

**Palaeontological Impact Assessment for the proposed  
construction of a gas pipeline near Vereeniging,  
Gauteng Province**

**Desktop Study**

**For**

**Landscape Dynamics**

**12 March 2019**

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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 Landscape Dynamics, 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 'M. Bamford', is written over a horizontal line.

## Executive Summary

SAHRA has requested a palaeontological impact assessment, CaseID13286, for the proposed construction of a transmission line to transport natural gas. The diameter of the pipeline is approximately 150 mm and it is approximately 5 km long. The site is located in Vereeniging in the Gauteng Province. The route lies on sediments of the Vryheid Formation and Adelaide Subgroup and other non-fossiliferous sediments. 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 proposed construction.

Only the Vryheid Formation could potentially contain plants of the *Glossopteris* flora but vertebrates very rarely occur with fossil plants. However it is unlikely that any fossils will occur on the surface because of previous disturbance by agricultural, urban and mining activities.. Since there is a small chance that fossils could occur below the surface a Fossil Chance Find Protocol should be added to the EMPr for when excavations commence.

## Table of Contents

Expertise of Specialist .....	1
Declaration of Independence .....	1
1. Background .....	4
2. Methods and Terms of Reference .....	5
3 i. Project location and geological context.....	6
ii. Palaeontological context .....	6
4. Impact assessment .....	9
5. Assumptions and uncertainties .....	10
6. Recommendation .....	10
7. References.....	10
8. Chance Find Protocol .....	11
Appendix A (examples of fossils) .....	13
Appendix B (short CV of specialist) .....	15

# 1. Background

An archaeological impact assessment has been completed for the proposed construction of a transmission line to transport natural gas. The diameter of the pipeline is approximately 150 mm and it is approximately 5 km long. The site is located in Vereeniging in the Gauteng Province. At SAHRA's request (CaseID: 13286), a desktop palaeontological impact assessment is presented here 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).

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	Appendix B
The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
A declaration that the person is independent in a form as may be specified by the competent authority	Page 1
An indication of the scope of, and the purpose for which, the report was prepared	Section 1
The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section <b>Error! Reference source not found.</b> <b>Error! Reference source not found.</b> 5
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 5
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
Any mitigation measures for inclusion in the EMPr	N/A
Any conditions for inclusion in the environmental authorisation	N/A

Any monitoring requirements for inclusion in the EMP or environmental authorisation	Section 8
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	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 EMP, 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	N/A
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

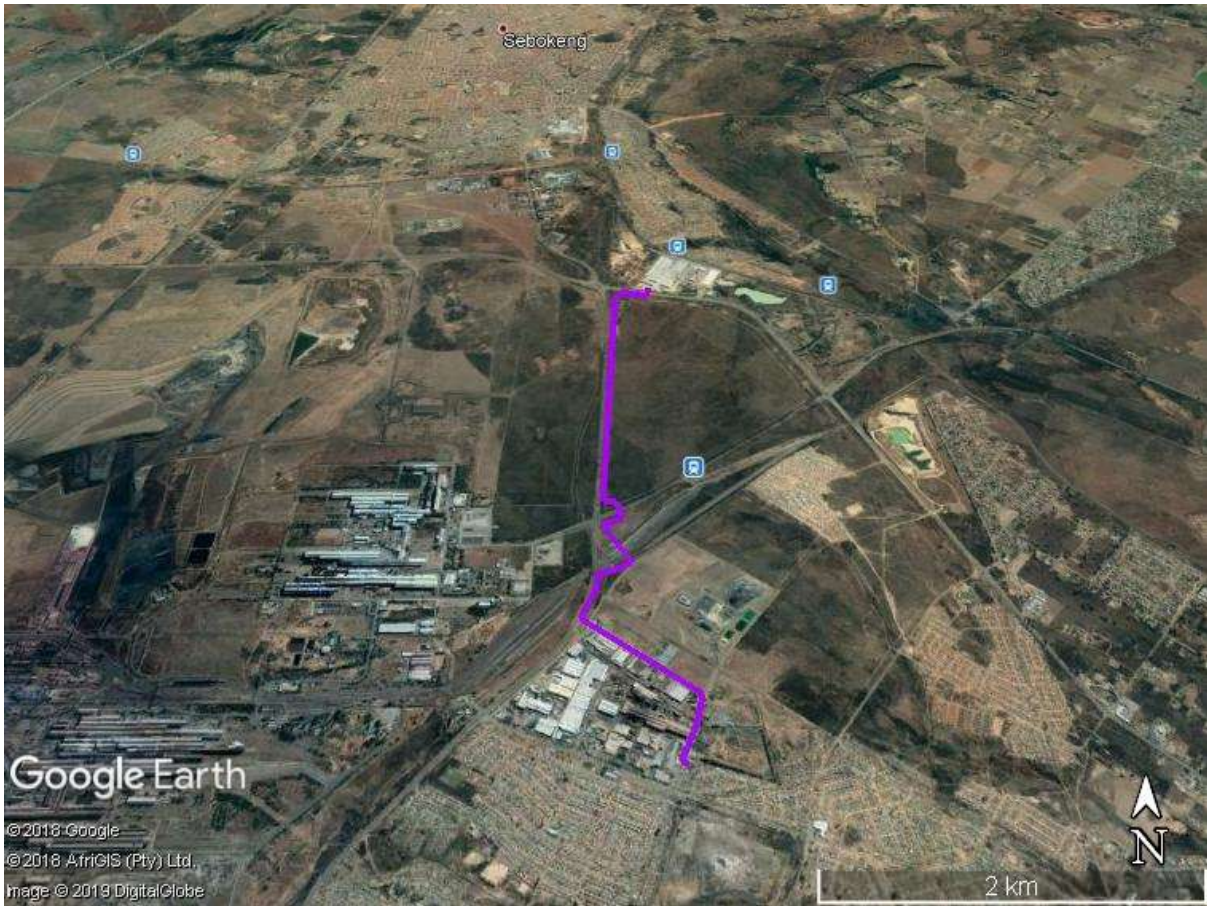


Figure 1: Google Earth map of the proposed route for the gas pipeline from Vereeniging northwards. Map supplied by Landscape Dynamics.

## 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 (*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 location of the project lies on the northern margin of the Main Karoo Basin and includes the ancient rocks of the Transvaal Supergroup, Pretoria Group, namely the Timeball Hill and Hekpoort Formations. Rocks of the Timeball Formation comprise a lower lava member, a lower mudrock member, quartzite member and upper diamictite, conglomerate and mudrock members. These were laid down in a relatively deep lacustrine distal fluvio-deltaic environment with deposition and turbidity currents of the suspended matter clearly evident (Erikssen et al., 2006, 2012). The slightly younger Hekpoort Formation is volcanic and is composed of basaltic andesite and pyroclastic rocks.

Ecca Group sediments of the Vryheid Formation and Volksrust Formation (very minor component) are composed of shales, sandstones, mudrock and coals. They were deposited around the large inland sea that receded over time, and are overlain by the Beaufort deposits that were the result of a shrinking sea and shift from lacustrine to braided stream settings.

Much younger sands of the Quaternary aged Kalahari group overlie much of the area to the west.

### ii. Palaeontological context

Volcanic rocks of the Hekpoort Formation do not preserve any fossils. Mudstones of the Timeball Hill Formation could contain fossils but they are too old for body fossils, and they are relatively deep water deposits so it is unlikely that there would be any traces of tidal



microbial activity that has been reported from the Magaliesberg Formation (Erikssen et al., 2012).

Fossil plants occur in the Vryheid Formation shales and mudrocks and these are typical *Glossopteris* flora plants, for example *Glossopteris* leaf impressions, ferns, sphenophytes, lycopsids and some early gymnosperms (Plumstead, 1969; Anderson and Anderson, 1985). The upward-coarsening cycles of the Vryheid Formation are deltaic in origin. Fossil plants are usually associated with shale lenses and coal seams. Where plants are found, more often than not, no vertebrates are found. The overlying Volksrust Formation comprises grey to black silty shale with thin sandstone or siltstone lenses. It probably represents a transgressive open shelf sequence (Johnson et al., 2006) and fossils have not been recorded from this formation.

Quaternary Kalahari sands are Aeolian and do not preserve fossils. Very rarely are fossils preserved in pans but there so not appear to be any pans in this locality.

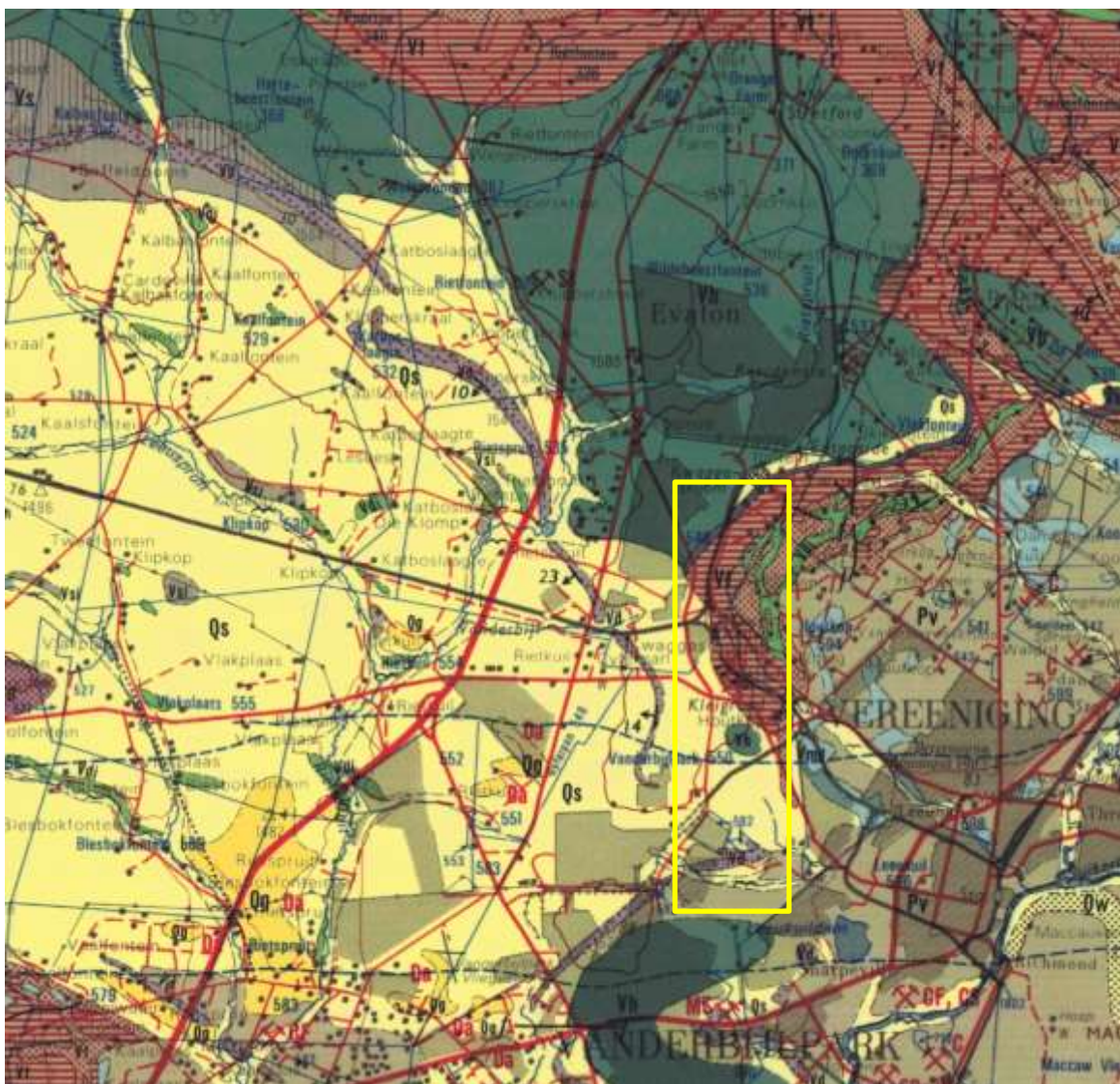




Figure 2: Geological map of the area around Vereeniging. The location of the proposed project is indicated within the yellow rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 1986.

Table 2: Explanation of symbols for the geological map and approximate ages (Erikssen et al., 2006. Johnson et al., 2006; McCarthy et al., 2006; Robb et al., 2006; van der Westhuizen et al., 2006). SG = Supergroup; Fm = Formation.

Symbol	Group/Formation	Lithology	Approximate Age
Qs	Quaternary Kalahari sand	sand	Last ca 2.5 Ma
Jd	Jurassic	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Pvo	Volksrust Fm	shale	Middle Permian, Upper Ecca
Pv	Vryheid Fm	Shales, sandstone, coal	Early Permian, Middle Ecca
Vh	Hekpoort Fm, Pretoria Group, Transvaal SG	Basaltic andesite, pyroclastic rocks	Ca 2222 Ma
Vt	Timeball Hill Fm, Pretirai Group, Transvaal SG	Mudrocks, diamictite, quartzite	<2222 Ma

The palaeontological sensitivity of the area under consideration is presented in Figure 3.

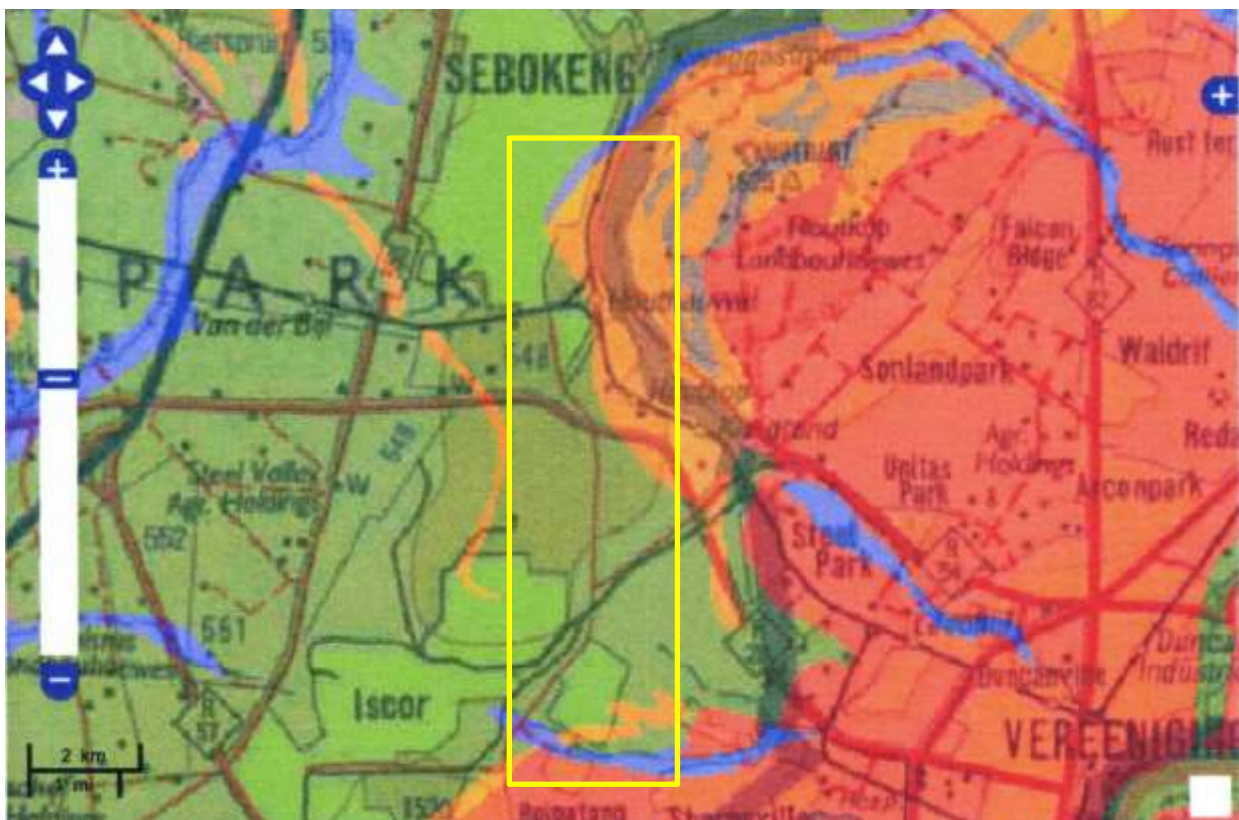


Figure 3: SAHRIS palaeosensitivity maps for the proposed gas pipeline route is shown within the yellow rectangle. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

## 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	The Vryheid Fm, could contain fossil materials of plants of the <i>Glossopteris</i> flora. The impact would be moderate
	L	..
	L+	-
	M+	-
	H+	-
DURATION	L	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	L	Since only the possible fossils within the area would be r fossil plants from the <i>Glossopteris</i> flora in the shales, the spatial scale will be localised within the site boundary.
	M	-
	H	-

PART B: ASSESSMENT		
PROBABILITY	H	-
	M	There is a moderate chance of fossils occurring but the surface has been heavily disturbed by agricultural, urban or mining activities. There is a small chance that once excavations begin fossils will be exposed from below the surface so a Chance Find Protocol should be added to the EMPr.
	L	-

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 the correct age and type to preserve fossils. Earlier disturbance by agricultural, urban and mining activities would have destroyed any fossils exposed on the surface. There might be undisturbed fossils below the surface. Since there is a small chance that fossils from the Vryheid Formation may be disturbed a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria and results of the survey, 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 volcanic rocks of the Hekpoort Formation and ancient mudstones of the deep-water Timeball Hill Formation do not contain fossils. The Vryheid Formation is likely to contain fossils of the Glossopteris flora, but no vertebrates. Surface exposures would not preserve fossils but they occur below ground. Quaternary sands are windblown and would not preserve fossils.

## 6. Recommendation

Based on experience and the lack of any records of fossils from the area, it is unlikely that any fossils would be preserved on the land surface. There is a small chance that fossil may occur below the surface in the Vryheid Formation so a Chance Find Protocol should be added to the EMPr: if fossils are found once excavations have commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample, with a SAHRA permit.

## 7. References

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

Erikssen, 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.

Erikssen, P.G., Bartman, R., Catuneanu, O., Mazumder, R., Lenhardt, N., 2012. A case study of microbial mats-related features in coastal epeiric sandstones from the Palaeoproterozoic Pretoria Group, Transvaal Supergroup, Kaapvaal craton, South Africa; the effect of preservation (reflecting sequence stratigraphic models) on the relationship between mat features and inferred palaeoenvironment. *Sedimentary Geology* 263, 67-75.

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.

Robb, L.J., Brandl, G., Anhaeusser, C.R., Poujol, M., 2006. Archaean Granitoid Intrusions. 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 57-94.

Van der Westhuizen, W.A., de Bruijn, H., Meintjes, P.G., 2006. The Ventersdorp 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 187-208.

## 8. Chance Find Protocol

### **Monitoring Programme for Palaeontology – to commence once the excavations for infrastructure 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 9, 10). 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 or 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 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 an AMAFA 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. Annual reports by the palaeontologist must be sent to AMAFA.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

#### Appendix A – examples of fossils from the Vryheid Formation

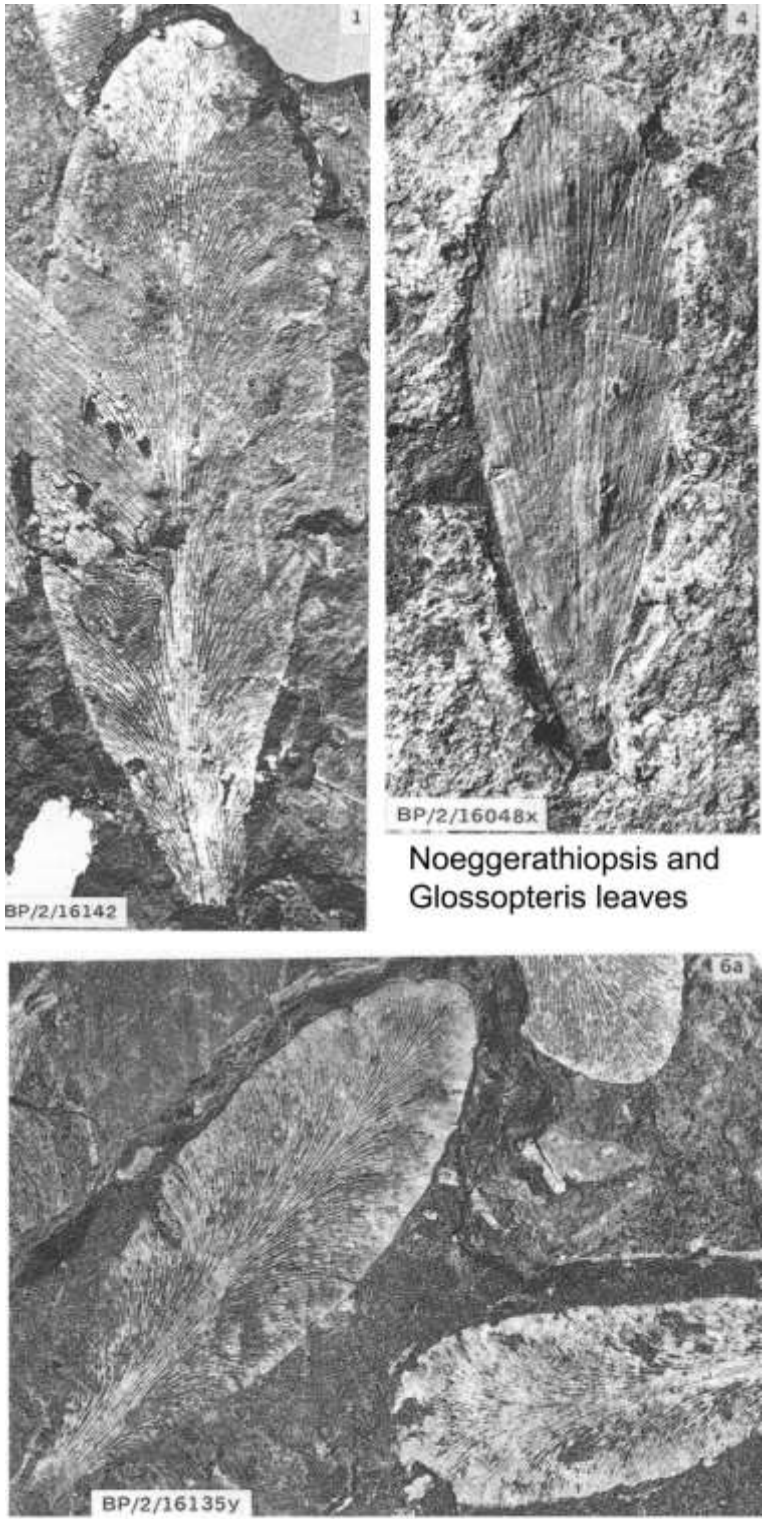


Figure 4: *Glossopteris* and cordaitalean leaves from Ecca sediments





Fern: *Asterotheca* sp.



Sphenophytes: whorls of leaves on a striated stem



Figure 5. More fossils from the Vryheid Formation.

## Curriculum vitae (short) - Marion Bamford PhD January 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  
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### 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 2018 peer-reviewed journals or scholarly books: over 125 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)