

**Palaeontological Impact Assessment for the proposed
Siyanqoba 132kV Overhaed Electrical Line,
Mpumalanga Province**

Desktop (Phase 1) Report

For

ASHA Consulting

08 May 2021

Prof Marion Bamford

Palaeobotanist

P Bag 652, WITS 2050

Johannesburg, South Africa

Marion.bamford@wits.ac.za

Expertise of Specialist

The Palaeontologist Consultant is: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 32 years research; 24 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by ASHA Consulting, Muizenberg, 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:

A handwritten signature in blue ink, appearing to read 'MKBamford', with a horizontal line underneath it.

Executive Summary

A Palaeontological Impact Assessment was requested for the proposed Siyanqoba 132kV Overhead Electrical Line for Siyanqoba between Hlalanikahle and Kosmos.

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) incorporating site observations by the archaeologist was completed for the proposed project.

The proposed route lies on potentially fossiliferous rocks of the Vryheid Formation (Ecca Group, Karoo Supergroup). Impressions of plants of the *Glossopteris* flora can occur in these strata but the distribution is sporadic and difficult to predict. No fossils were seen by the archaeologist and they would likely not be visible unless they were revealed in new excavations. The vast majority of the surface was sand-covered. Therefore, a Fossil Chance Find Protocol should be added to the EMPr. Based on this information, it is recommended that no specialist palaeontological site visit is required unless fossils are discovered once excavations have commenced.

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1. Background

A Palaeontological Impact Assessment was requested for proposed Siyanqoba 132kV Overhead Electrical Line for Siyanqoba between Hlalanikahle and Kosmos. The route is in a disturbed, semi-rural area (Figure 1).

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) incorporating site observations by the archaeologist was completed for the proposed project.

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
a ii	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
c ii	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 proposed route for the Siyanqoba 132kV Overhead Electrical Line with the sections shown by the green line outline. Map reference: 1.VE2001-1-RP REVC 2020-04-15.

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 (as reported herein, and collect or rescue fossils if required);
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*as indicated in section 4 below*); and
4. Determination of fossils' representivity or scientific importance to decide if the fossils can be destroyed or a just a representative sample collected and housed in a recognised repository.

3. Geology and Palaeontology

i. Project location and geological context

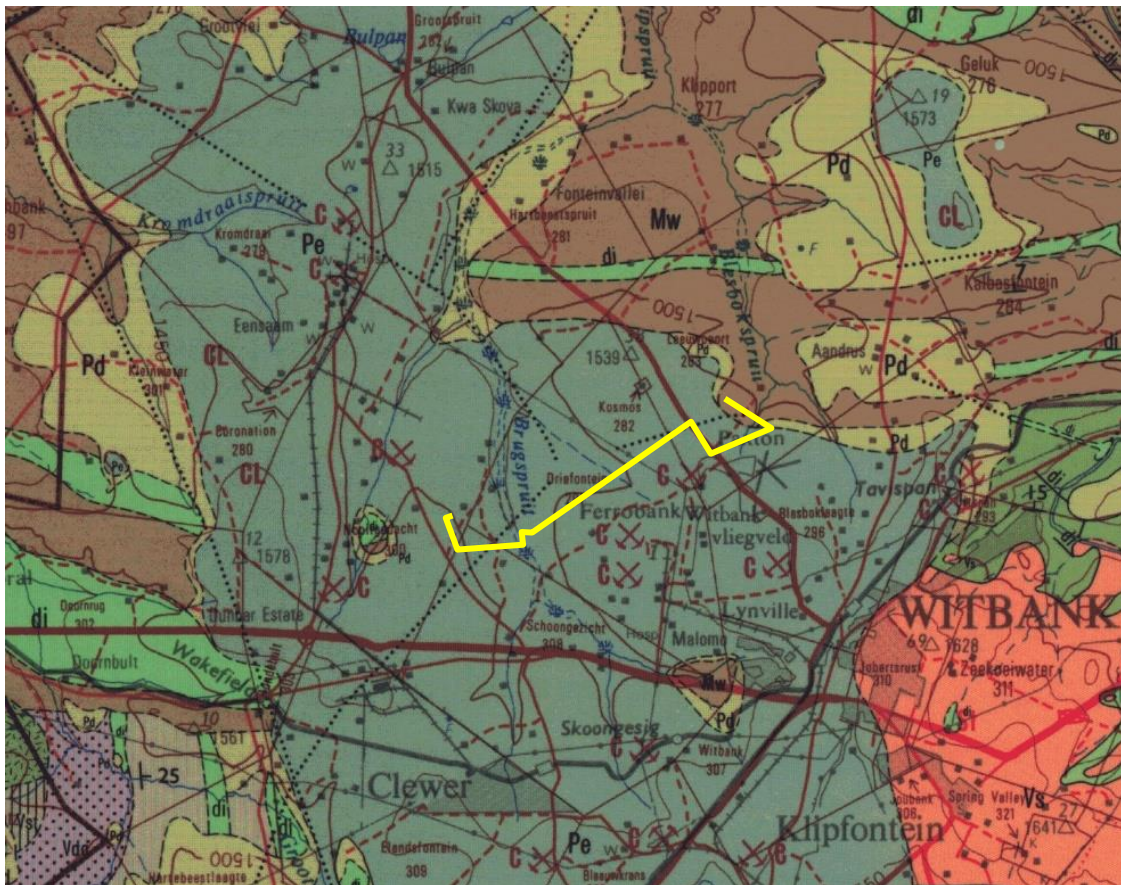


Figure 2: Geological map of the area around Witbank with the electrical line route shown (yellow line). Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2528 Pretoria.

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

Symbol	Group/Formation	Lithology	Approximate Age
Pe	Ecca Group, Karoo SG (probably Vryheid Fm)	Shales, mudstones, sandstones, coal	Early Permian, lower Ecca
Pd	Dwyka Group, Karoo SG	Diamictites, tillites, mudstones, sandstones	Late Carboniferous to Early Permian
Mw	Wilge River Fm, Waterberg Group	Sandstone, quartzitic in places	Archaean 2000 – 1700 Ma
Di	diabase	diabase	
Vg	Gabbro-norite, Rustenburg Layered Suite, Bushveld Complex	Gabbro-norite	>2000 Ma

The site lies on the edge of the Middelburg Basin that has rocks of the Waterberg Group, and on the margin of the Transvaal Basin that has rocks of the Transvaal Supergroup with the intrusive Rustenburg Layered Suite, and overlain by the basal strata of the Karoo Supergroup (Figure 2). Diabase intrudes through the older rocks.

The Middelburg Basin extends from east of Pretoria eastwards for about 139km to the town of Middelburg and the Wilge River Formation is the only stratigraphic unit in the basin (Barker et al., 2006). This formation most probably represents an erosional remnant of a much larger basin, possibly linked with the main basin of the Waterberg Group (ibid).

The Karoo Supergroup rocks cover a very large proportion of South Africa and are bounded along the southern margin by the Cape Fold Belt and along the northern margin by the much older Transvaal Supergroup rocks. Representing some 120 million years (300 – 183Ma), the Karoo Supergroup rocks have preserved a diversity of fossil plants, insects, vertebrates and invertebrates.

During the Carboniferous period South Africa was part of the huge continental landmass known as Gondwanaland and was positioned over the South Pole. As a result, there were several ice sheets that formed and melted, and covered most of South Africa (Visser, 1986, 1989; Isbell et al., 2012). Gradual melting of the ice occurred as the continental mass moved northwards and the earth warmed, formed sediments in the large inland sea. These are the oldest rocks in the system and are exposed around the outer part of the ancient Karoo Basin and are known as the Dwyka Group. They comprise tillites, diamictites, mudstones, siltstones and sandstones that were deposited as the basin filled.

Overlying the Dwyka Group rocks are rocks of the Ecca Group that are Early Permian in age. There are eleven formations recognised in this group but they do not all extend throughout the Karoo Basin. In the Free State, Mpumalanga and KwaZulu Natal, from the base upwards are the Pietermaritzburg Formation, Vryheid Formation and the Volksrust Formation. All of these sediments have varying proportions of sandstones, mudstones, shales and siltstones and represent shallow to deep water settings, deltas, rivers, streams and overbank depositional environments.

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 3. The power line route is on the Ecca Group, most likely the Vryheid Formation because there are collieries in the region that are exploiting the coal seams of the Vryheid Formation. Coals are formed from the buried peats that are altered by heat and pressure to form coals. Plants that formed the peats are those of the *Glossopteris* flora (*Glossopteris* leaves, seeds, reproductive structures; cordaitales, lycopods, sphenophytes, ferns and early gymnosperms. None of these plants is visible in the coals but they may be preserved as impressions in the shale lenses associated with the coal seams.

Vertebrates are not found in the Ecca Group because different conditions are required for the preservation of plants compared to those for bones. The plants are preserved in swampy anoxic and acidic (reducing) environments. The Karoo vertebrates are younger and were commonly preserved in overbank and flood-plain environments that were more oxidised.

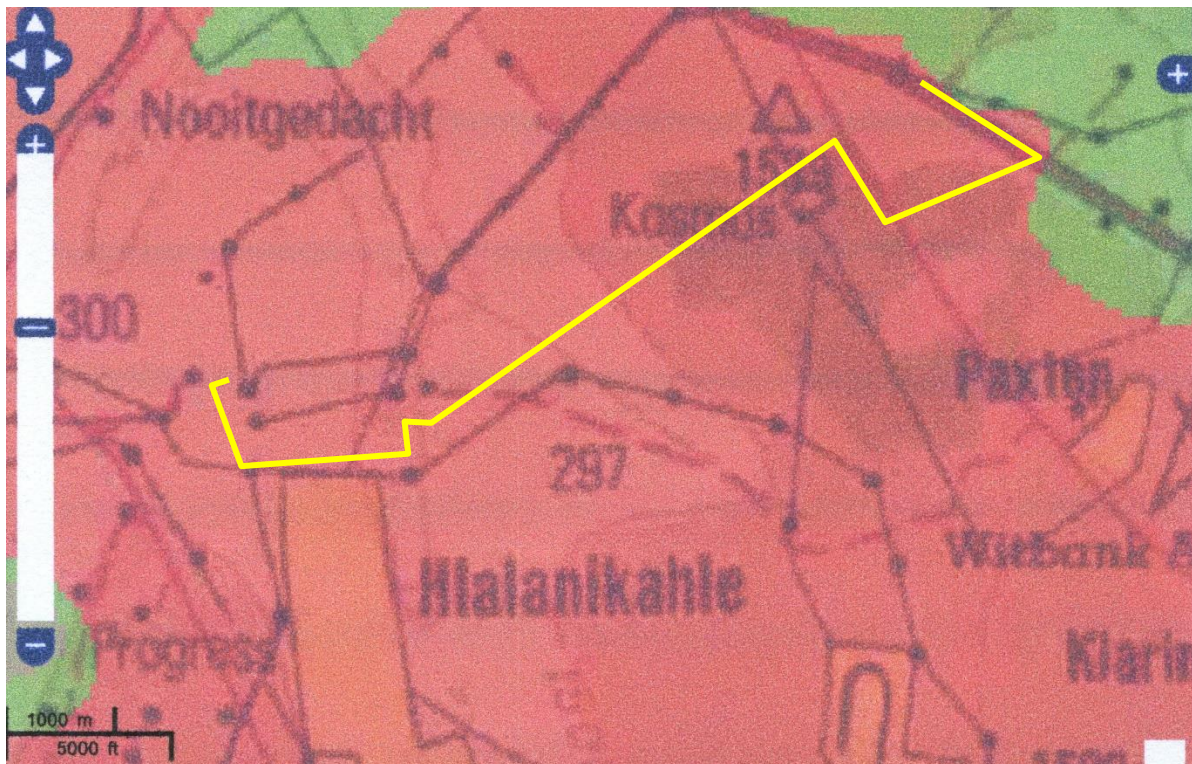


Figure 3: SAHRIS palaeosensitivity map for the route for the proposed Siyanqoba powerline (yellow line). Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

From the SAHRIS map above the area is indicated as very highly sensitive (red) so a site visit was undertaken by a professional archaeologist for the heritage survey (Dr Jaco van der Walt), and his observations are recorded below. No fossils were found.

iii. Site visit observations

Table 3: Observations and photographs from the professional archaeologist

Stop for photos	Observations	Figure
Stop 1 (NE route)	Flat topography, well vegetated and no rocky outcrops present	5
Stop 2	Margin of trees and grassland	6
Stop 3	Sandstone outcrop that has been disturbed; flat outcrop of sandstone; flat outcrop of sandstone that has been eroded by water and tree roots	7, 8, 9
Stop 4	Flat outcrop of sandstone; ferricrete (Ferricrete is a hard, erosion-resistant layer of sedimentary rock, usually conglomerate or breccia, that has been cemented into a duricrust by iron oxides. The iron oxide cements are derived from the oxidation of percolating solutions of iron salts. Occur in wetter environment	10, 11
Stop 5	Trench revealing a deep sandy overlying stratum	12
Stop 6 (SW route)	Another trench, also revealing sand	13
Not marked	Shallow diggings for coal that is near the surface – no associated shale lens with fossil plant impressions	14
Summary	No fossils and potentially fossiliferous outcrops were seen	



Figure 4: Route taken by Dr van der Walt and each camera symbol denotes the photo-stops as referred in Table 3, and listed photos reproduced below. All photographs are accredited to Dr van der Walt.



Figure 5: Photostop 1 showing the trees and soil cover.



Figure 6: Stop 2 on the margin of the trees of a derelict *Eucalyptus* plantation and grassland



Figure 7: Stop 3 – unusual lump of sandstone



Figure 8: Stop 3 – flat outcrop of sandstone exposed between the grass cover indicating shallow soils



Figure 9: Stop 3.



Figure 10: Stop 4 with flat rocks.



Figure 11: Stop 4 showing ferricrete (gravelly appearance).



Figure 12: Stop 5 showing the deep sandy layer in the trench.



Figure 13: Stop 6 showing another trench and deep sand.



Figure 14: Shallow diggings made by the local inhabitants for poor quality coal that is near the surface.

4. Impact assessment

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

TABLE 4A: 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 4B: IMPACT ASSESSMENT

PART B: ASSESSMENT		
SEVERITY/NATURE	H	-
	M	-
	L	Soils, sands and ferricretes do not preserve plant fossils; so far there are no records from the Vryheid Fm of plant or animal fossils in this region so it is very unlikely that fossils occur on the site. The impact would be very unlikely.
	L+	-
	M+	-
	H+	-
	DURATION	L
M		-
H		Where manifest, the impact will be permanent.
SPATIAL SCALE	L	Since the only possible fossils within the area would be fossil plants from the <i>Glossopteris</i> flora in the shales, 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 sand that covers most of the area, or in the flat sandstones. Nonetheless, a Fossil Chance Find Protocol should be added to the eventual EMP.

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 Permian, Ecca Group, but not refined to any formation (lack of fossils most likely). The other rocks are much too old to contain body fossils, or of the right kind. Furthermore, the material to be excavated for foundations is soil and loose sand and this does not preserve fossils. Since there is a small chance that fossils occur below ground in the Ecca Group (most likely the Vryheid Formation) and 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.

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 may contain fossil plants, insects and coal. Vertebrates do not occur in the Ecca Group. The Recent covering sands and soils would not preserve fossils.

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 loose soils and sands of the Quaternary. There is a small chance that fossils may occur below the ground surface in the shales of the early Permian Vryheid Formation. Therefore, a Fossil Chance Find Protocol should be added to the EMPr: if fossils are found once excavations for pylon foundations have commenced then they should be rescued and a professional palaeontologist called to assess and collect a representative sample.

7. References

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

Barker, O B., Brandl, G., Callaghan, C.C., Erikssen, P.G., van der Neut, M., 2006. The Soutspanberg 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.

Eriksson, P.G., Altermann, W., Hartzler, 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.

Isbell, J.L., Henry, L.C., Gulbranson, E.L., Limarino, C.O., Fraiser, F.L., Koch, Z.J., Ciccio, P.I., Dineen, A.A., 2012. Glacial paradoxes during the late Paleozoic ice age: Evaluating the equilibrium line altitude as a control on glaciation. *Gondwana Research* 22, 1-19.

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.

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.

Visser, J.N.J., 1989. The Permo-Carboniferous Dwyka Formation of southern Africa: deposition by a predominantly subpolar marine icesheet. *Palaeogeography, Palaeoclimatology, Palaeoecology* 70, 377-391.

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 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 (plants, insects, bone, coal) should be put aside in a suitably protected place. This way the mining 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 15). 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.

Appendix A – Examples of fossil plants from the Vryheid Formation

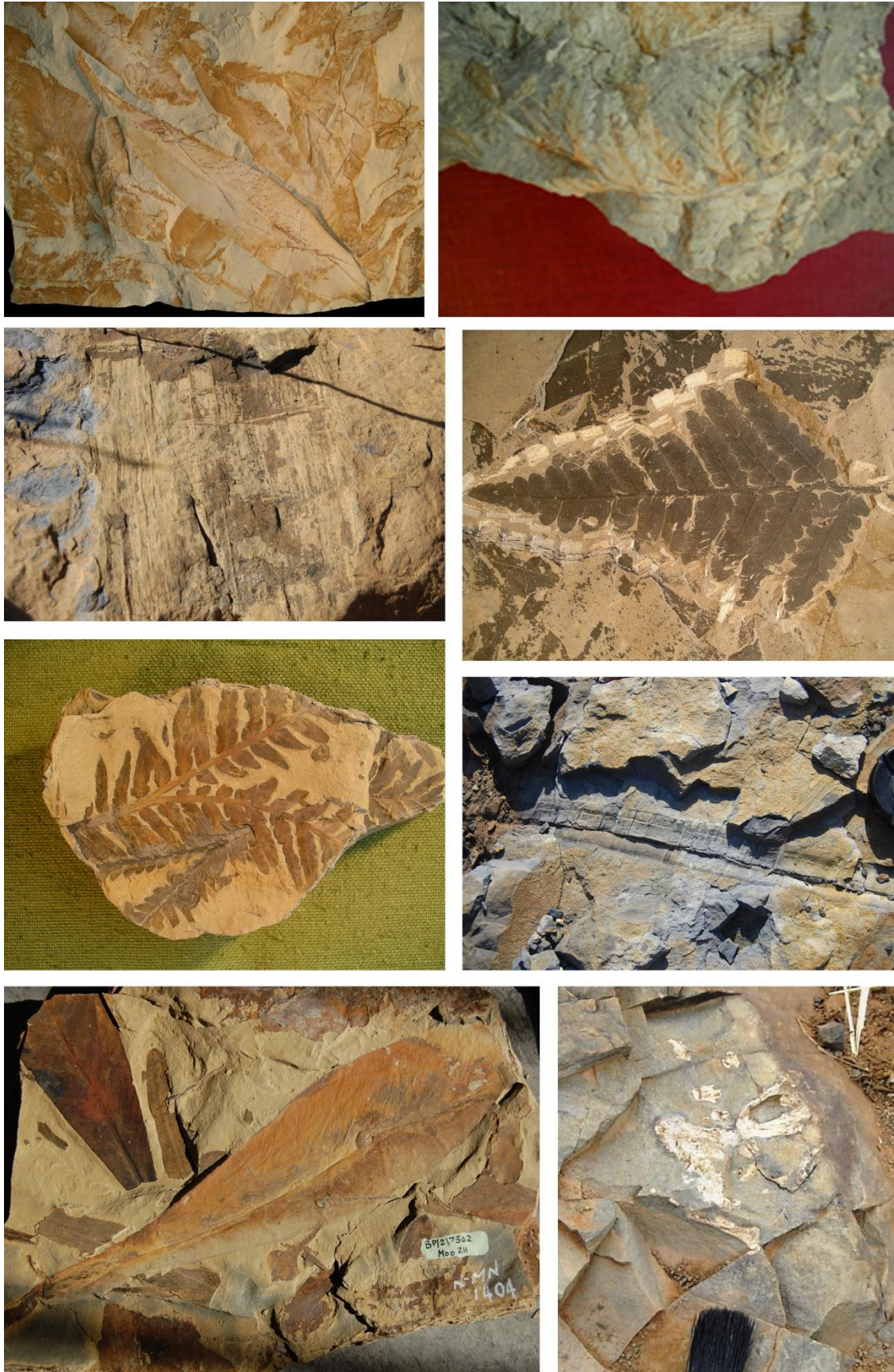


Figure 15: A selection of *Glossopteris* flora plants (Vryheid Formation) with in situ bone shown in the bottom right.

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD January 2021

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	11	2
Masters	10	5
PhD	11	4
Postdoctoral fellows	10	4

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 –
Journal of African Earth Sciences: 2020 –

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
- Klipootjie 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
- Lielifontein 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

xi) Research Output

Publications by M K Bamford up to December 2019 peer-reviewed journals or scholarly books: over 150 articles published; 5 submitted/in press; 8 book chapters.

Scopus h index = 29; Google scholar h index = 36;

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)