Palaeontological Impact Assessment for the proposed Prospecting Rights Application for Glosam Mine, approximately 20 km north of Postmasburg, Northwest Province

Prepared by

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Palaeobotanist

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Expertise of Specialist

The Palaeontologist Consultant is: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 30 years research; 22 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Archaeological & Heritage Services Africa (Pty) Ltd, 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: 

Executive Summary

A palaeontological Impact Assessment was requested for the prospecting rights applications for Glosam Mine, approximately 20 km north of Postmasburg, Northern Cape Province. To comply with 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 application.

The proposed site lies on the dolomites of the Reivilo Formation (Campbell Rand Subgroup, Ghaap Group, Transvaal Supergroup) that is composed of giant stromatolites in some areas. Since there is a very small chance of fining fossil algal cells in the traces fossils, i.e. stromatolites, a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no palaeontological site visit is required unless the geologist, environmental office or responsible person finds fossils, sends photographs to a palaeontologist to be assessed and the palaeontologists recommends collection, with a valid SAHRA permit. It is the opinion of the palaeontolotogist that the prospecting right be granted.

Table of Contents

1. Background

As part of a Prospecting Rights Application for Glosam Mine, about 2km north of Glosam settlement, and 20km north of Postmasburg, GPS coordinates: 28˚03’54.2”S, 23˚02’43.7”E, an Environmental Impact Assessment is being completed.

To comply with 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 prospecting rights application and is presented here.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (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	Appendix B
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
b	A declaration that the person is independent in a form as may be specified by the competent authority	Page 2
c	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
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
cii	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
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 2
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 4
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 5
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 4
k	Any mitigation measures for inclusion in the EMPr	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	Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	N/A
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	N/A
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 if any comments that were received during any consultation process	N/A
q	Any other information requested by the competent authority.	N/A

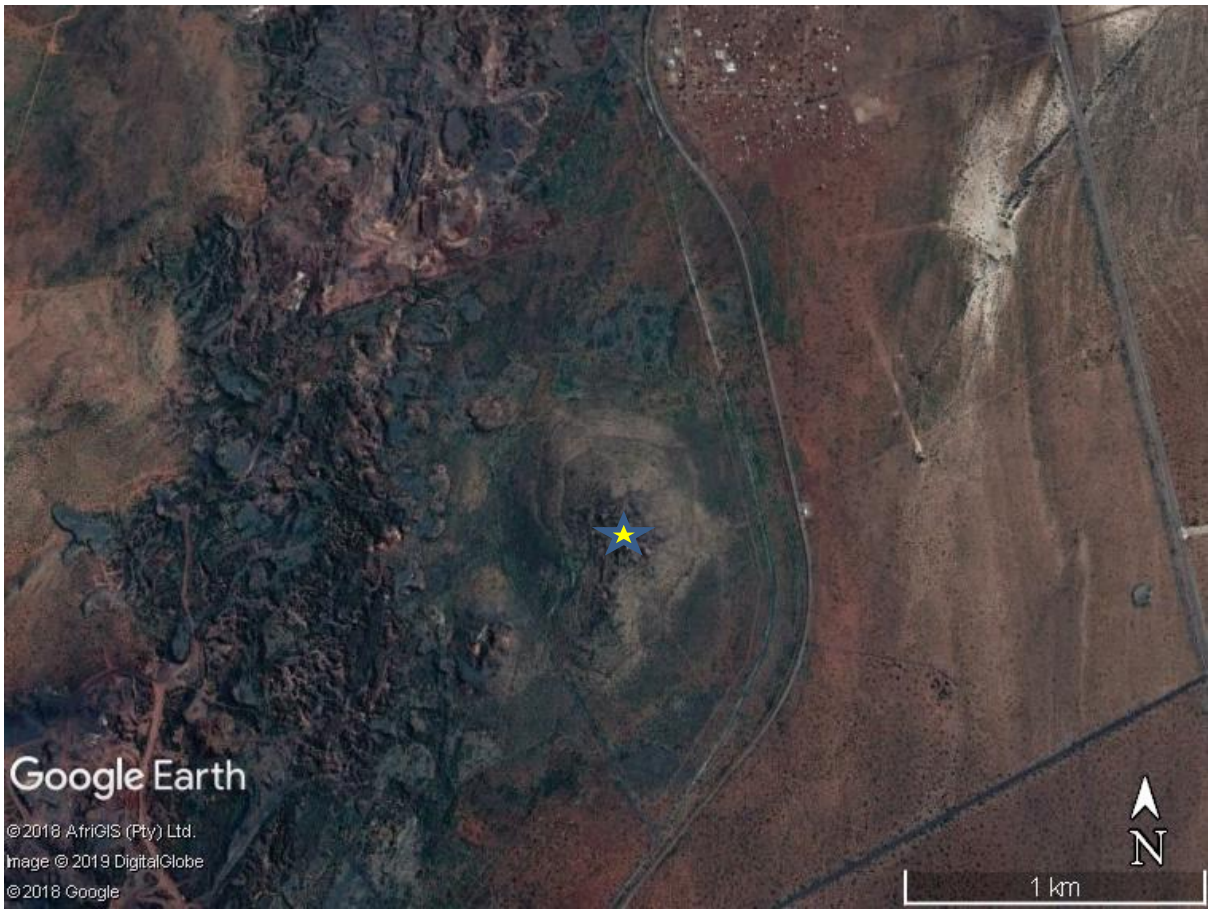

Figure 1: Google Earth map of the Glosam Mine (star) area for the prospecting rights application, about 20 km north of Postmasburg. Northern Cape Province.

2. 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 included records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases;
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' representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (*not applicable to this assessment*).

3. Geology and Palaeontology

i. Project location and geological context

The Postmasburg Manganese Field extends from Postmasburg northwards to Sishen and is formed as two belts, an East and a West belt (Astrup and Tsikos, 1998). Both belts lie on the Maremane Dome which is composed of carbonate rocks of the Campbell Rand Subgroup (Transvaal Supergroup).

Glosam Mine is in the western belt and lies on rocks of the Mapedi Formation (Olifantshoek Supergroup) along its western side and Campbell Rand Subgroup (Transvaal Supergroup) on the eastern side. The Koegas Subgroup (Postmasburg Group, Transvaal Supergroup) is to the far west (Figures 2, 3) (Astrup and Tsikos, 1998; Moen, 2006).

In Griqualand West the Transvaal Supergroup is divided into two Groups, the lower Ghaap and upper Postmasburg Groups. The Ghaap Group is divided into four subgroups, from the oldest, Schmidtsdrift, Campbell Rand, Asbestos Hills and Koegas Subgroups (Eriksson et al., 2006, p. 244). The Koegas Subgroup is overlain by the Postmasburg Group and the latter is divided into the lower Makganyene Formation and the Ongeluk Formation (ibid). There are eight formations in the Campbell Rand Subgroup, the two lower ones being the Monteville and Reivilo Formations, while in the Asbestos Subgroup there are three formations, from the base, the Kliphuis, Kuruman and Danielskuil Formations, with all three composed of iron-formation. The Campbell Rand Subgroup is more than 2500 million years old and the Asbestos Hills Subgroup is dated at about 2500 to 2432 Ma.

The overlying Koegas Subgroup (Postmasburg Group) is made up of mixed sediments, namely mixed siliciclastics, quartzites, shales, siltstones, some stromatolitic carbonates and jasperoidal iron formation (Eriksson et al., 2006).

Slightly younger rocks in the area are those of the Olifantshoek Supergroup that are about 1893 million years old (Moen, 2006). The lower part of the Olifantshoek Supergroup is divided into three formations, all of which are exposed near Postmasburg. The lower Mapedi and Gamagara Formations comprise shale with interbedded quartzite and basaltic lava. The middle Lucknow Formation comprises white quartzite and shale with subordinate dolomite and conglomerate while the upper Hartley Formation is composed of basalt and tuff with interbedded lenses of quartzite and conglomerate (Moen, 2006, p. 320). According to Moen (2006), the lower Olifantshoek Supergroup represents fluvial and clastic deposition of sediments on the western edge of the Kaapvaal Craton where subsidence occurred, in a graben, so the deposits are deep.

Quaternary Kalahari sands cover large parts of the rocks in this region, especially to the west.

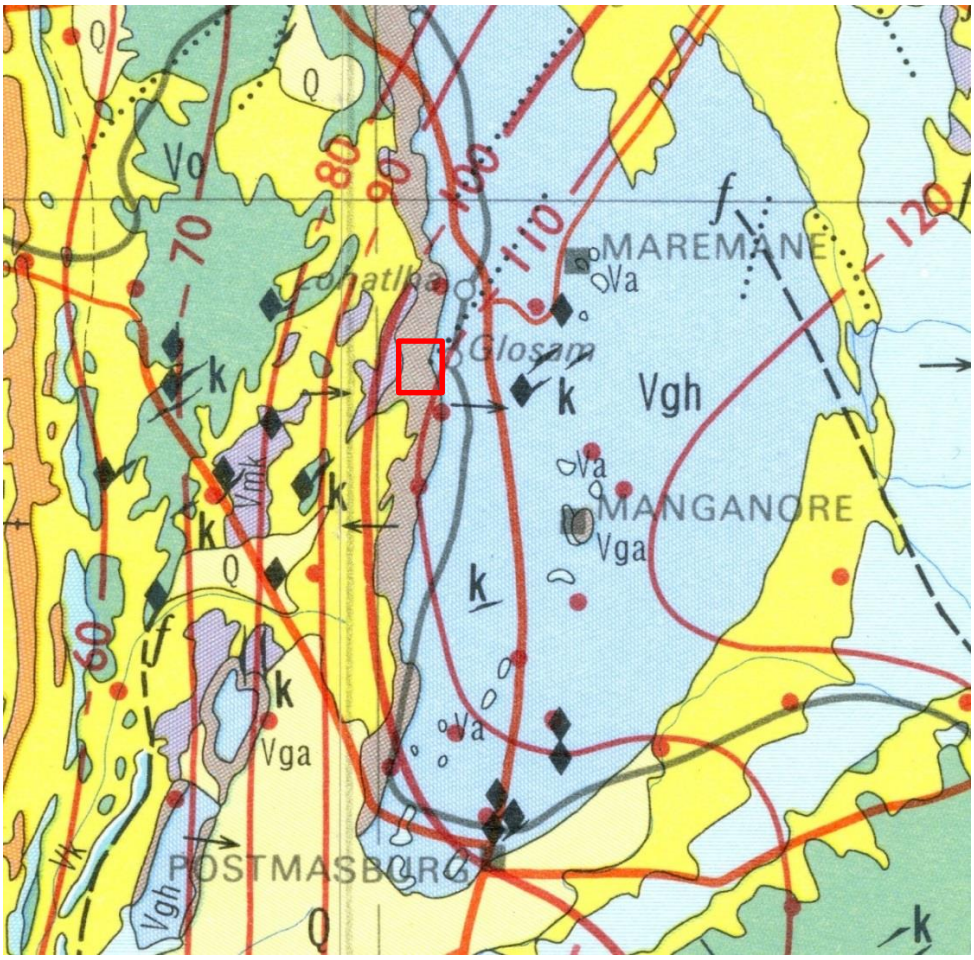

Figure 2: Geological map of the area around Glosam and Postmasburg. The location of the proposed project is indicated with the red rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 1 000 000 map 1984.

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

Symbol	Group/Formation	Lithology	Approximate Age
Q	Kalahari sands, Quaternary	Alluvial and aeolian sands	Last ca 2.5 Ma
T-Qk	Sands overlying Tertiary rocks	Alluvial and aeolian sands	Last 65 Ma
Vha	Hartley Fm, Olifantshoek SG	Andesite, tuff, conglomerate	Ca 1893 Ma
Vlu	Lucknow Fm, Olifantshoek Sequence	Quartzitic limestone	>1893 Ma
Vga	Mapedi and Gamagara Fm, Griqualand West Sequence	Shale, quartzite, conglomerate	>1893 Ma
Vo	Ongeluk Fm, Posmasburg Group, Transvaal SG	Andesite, lava	2222 Ma
Vk	Koegas Subgroup, Posmasburg Group, Transvaal SG.	Mudstone, iron formation, riebeckitite	2420 Ma
Vgh	Cambell Rand Subgroup, Ghaap Group	Dolomite, limestone, shale	>2420 Ma
Vgh	Ghaap Group, Transvaal SG	Dolomite, limestone, chert	>2420 Ma

ii. Palaeontological context

The site for prospecting is on iron and managanese rich rocks of the Cambell Rand Subgroup (Ghaap Group, Transvaal Supergroup) and the Mapedi and Gamagara Formations (Olifantshoek Supergroup). Some Kalahari Quaternary alluvial and aeolian sands are also present.

The ancient rocks of the Transvaal and Olifantshoek Supergroups generally do not contain fossils as they are too old for body fossils and not suitable for microfossils because of water depth, volcanic origin or metamorphism. Some shallow water and low energy environments preserved stromatolites in the dolomites but not the ones in this area.

Plio-Pleistocene fossils have been recovered from palaeo-pans in the region, for example Kathu Pan and Townlands (Walker et al., 2017,) but there are no pans evident in the project footprint.

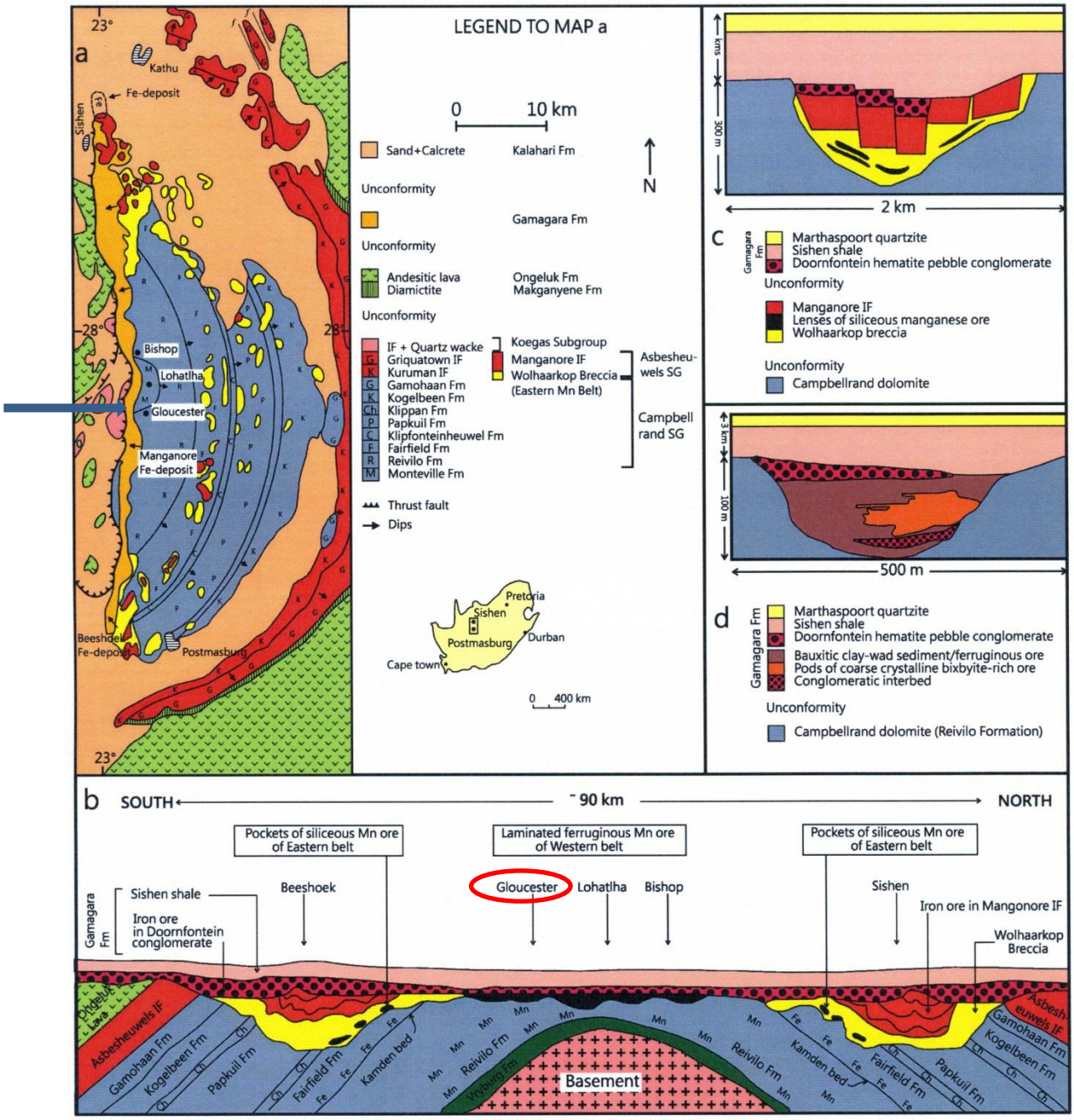

Fig. 21. (a) Geological map of the Maremane dome and (b) schematic N-S cross section. (c) Karst-hosted Postmasburg manganese deposit along the Eastern Belt (Manganore area), and (d) Western Belt (Lohatlha area). Note in (d) that Sishen-type high-grade BIF-hoste hematite iron deposits overlie the manganese deposits of the Eastern Belt below the unconformity at the base of the ~2.0 Ga Gamagara Mapedi red bed succession (Compiled from Gutzmer and Beukes, 1996b; Cairncross et al., 1997).

Figure 3: Detailed geological map and cross-section of the Maremane dome. Glosam Mine is on Farm Gloucester and is indicated on the map. (Map from Beukes et al., 2016).

From the more detailed map above the Glosam prospecting rights area is on the Reivilo Formation, (Campbell Rand Subgroup, Ghaap Group, Transvaal Supergroup) that is made up of dolomite and giant stromatolitic domes intercalated with cycles of columnar stromatolites and fenestral facies (Eriksson et al., 2006). Stromatolites are trace fossils of

ancient algal colonies and are composed of layer upon layer of minerals that were laid down by the algae in warm shallow saline waters. Very rarely the algal cells are preserved but they can only be seen in polished thin sections under the microscope.

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 3:

TABLE 3A: 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 SPATIAL SCALE of impacts	**L**	Localised - Within the site boundary.
	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

TABLE 3B: IMPACT ASSESSMENT

PART B: ASSESSMENT		
SEVERITY/NATURE	**H**	-
	M	Giant stromatolites have been recorded from the Reivilo Fm but not from this site. Kalahari sands could preserve fossils in palaeo-pans or dunes or caves in older rocks, but none is evident from the Google earth imagery. The impact would be unlikely.
	L	
	L+	-
	M+	-
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.

PART B: ASSESSMENT		
SPATIAL SCALE	L	Since only the possible fossils within the area would be trace fossil, i.e. stromatolites, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	H	-
	M	-
	L	It is extremely unlikely that any fossil algal cells would be found in the trace fossils, the stromatolites..

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 rocks are either much too old to contain fossils or are trace fossils, stromatolites. Since there is an extremely small chance that fossils may occur in the stromatolites, although not recorded, 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 extremely low.

5. 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 dolomites, sandstones, shales and sands are typical for the country and do not contain fossil plant, insect, invertebrate and vertebrate material. The stromatolites of the Reivilo Formation might preserve fossil algae.

6. 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 stromatolites of the Reivilo Formation. Since there is very small chance that fossils may a Fossil Chance Find Protocol should be added to the EMPr: if fossils are found once excavations have commenced then they should be rescued, photographs sent to a palaeontologist to assess and if deemed important then to collect a representative sample, with the relevant SAHRA permit.

7. References

Astrup, J., Tsikos, H., 1998. Manganese. In: M.G.C. Wilson and C.R. Anhaeusser (Eds). The Mineral Resources of South Africa: Handbook. Council for Geosciences 16, p. 450-460.

Beukes, N.J., 1987. Facies relations, depositional environments, and diagenesis in a major early Proterozoic stromatolitic carbonate platform to basinal sequence, Campbell Rand Subgroup, Transvaal Supergroup, southern Africa. Sedimentary Geology 54, 1-46.

Beukes, N.J., Swindell, E,W.P., Wabo, H., 2016. Manganese deposits of Africa. Episodes, 39(3), 1-33. DOI: 10.18814/epiiugs/2016/v39i2/95779.

Erikssen, P.G., Altermann, W., Hartzer, F.J., 2006. The Transvaal Supergroup and its pre-cursors. 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.

Walker, S.J.H., Lukich, V., Chazan, M., 2014. Kathu Townlands: A High Density Earlier Stone Age Locality in the Interior of South Africa. PLoS ONE 9(7): e103436. doi:10.1371/journal.pone.0103436

8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the drilling and excavations begin.

1. The following procedure is only required if fossils are seen on the surface and when excavations and/or drilling commence.
2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (stromatolites, plants, insects, bone, coal) should be put aside in a suitably protected place. This way the prospecting activities will not be interrupted.
3. Photographs of similar fossil plants must be provided to the developer to assist in recognizing the fossil plants in the shales and mudstones (for example see Figure 4). 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 the site inspections by the palaeontologist will not be necessary.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

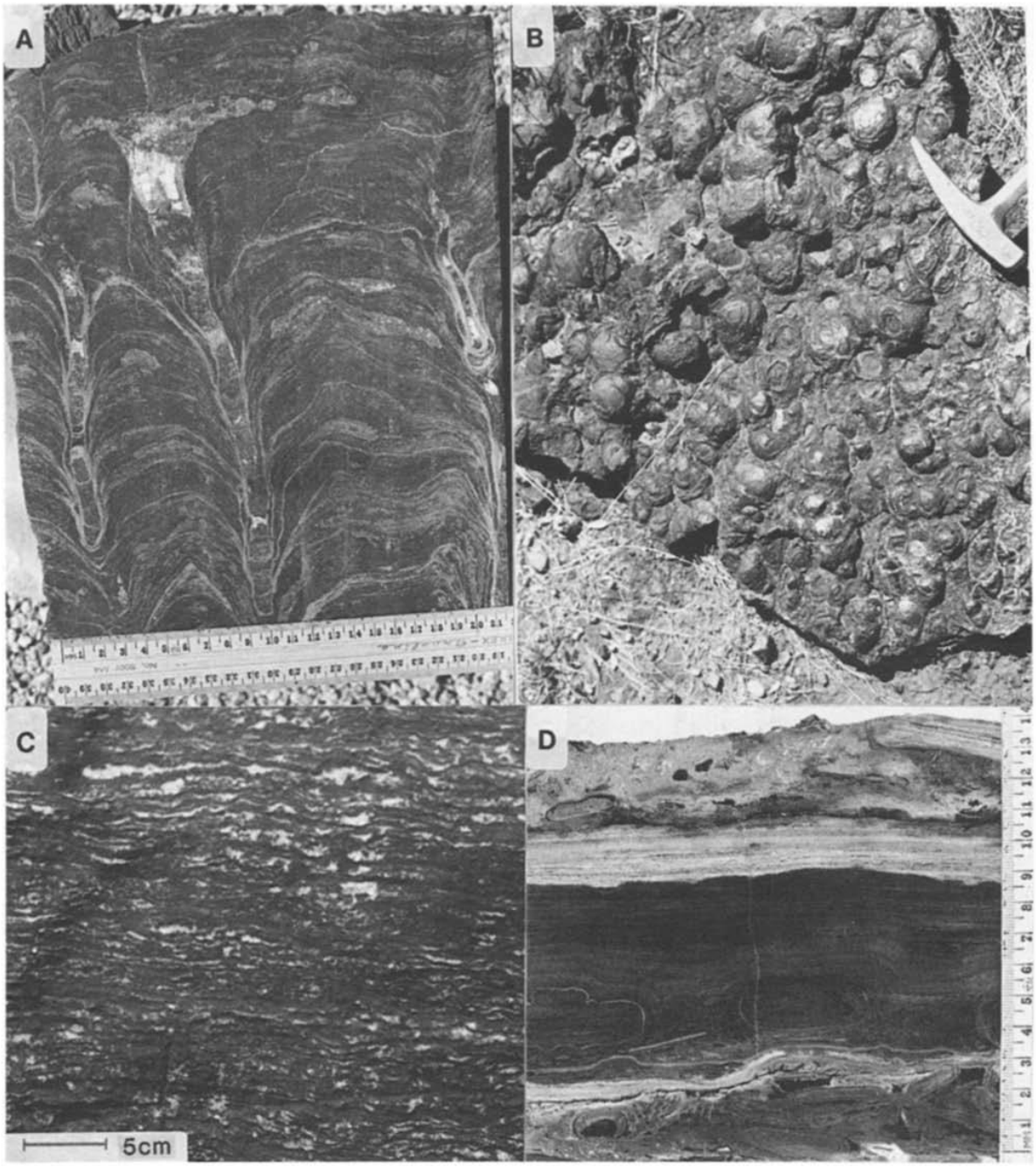

Figure 4: Examples of stromatolites (Figure 5 in Beukes, 1985).

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
June 2019

I) Personal details

Surname	:	**Bamford**
First names	:	**Marion Kathleen**
Present employment	:	Professor; Director of the Evolutionary Studies Institute. Member Management Committee of the NRF/DST Centre of Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa-
Telephone	:	+27 11 717 6690
Fax	:	+27 11 717 6694
Cell	:	082 555 6937
E-mail	:	marion.bamford@wits.ac.za ; marionbamford12@gmail.com

ii) Academic qualifications

Tertiary Education: All at the University of the Witwatersrand:
1980-1982: BSc, majors in Botany and Microbiology. Graduated April 1983.
1983: BSc Honours, Botany and Palaeobotany. Graduated April 1984.
1984-1986: MSc in Palaeobotany. Graduated with Distinction, November 1986.
1986-1989: PhD in Palaeobotany. Graduated in June 1990.

iii) Professional qualifications

Wood Anatomy Training (overseas as nothing was available in South Africa):
1994 - Service d'Anatomie des Bois, Musée Royal de l'Afrique Centrale, Tervuren, Belgium, by Roger Dechamps
1997 - Université Pierre et Marie Curie, Paris, France, by Dr Jean-Claude Koeniguer
1997 - Université Claude Bernard, Lyon, France by Prof Georges Barale, Dr Jean-Pierre Gros, and Dr Marc Philippe

iv) Membership of professional bodies/associations

Palaeontological Society of Southern Africa
Royal Society of Southern Africa - Fellow: 2006 onwards
Academy of Sciences of South Africa - Member: Oct 2014 onwards
International Association of Wood Anatomists - First enrolled: January 1991
International Organization of Palaeobotany – 1993+

Botanical Society of South Africa
South African Committee on Stratigraphy – Biostratigraphy - 1997 - 2016
SASQUA (South African Society for Quaternary Research) – 1997+
PAGES - 2008 –onwards: South African representative
ROCEEH / WAVE – 2008+
INQUA – PALCOMM – 2011+onwards

vii) Supervision of Higher Degrees

All at Wits University

Degree	Graduated/completed	Current
Honours	6	1
Masters	8	1
PhD	10	3
Postdoctoral fellows	9	3

viii) Undergraduate teaching
Geology II – Palaeobotany GEOL2008 – average 65 students per year
Biology III – Palaeobotany APES3029 – average 25 students per year
Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology; Micropalaeontology – average 2-8 students per year.

ix) Editing and reviewing
Editor: Palaeontologia africana: 2003 to 2013; 2014 – Assistant editor
Guest Editor: Quaternary International: 2005 volume
Member of Board of Review: Review of Palaeobotany and Palynology: 2010 –
Cretaceous Research: 2014 -

Review of manuscripts for ISI-listed journals: 25 local and international journals

x) Palaeontological Impact Assessments

Selected – list not complete:

- Thukela Biosphere Conservancy 1996; 2002 for DWAF
- Vioolsdrift 2007 for Xibula Exploration
- Rietfontein 2009 for Zitholele Consulting
- Bloeddrift-Baken 2010 for TransHex
- New Kleinfontein Gold Mine 2012 for Prime Resources (Pty) Ltd.
- Thabazimbi Iron Cave 2012 for Professional Grave Solutions (Pty) Ltd
- Delmas 2013 for Jones and Wagener
- Klipfontein 2013 for Jones and Wagener
- Platinum mine 2013 for Lonmin
- Syferfontein 2014 for Digby Wells
- Canyon Springs 2014 for Prime Resources
- Kimberley Eskom 2014 for Landscape Dynamics

- Yzermyne 2014 for Digby Wells
- Matimba 2015 for Royal HaskoningDV
- Commissiekraal 2015 for SLR
- Harmony PV 2015 for Savannah Environmental
- Glencore-Tweefontein 2015 for Digby Wells
- Umkomazi 2015 for JLB Consulting
- Ixia coal 2016 for Digby Wells
- Lambda Eskom for Digby Wells
- Alexander Scoping for SLR
- Perseus-Kronos-Aries Eskom 2016 for NGT
- Mala Mala 2017 for Henwood
- Modimolle 2017 for Green Vision
- Klipoortjie and Finaalspan 2017 for Delta BEC
- Ledjadja borrow pits 2018 for Digby Wells
- Lungile poultry farm 2018 for CTS
- Olienhout Dam 2018 for JP Celliers
- Isondlo and Kwasobabili 2018 for GCS
- Kanakies Gypsum 2018 for Cabanga
- Nababeep Copper mine 2018
- Glencore-Mbali pipeline 2018 for Digby Wells
-

xi) Research Output

Publications by M K Bamford up to June 2019 peer-reviewed journals or scholarly books: over 130 articles published; 5 submitted/in press; 8 book chapters.
Scopus h index = 26; Google scholar h index = 30;
Conferences: numerous presentations at local and international conferences.

xii) NRF Rating

NRF Rating: B-2 (2016-2020)
NRF Rating: B-3 (2010-2015)
NRF Rating: B-3 (2005-2009)
NRF Rating: C-2 (1999-2004)