	Unlikely/ seldom

The surface activities would not impact on the fossil heritage as the rocks are ancient and volcanic so it is extremely unlikely that any fossils would be present. The IMPACT is nil (according to the scheme in Table 3).

Foundations for the power station, new powerlines, access roads and decmmissionig of the old structures would penetrate only a few metres below ground surface at the most - of the soils - so there would be minor deterioration of the soils and minial impact on any potential fossils which, if present, would be in hard rock. Therefore the SEVERITY/NATURE of the environmental impact would be L.

DURATION of the impact would be permanent: H.

No fossils are likely to be found in the granites but if any were then the SPATIAL SCALE will be localised within the site boundary: L.

There is no chance of finding microfossils in the soils as these have been reported only from hard rocks of older Formations, but not soils or unconsolidated sediments. Therefore, the PROBABILITY of affecting any fossils is unlikely or seldom: L

6. 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 basement rocks, granites, gneisses, greywackes, cherts, basalts and other volcanic rocks are typical for the country and do not contain any fossil material. The rocks of the Onverwacht and Fig Tree Groups could contain microbial fossils, however, they have yet to be recorded from the proposed site for the Chemie-Foskor project, however there is an extremely small chance that fossil microbes could be found in the hard rocks of the Murchison Greenstone Belt.

7. Recommendation

It is extremely unlikely that any fossils occur in the site for the proposed project because mostly the rocks are much too old and volcanic in origin.

As far as the palaeontology is concerned the proposed development can go ahead. Both routes are feasible. Since there is an extremely small chance of finding fossils in the hard rocks a chance find protocol has been added to this report and should be included in the final EMPr. Any further palaeontological assessment would be unnecessary until any fossils are found by the responsible person (environmental officer or geologist on site during excavations).

8. Chance Find Protocol for Palaeontology – to commence once the excavations begin.

1. The following procedure is only required if fossils are seen on the surface and when excavations commence.
2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (microfossils – but invisible to the naked eye, black organic-rich material) should be put aside in a suitably protected place. This way the construction activities will not be interrupted.
3. Photographs of similar fossil microbes must be provided to the developer to assist in recognizing the fossil plants in the shales and mudstones (for example see Figure 5). 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 the palaeontologist is of the opinion that the material may be fossiliferous then a sample should be sent to the palaeontologist and analysed.
6. Further fossil material that is 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 the site inspections by the palaeontologist will not be required. If fossils are found then a report by the palaeontologist must be sent to SAHRA.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

9. References

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Kremer, B., Kazmierczak, J., 2017. Cellularly preserved microbial fossils from 3.4 Ga deposits of South Africa: A testimony of early appearance of oxygenic life? Precambrian Research 295, 117-129.

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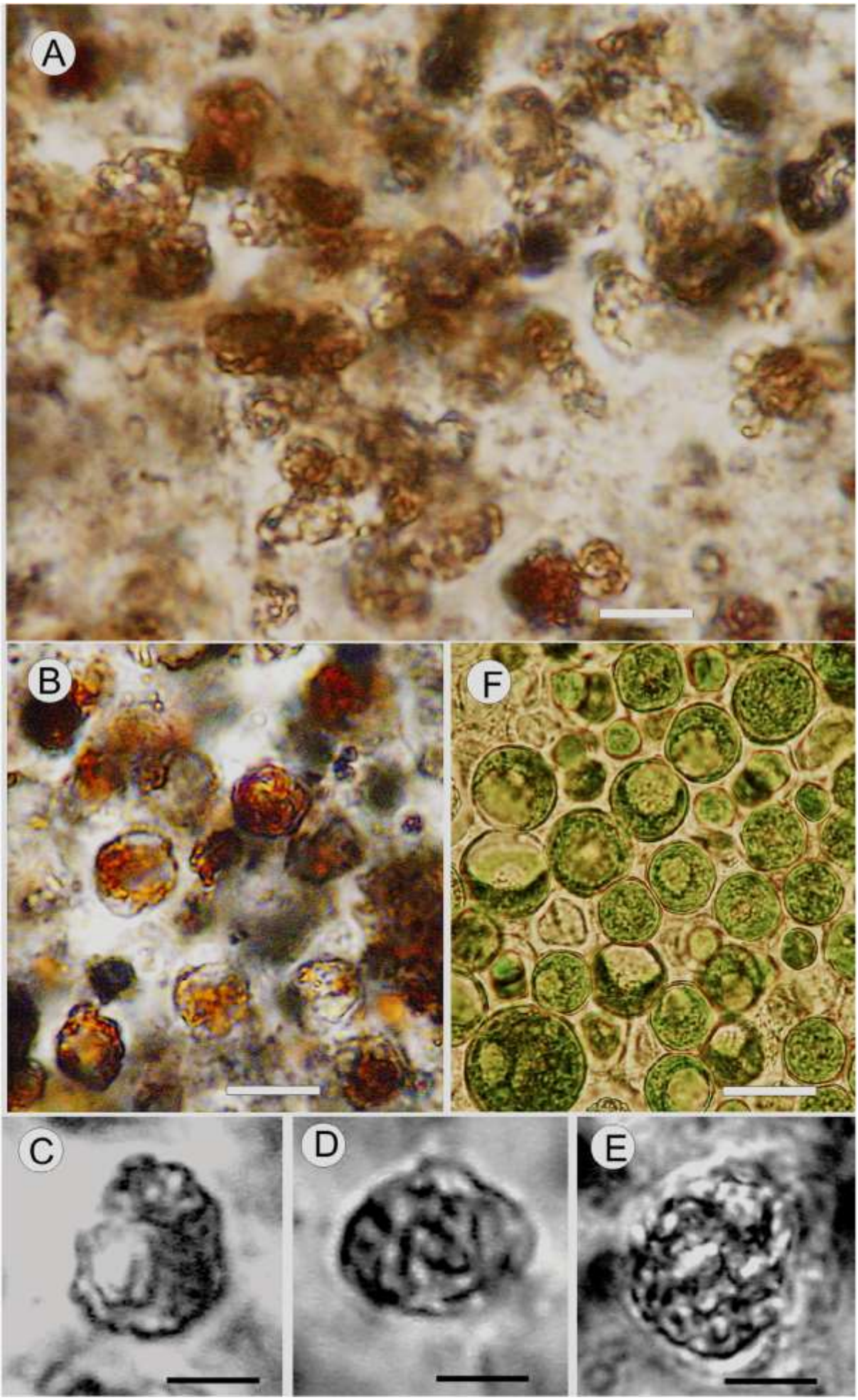
Verwoerd, W.J., du Toit, M.C., 2006. The Phalaborwa and Schiel complexes. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. pp 291-299.

Figure 5 (below): Copy of Figure 8 from Kremer and Kazmierczak (2017) to show what microbes could be found in the Murchison Greenstone Belt. Note these microbes are microscopic and could not be seen with the naked eye.

A-E Kromberg Fm black chert (sample SA-226) pleurocapsalean cyanobacteria. Coccoidal cell-like objects from the Kromberg chert, some in part divided, presumably by incomplete multiple fission. (F) For comparison cultivated cells of modern *Stanieria cf. cyanosphaera* showing pattern of cell division, in part by asymmetrical multiple fission almost identical to that of cell-like bodies from the Kromberg chert shown in (A to E). All optical micrographs. (A), (B) and (F) photographed in plain transmitted light, (C) to (E) in inverted transmitted light. Scale bars for (A) and (E) are 20 mm, for (B) to (D) 15 mm.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