Palaeontological Impact Assessment for the proposed Lady Grey and Sterkfontein projects for Nyati Wilderness, Waterberg, Limpopo Province

Desktop Study (Phase 1)

For

Envirolution

24 January 2023; Rev 09 March 2023

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Expertise of Specialist

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, mASSAf
Experience: 33 years research and lecturing in Palaeontology
25 years PIA studies and over 300 projects completed

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Envirolution, 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 proposed Lady Grey 646LR and Sterkfontein 644LR projects to be incorporated to Nyati Wilderness, Waterberg, Limpopo Province. These include the construction of new roads, paths, Upgrading 3 existing dams on Farm Lady Grey and Sterkfontein

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 project area mainly lies on the coarse-grained sandstones of the Mogalakwena Formation (Kransberg Subgroup, Waterberg Group. Based on the age of the sediments and their coarseness, it is very unlikely that there were any trace fossils present. Furthermore, they are very difficult to recognise, and the attribution of such structures to biotic action has been questioned. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. Since it is very unlikely that the development will impact the fossil heritage, it is recommended that the project be authorised, as far as the palaeontology is concerned.

Table of Contents

1. Background

Nyati Wilderness is situated in the Limpopo Province. To increase the tourism opportunities and capacity to Nyati Wilderness, Nyati Wilderness was recently increased to include the Riverdans Properties to the east and south-east as well as the Farm Lady Grey 646 and Sterkfontein 644 (Figures 1, 2). This report for the proposed new projects on Farm Lady Grey and Sterkfontein.

The complete scope of works for the developments on Farms Lady Grey and Sterkfontein is as follows:

- There are 3 existing dams that will be upgraded/enlarged (Earth Dam 1,2 &3)
- The construction of approximately 18.9 Km of new roads labelled L1, L2, L3, L4, L5, L6, L7, L8, L9, L10, L11, L12 and L13

A Palaeontological Impact Assessment was requested for the Lady Grey and Sterkfontein projects for Nyati Wilderness. 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 completed new 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).

	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 1
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

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
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	Section 8, 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 8, Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 6
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 6, 8

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	Relevant section in report
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

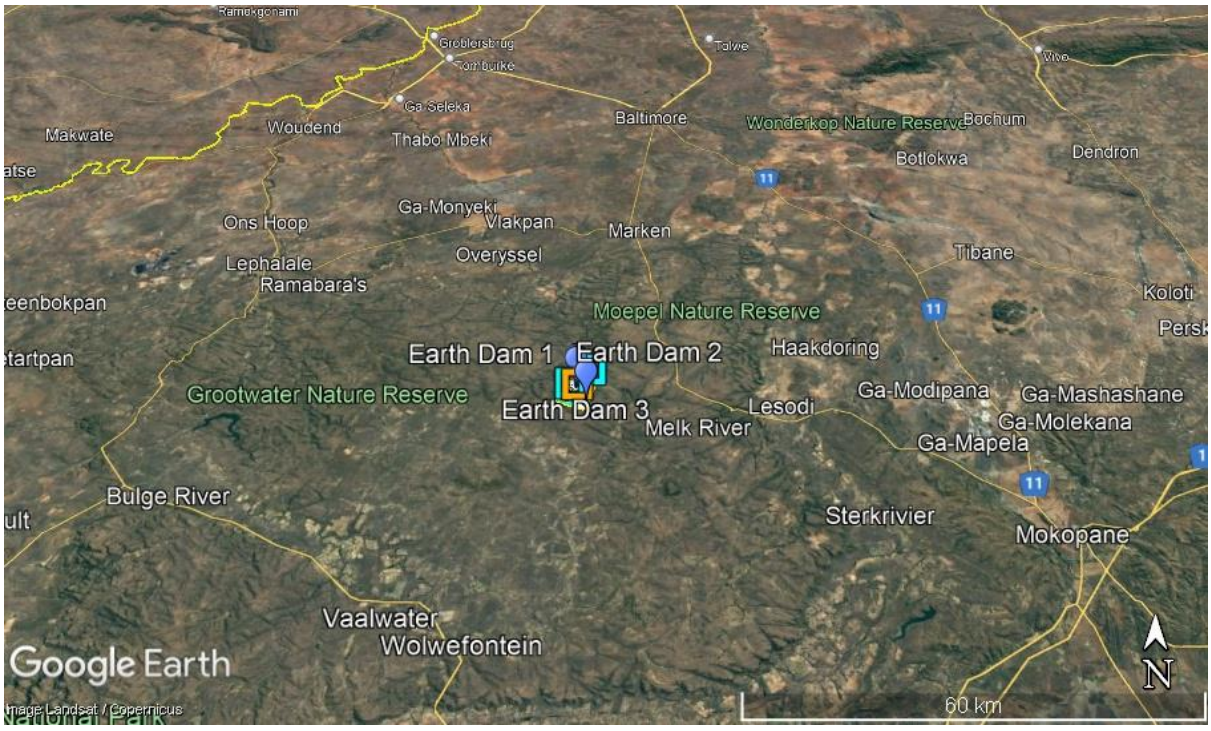


Figure 1: Google Earth map of the general area to show the Lady Grey projects, dams and roads on the farms (white lines and labels).

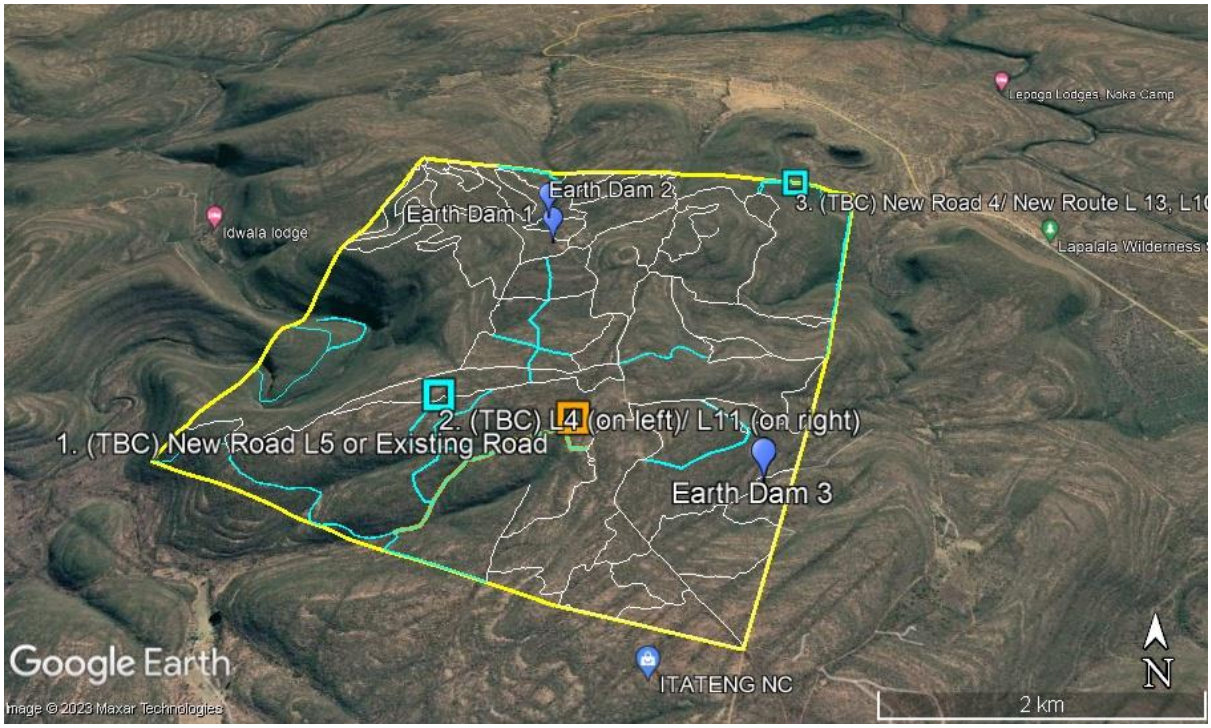


Figure 2: Google Earth Map of the new areas and developments for Nyati Wilderness in the Waterberg on Farms Lady Grey and Sterkfontein. Dams as labelled, blue and green lines are roads, white lines are paths. Yellow line is the farm boundary.

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 project lies in the Waterberg Basin in Limpopo Province (Figure 3).

The Palaeoproterozoic rocks of southern Africa occur in Limpopo, Mpumalanga and Gauteng Provinces and extend westwards into Botswana, and occur in three basins. Three main strata are recognised, the Soutspansberg Group, the Waterberg Group and the Blouberg Formation. A number of attempts have been made to correlate the strata in the different basins, the Waterberg Basin, the Soutpansberg Basin and the Middelburg Basin.

The Waterberg Group occurs in the Waterberg and Nylstroom Basins (Barker et al., 2006) and rests unconformably on rocks of the Transvaal Supergroup and the Bushveld Complex. It is overlain by Karoo Supergroup rocks. Three subgroups are recognised throughout the main Waterberg Basin but only the oldest subgroup occurs in the Nylstroom Basin. Different formations are noted in the south, southwest and central areas compared to the North, northeast and central areas according to SACS (1980).

The Waterberg Group was deposited between 2000 and 1700 million years ago, well after the Great Oxidation Event (GOE, ca 2.5 Ga) so oxygen was available and these shallow water deposits are known as red beds. It has been divided into three subgroups with the basal group, the Nylstroom Subgroup not occurring in the study area (Figure 3). The Nylstroom and Matlabas Subgroups form a crude upward-fining sequence with rudites and arenites at the base and grading to lutites and well-sorted arenites at the top. The overlying Kransberg Subgroup forms a second, similar, upward-fining sequence in the Waterberg Basin (Barker et al., 2006).

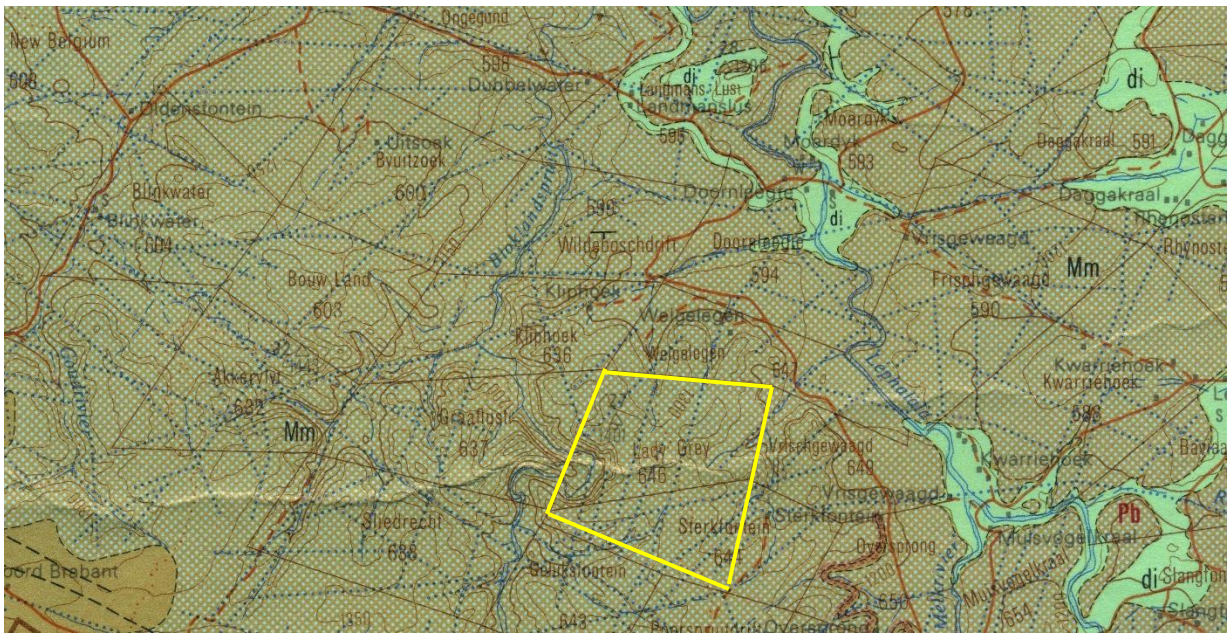


Figure 3: Geological map of the area around the Farms Lady Grey 646 and Sterkfontein 644 for the Nyati Wilderness project indicated within the yellow rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2328 Ellisrus.

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

Symbol	Group/Formation	Lithology	Approximate Age
Mc	Cleremont Fm, Kransberg Subgroup, Waterberg Group	Coarse-grained white sandstone	Palaeoproterozoic ca 1 880 Ma
Mm	Mokalakwena Fm, Kransberg Subgroup, Waterberg Group	Coarse-grained purplish and brown sandstone	Palaeoproterozoic
Mma / Mmc	Makgabeng Fm, Matlabas Subgroup, Waterberg Group	Medium-grained yellowish, laminated sandstone	Palaeoproterozoic ca 2 000 Ma
di	diabase	diabase	

In this northern-central part of the basin there is only the Makgabeng Formation of the Matlabas Subgroup and the three formations of the Kransberg Subgroup, namely the Mogalakwena, Cleremont and Vaalwater Formations. The Farm Lady Grey lies entirely on the Mogalakwena Formation.

The **Mogalakwena Formation** is composed of granule-rich lithic arenites and granule rudites with pebble washes and interbedded pebble to cobble rudites (Bumby, 2000; Barker et al., 2006). Palaeocurrents are towards the west-southwest from large braided rivers from highlands in the north-northeast (ibid).

In a recent publication on the Waterberg Group, Corcoran et al (2013) described the Makgabeng Formation (Matlabas Subgroup) as representing mainly aeolian sedimentation with the strongest evidence for arid conditions in the horizontally bedded and rippled mudstone and sandstone lithofacies. Heavy precipitation occurred with subsequent drying up based on desiccation cracks, evaporite casts and roll-up structures. Increasingly wetter conditions over time are evidenced by the massive sandstone lithofacies that become more predominant toward the top of the Makgabeng stratigraphy. Such playa lakes in the palaeo-desert preserved microbial mat features (Simpson et al., 2013). In contrast, the overlying Mogalakwena Formation, is primarily composed of conglomerate and interbedded trough cross-bedded sandstone. The lower deposits represent coarse-grained sandstone sheets and local conglomerate-filled channels, indicating migration of braided fluvial channels (Corcoran et al., 2013). The upper part of the Mogalakwena Formation, which is well preserved in the northern part of the basin. It is composed

of distinct cycles of fining-upward coarse to fine-grained sediments that are considered to have formed in a braided stream environment in which conglomerate and lower sandstone are considered in-channel deposits, and the upper sandstone and siltstone represent bar-top deposits of river channels. This more dynamic and higher energy setting is not conducive to the formation of microbial mat features (Noffke, 2009).

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 4. Farm Lady Grey is on the sandstones of the Mogalakwena Formation and the whole area is indicated as moderately sensitive (green). It should be noted, however that in the SAHRIS maps the Waterberg Group is green – moderately sensitive even though the PTR Limpopo shows it be blue – insignificant.

There were only microbial life forms during the Palaeoproterozoic and no larger life forms that could be fossilised (Cowan, 1995). Microbes themselves are seldom preserved but their traces can be found in fine-grained, low energy environment, not coarse sandstones. Such traces are called Microbially Induced Sedimentary Structures (MISS) and are evidence of bacterial slimes that cement the sand grains in particular patterns, such as mud cracks, furrows and swirls (Noffke, 2009). Since the Mokalakwena and Makgabeng Formations are coarse-grained it is very unlikely that they would preserve any trace fossils. Simpson et al. (2013) reported MISS from the Makgabeng Formation in the north western part of the basin. They comprised mat fragments and roll-up features in the at the transition from inter-dune deposits to overlying dune toe, but in practice these features would be very difficult to recognise. Davies et al. (2016) have questioned the interpretation of many reported MISS features; they claim that many of them are abiotic geological features and have nothing to do with microbial activity.

Figure 3: SAHRIS palaeosensitivity map for the site for the Farms Lady Grey 646 and Sterkfontein 644 shown within the yellow polygon. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

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	-
	L	Coarse-grained sands do not preserve fossils; so far there are no records from the Waterberg Group of plant or animal fossils in this region so it is very unlikely that fossils occur on the site. The impact would be negligible
	L+	-
	M+	-
	H+	-
DURATION	**L**	-
	M	-

PART B: Assessment		
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	**L**	Since the only possible fossils within the area would be trace fossils (MISS) in the sandstones, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	**-**
	L	It is extremely unlikely that any fossils would be found in the loose soils and sands that cover the area or in the sandstones because of their age and grain-size.

Based on the nature of the sediments in the footprint it is extremely unlikely that there were any fossils or trace fossils present so there would have been no impact on the fossil heritage. Taking account of the defined criteria, the impact on fossil heritage resources is zero to 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 sandstones, shales and sands are typical for the country and do not contain trace fossils, fossil plant, insect, invertebrate and vertebrate material.

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the Waterberg Group, it is extremely unlikely that any fossils or trace fossils would be preserved in the sandstones or surface soils. Nonetheless, a Fossil Chance Find Protocol (Section 8) should be added to the EMPr. If trace fossils are found by the contractor, environmental officer or other responsible person once excavations for roads, paths, dams and other infrastructure have commenced, then they should be photographed, put aside and SAHRA notified. Since is it extremely unlikely that there will be any impact on the fossil heritage, it is recommended that, as far as the palaeontology is concerned, all aspects of the project be authorised.

7. References

Barker, O B., Brandl, G., Callaghan, C.C., Erikssen, P.G., van der Neut, M., 2006. The Soutpansberg and Waterberg Groups and the Blouberg Formation. 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 301-318.

Corcoran, P.L., Bumby, A.J. and Davis, D.W., 2013. The Paleoproterozoic Waterberg Group, South Africa: provenance and its relation to the timing of the Limpopo orogeny. Precambrian Research, 230, 45-60.

Cowan, R., 1995. History of Life. 2nd Edition. Blackwell Scientific Publications, Boston. 462pp.

Davies, N.S., Liu, G.L., Gibling, M.R., Miller, R.F., 2016.Resolving MISS conceptions and misconceptions: A geological approach to sedimentary surface textures generated by microbial and abiotic processes. Earth-Science Reviews 154, 210–246.

Noffke, N., 2009. The criteria for the biogenicity of microbially induced sedimentary structures (MISS) in Archean and younger, sandy deposits. Earth Science Reviews 96, 173–180.

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.

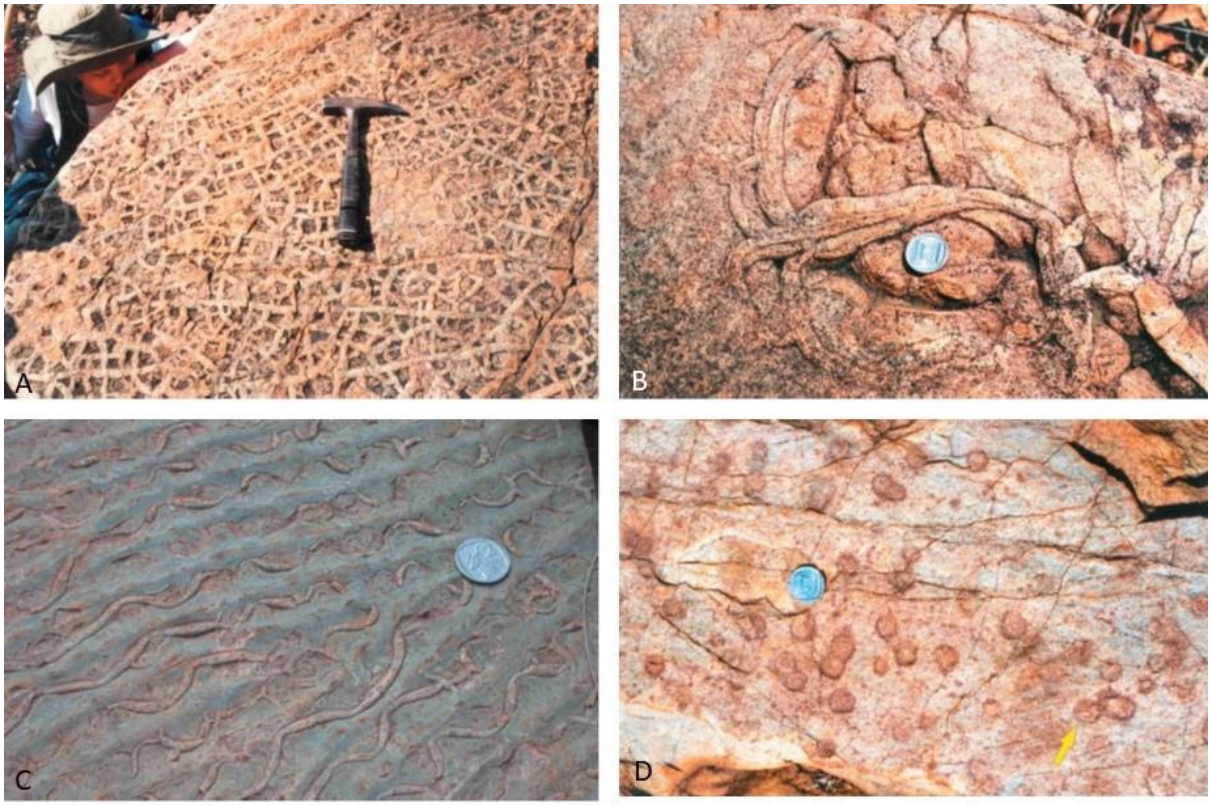
Simpson, E.L., Heness, E., Bumby, A., Eriksson, P.G., Eriksson, K.A, Hilbert-Wolf, H.L., Linnevelt, S., Malenda, H.F., Modungwa, T., Okaforba, O.J., 2013. Evidence for 2.0 Ga continental microbial mats in a paleodesert setting. Precambrian Research 327, 36-50.

8. Chance Find Protocol

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

1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations 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 (trace fossils, plants, insects) 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 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 there is any possible fossil material found by the developer/environmental officer 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 trace fossils 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.

9. Appendix A – examples of fossils from the Waterberg Group



Magaliesberg Fm trace fossils, near Pretoria (all from Bosch & Eriksson, 2008): A – cracks,. B – sinuous structure, C – *Manchuriphycus*, D – circular structures. R1 coin for scale.

Figure 5: Photographs of trace fossils in sandstones that could be found in the Waterberg Group arenites and sandstones.

10. Appendix A – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD

December 2022

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
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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.

NRF Rating: C-2 (1999-2004); B-3 (2005-2015); B-2 (2016-2020); B-1 (2021-2026)

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	13	0
Masters	13	2
PhD	13	5
Postdoctoral fellows	15	2

viii) Undergraduate teaching

Geology II – Palaeobotany GEOL2008 – average 65 students per year

Biology III – Palaeobotany APES3029 – average 45 students per year

Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology; Micropalaeontology – average 12-20 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 –

Associate Editor Open Science UK: 2021 -

Review of manuscripts for ISI-listed journals: 30 local and international journals

Reviewing of funding applications for NRF, PAST, NWO, SIDA, National Geographic, Leakey Foundation

x) Palaeontological Impact Assessments

Selected from the past five years only – list not complete:

- 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
- Remhoogte PR 2019 for A&HAS
- Bospoort Agriculture 2019 for Kudzala
- Overlooked Quarry 2019 for Cabanga
- Richards Bay Powerline 2019 for NGT
- Eilandia dam 2019 for ACO
- Eastlands Residential 2019 for HCAC
- Fairview MR 2019 for Cabanga
- Graspan project 2019 for HCAC
- Lieliefontein N&D 2019 for EnviroPro
- Skeerpoort Farm Mast 2020 for HCAC
- Vulindlela Eco village 2020 for 1World
- KwaZamakhule Township 2020 for Kudzala
- Sunset Copper 2020 for Digby Wells
- McCarthy-Salene 2020 for Prescali
- VLNR Lodge 2020 for HCAC
- Madadeni mixed use 2020 for EnviroPro
- Frankfort-Windfield Eskom Powerline 2020 for 1World
- Beaufort West PV Facility 2021 for ACO Associates
- Copper Sunset MR 2021 for Digby Wells
- Sannaspos PV facility 2021 for CTS Heritage
- Smithfield-Rouxville-Zastron PL 2021 for TheroServe

xi) Research Output

Publications by M K Bamford up to December 2022 peer-reviewed journals or scholarly books: over 170 articles published; 5 submitted/in press; 10 book chapters.

Scopus h-index = 30; Google scholar h-index = 39; -i10-index = 116.

Conferences: numerous presentations at local and international conferences.