Palaeontological Impact Assessment for the proposed development of coal mining, Thubelisha Project, Mpumalanga Province

Phase 2/Site Report

For

Digby Wells Environmental

10 February 2019

Prof Marion Bamford
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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; 23 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Digby Wells, 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 Phase 2 or site visit Palaeontological Impact Assessment was requested for the proposed development of coal mining and associated activities for the Thubelisha project, between Secunda, Bethal and Kriel, Mpumalanga (SAHRA case ID:12164). 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 field based Palaeontological Impact Assessment (PIA) was completed for the proposed development.

The site visit was undertaken from 28-31 January 2019 to survey a representative sample of farms that will be affected was completed and yielded no fossils at all. The Vryheid Formation (Ecca Group, Karoo Supergroup) contains coals that will be exploited and could potentially also contain plants of the *Glossopteris* flora in the shales between the coal seams. Fossils are not visible in the coal itself and no vertebrates are likely to occur. No fossils were found on the ground surface or in river cuttings. 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

1. Background

A Palaeontological Impact Assessment (PIA) (Phase 2) was requested by SAHRA for the proposed development of mining on a number of farms between Secunda/Trichardt, Bethel and Kriel, Mpumalanga, here called the Thubelisha project (SAHRA CaseID: 12164). 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 site visit was carried out and is reported here.

Sasol Mining (Pty) Ltd appointed Digby Wells Environmental (hereinafter Digby Wells) to update and consolidate the Thubelisha, Trichardsfontein and Vaalkop Environmental Management Plans (EMPs) in accordance with the Mineral and Petroleum Resources Development Act, 2002 (Act N0. 28 of 2002) (MPRDA). In support of the consolidation process, Digby Wells undertook a Heritage Resources Management (HRM) process, which included the compilation and submission of a Heritage Impact Assessment (HIA) report. The HIA, in turn, was submitted to the South African Heritage Resources Agency (SAHRA) and the Mpumalanga Provincial Heritage Resources Authority (MPHRA) online through the South African Heritage Resources Information System (SAHRIS) to comply with the requirements encapsulated in Section 38 of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA). Subsequently, SAHRA issued an interim comment requiring the compilation and submission of a PIA report before final comment on the submission can be made.

A site visit was undertaken between 28-31 January 2019 by Frederick Tolchard who is working with Prof Bamford to some of the farms that will be impacted by the project (see section 3iii) and the results are presented here.

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 i
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

A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain:	Relevant section in report
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 4 Plan 1
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 EMPr 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 EMPr, and where applicable, the closure plan	N/A
A description of any consultation process that was undertaken during the course of carrying out the study	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 area to be developed for the Thubelisha project. Map supplied by Digby Wells.

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*).

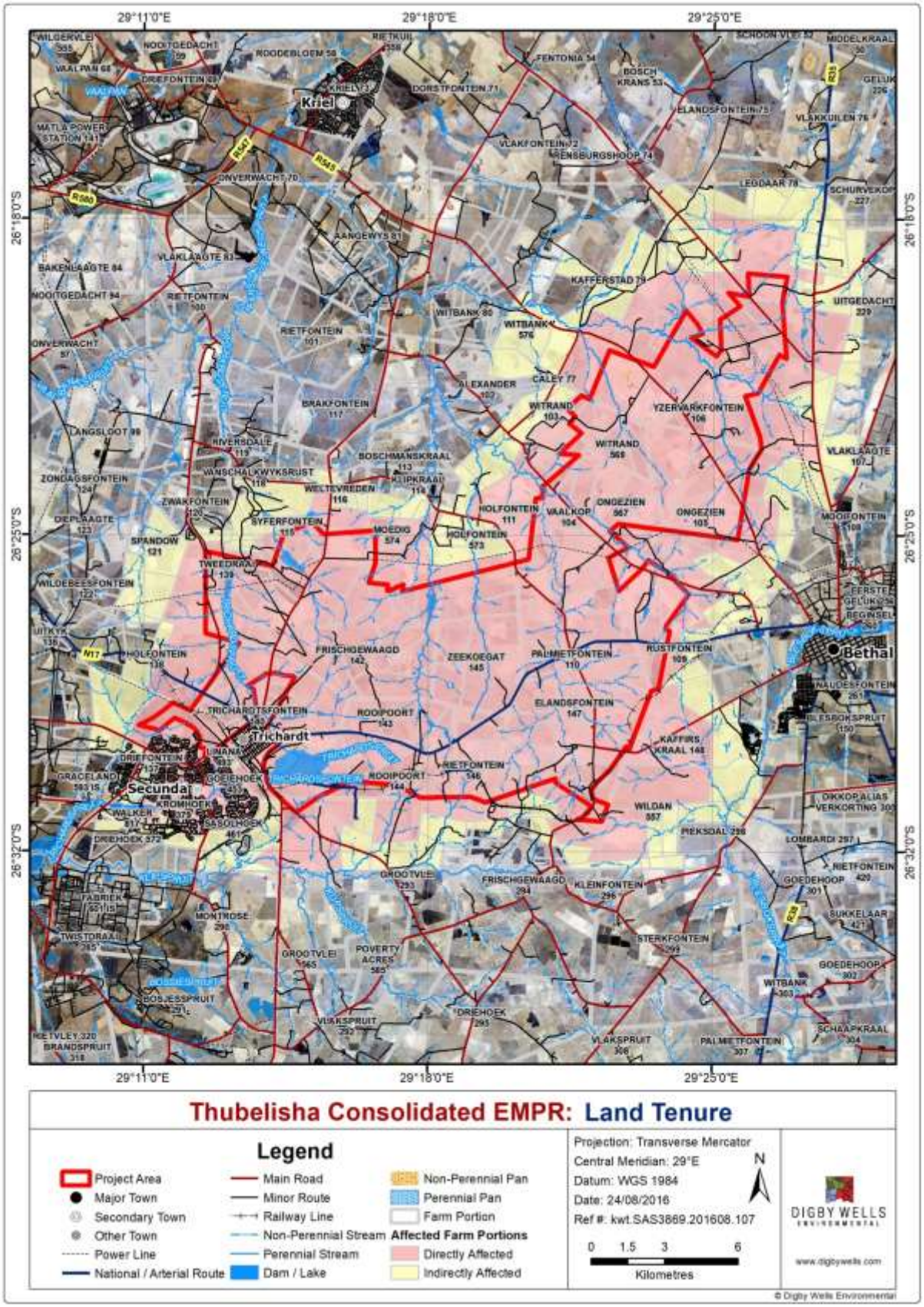

Figure 2: Map indicating the farms affected by the project, directly (pink) and indirectly (yellow) with farm names.

3. Geology and Palaeontology

i. Project location and geological context

The location of the project lies on the north eastern margin of the Main Karoo Basin and includes the Ecca Group (Pietermaritzburg, Vryheid, Volksrust Formations). Ecca Group shales, sandstones, mudrock and coals 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.

Jurassic dolerite is common in the region, but these are intrusive and of volcanic origin. The dykes cross-cut the Karoo strata and also tend to destroy any fossils that might have been in their vicinity. As they are non-fossiliferous they will not be discussed further.

ii. Palaeontological context

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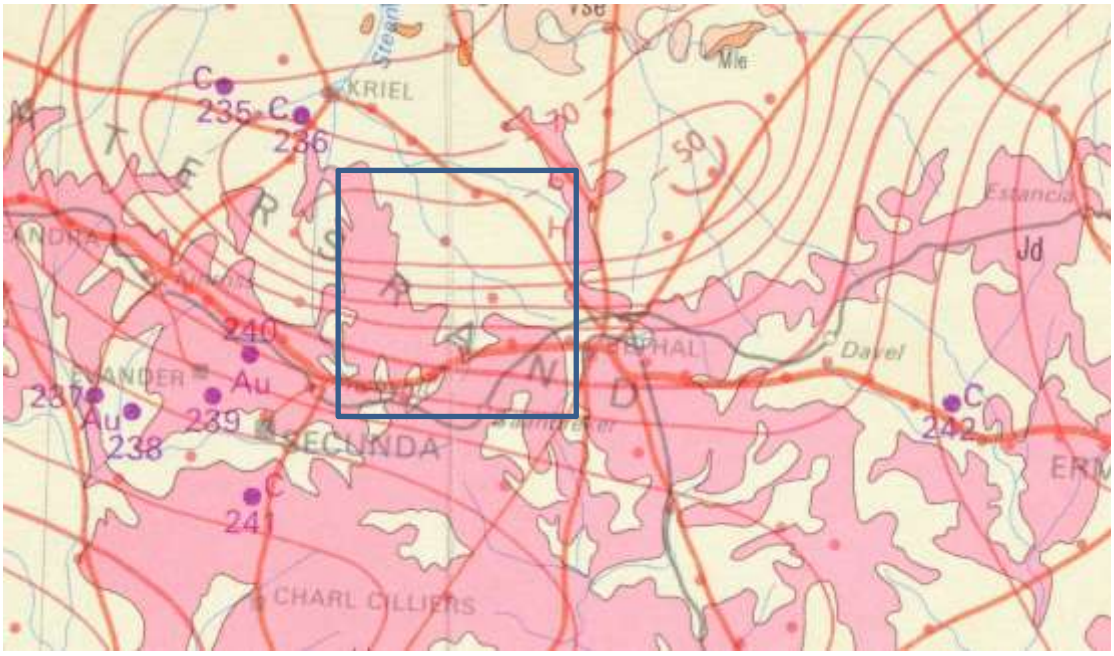


Figure 3: Geological map of the area between Secunda, Bethal and Kriel. The location of the proposed project is indicated within the blue rectangle. Yellow represents the Vryheid Formation (Pv). Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 1 000 000 map 1984.

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

Symbol	Group/Formation	Lithology	Approximate Age
Jd	Jurassic	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Pvo	Volksrust Fm, Ecca Group, Karoo SG.	shale	Middle Permian, Upper Ecca
Pv	Vryheid Fm, Ecca Group, Karoo SG	Shales, sandstone, coal	Early Permian, Middle Ecca

The Mpumalanga Coalfield has numerous coal mines and in general they exploit the coal seams 1-5 (base to top) and drill cores indicate the depth and relative thickness of the coal seams. In the Kriel area the uppermost seam, no 5, is 30m below the land surface (Snyman, 1998) so it is unlikely that any coal or associated fossiliferous shale lenses would be visible in farmlands but could be exposed in river cuttings or box cuts.

The palaeontological sensitivity of the area under consideration is presented in Figures 4-7.

Figure 4: SAHRIS palaeosensitivity map for the farm Trichardtsfontein 140, part of the Thubelisha project. The site surveyed is 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.

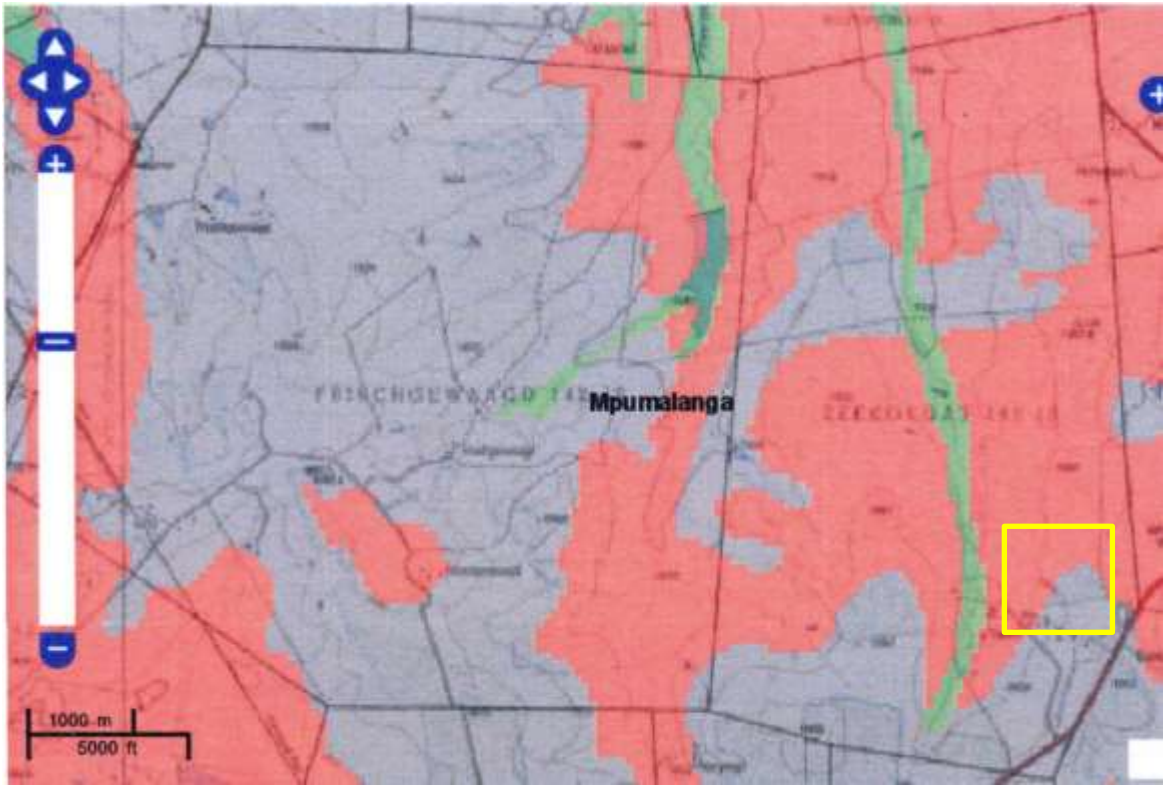


Figure 5: SAHRIS palaeosensitivity map for Farms Frischgewaagd 142 and Zeekoeigat 145 with the area surveyed within the yellow rectangle. (Colours for sensitivity as for Fig 4).

Figure 6: SAHRIS palaeosensitivity map for Farm Yzervarkfontein 106, with the area surveyed within the yellow rectangle. (Colours for sensitivity as for Fig 4).

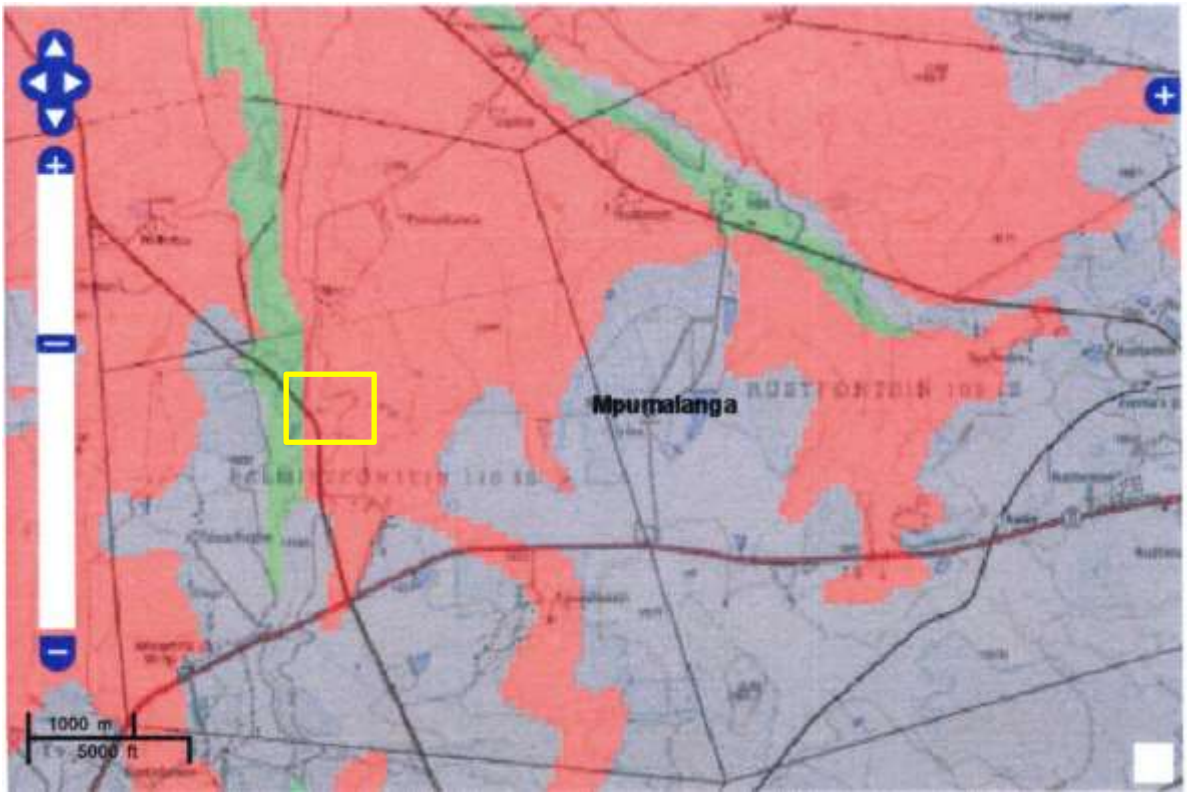


Figure 7: SAHRIS palaeosensitivity map for Farm Palmietfontein 110 with the area surveyed within the yellow rectangle. (Colours for sensitivity as for Fig 4).

iii. Site Visit

The site was visited on 28-31 January 2019, focussing on the highly sensitive areas and central farms where the development will be concentrated. Plan 1 presents an spatial overview of the site inspection locations.

Table 3: List of farms and sites visited with the latitude and longitude provided, observations and related figure for photographs of the site.

Site designation	GPS cords	Comment
Trichartsfontein entrance	S26°28.070' E29°13.008' 1611m	Figure 8a – almost flat topography, well vegetated soils and no fossils
Trichartsfontein exposed mudstone?	S26°28.171' E29°12.965' 1603m	Figure 8b – fine-grained mudstone with no bedding planes and no fossils
Trichartsfontein weathered dolomite quarry?	S26°28.216' E29°12.983' 1607m	Figure 9a-c Quarry with amorphous dolomite and no fossils.
Thubelisha conveyor belt to shaft	S26°28.222' E29°17.295' 1625m	Figure 9d. well-vegetated soils beneath the structures.

Site designation	GPS cords	Comment
Roadside 1	S26°29.122' E29°19.384' 1655m	No fossils
Zeekoegat entrance	S26°28.804' E29°19.905' 1673m	Flat well vegetated farmland and no exposures
Yzervarkfontein entrance	S26°22.116' E29°24.150' 1646m	Flat well vegetated farmland and no exposures
Palmietfontein entrance	S26°26.672' E29°21.272' 1596m	Figure 10a. Flat well vegetated farmland and no exposures.
River bed, exposed rock	S26°26.564' E29°21.160' 1592m	Figure 10b. No fossil imprints in the rock.
Rock exposure	S26°26.506' E29°21.093' 1601m	Figure 10c. Hard shales exposed but no plant impressions present.
Riverbank, Palmietfontein	S26°26.389' E29°21.311' 1591m	Figure 11a. Another river on the farm cutting through deep soils. No fossils.
Palmietfontein random point 1	S26°26.043' E29°20.463' 1617m	Figure 11b. Sandstone exposed but no fossils preserved.
River channel	S26°26.132' E29°21.347' 1607m	Figure 11d. Hard shales exposed but no plant impressions in the rocks
Donga	S26°26.223' E29°21.157' 1576m	Figure 11c. Hard shales exposed but no plant impressions in the rocks

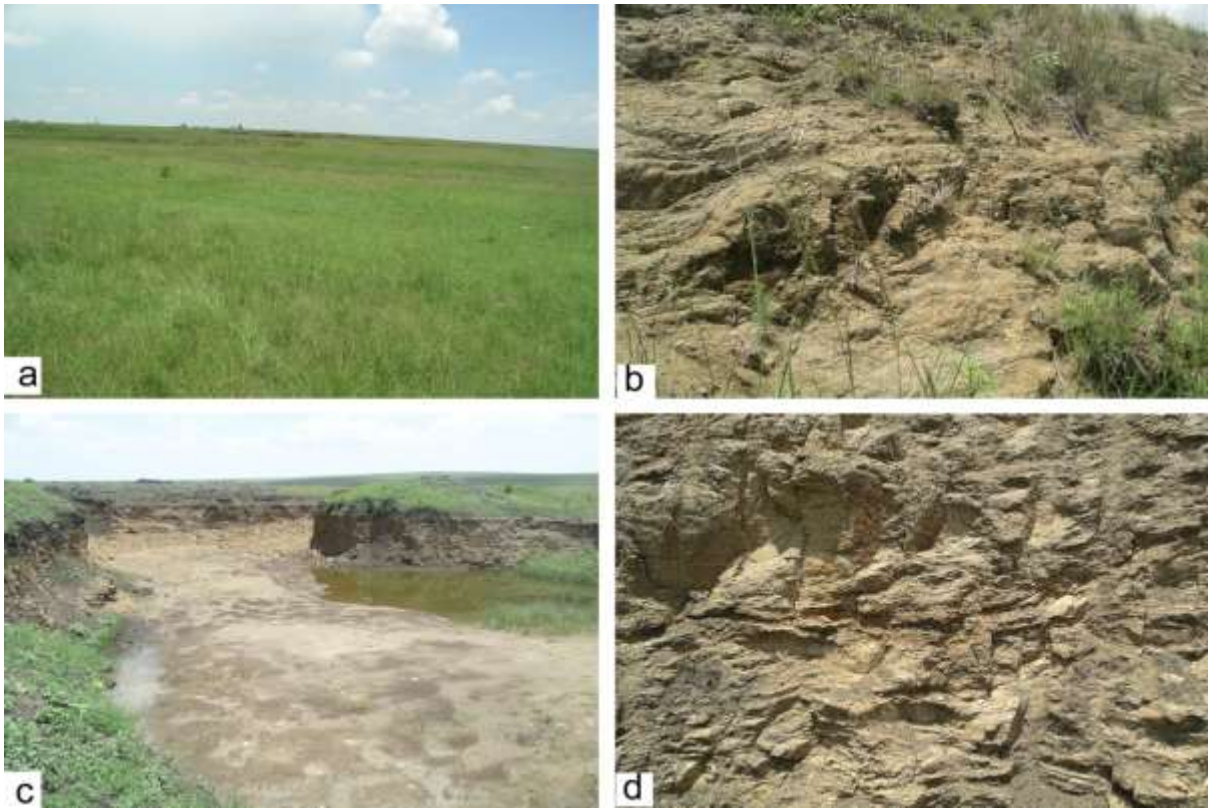


Figure 8: Photographs of the sites visited. A – General view of the farmland on Trichardtsfontein with well vegetated soils and no rocky outcrops. B-D – mudstone without bedding planes

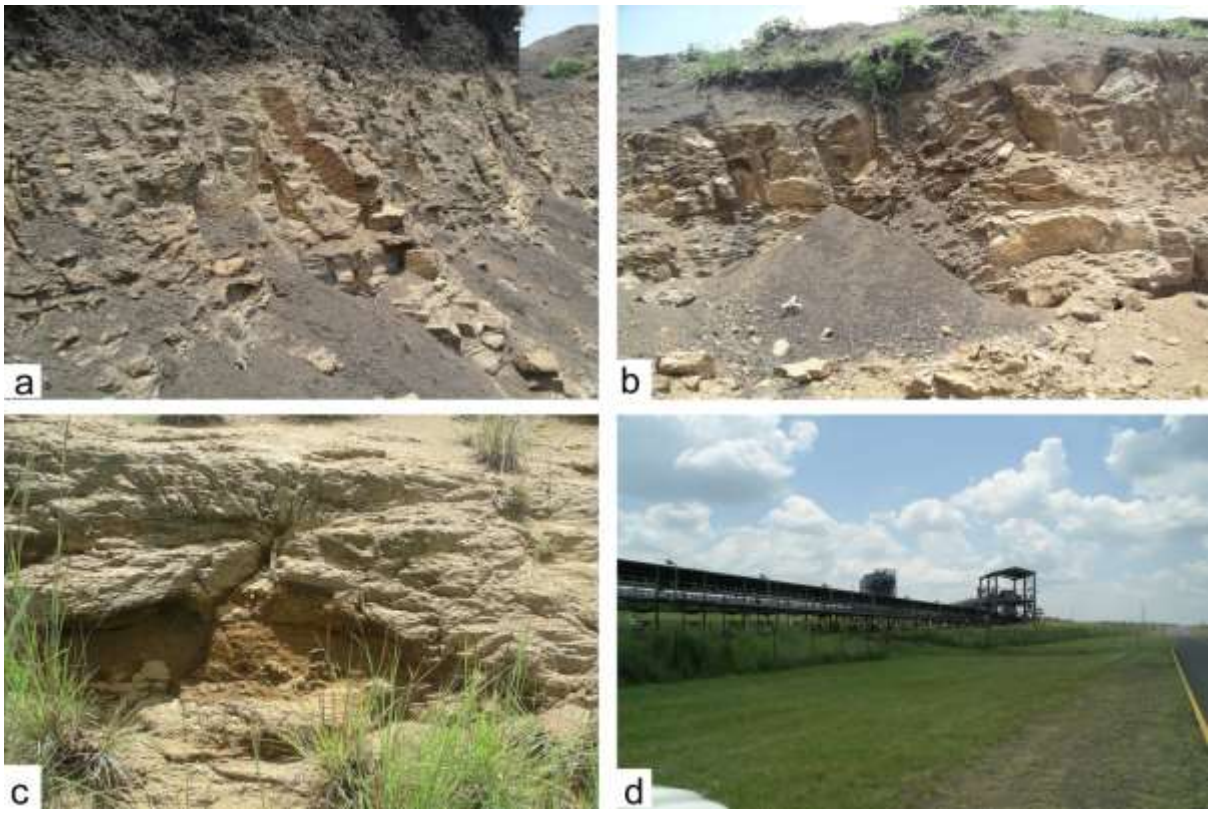


Figure 9: A-C - Trichardtsfontein quarry. D - Thubelisha conveyor belt.

Figure 10: Farm Palmietfontein and sandstone outcrops.

Figure 11: Palmietfontein river cutting, sandstone and donga but no coal or fossils visible.

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 4:

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	The Vryheid Fm siltstones and shales could contain impressions of plants of the Glossopteris 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 fossil plants from the *Glossopteris* 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** none were found during the survey. There is a small chance that once excavations begin fossils will be exposed from below the surface or associated with the shale lenses between the coal seams, so a Fossil 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, however none were found by the palaeontologist who surveyed the area. Since there is a small chance that fossils from the Vryheid Formation may be found below the surface and therefore will 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 dolomites, sandstones, shales and sands are typical for the country and do contain fossil plant, insect, invertebrate and vertebrate material. From the survey we are certain that there are no surface exposures of fossils. They may occur below ground.

6. Recommendation

Based on experience and the lack of any fossils recorded from the area, it is unlikely that many fossils would be preserved in the site. There is very small chance that fossils may occur below the surface so a Fossil 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.

7. References

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

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.

Snyman, C.P., 1998. Coal. In: Wilson, M.G.C., and Anhaeusser, C.P., (Eds). The Mineral Resources of South Africa: Handbook, Council for Geosciences 16, 136-205.

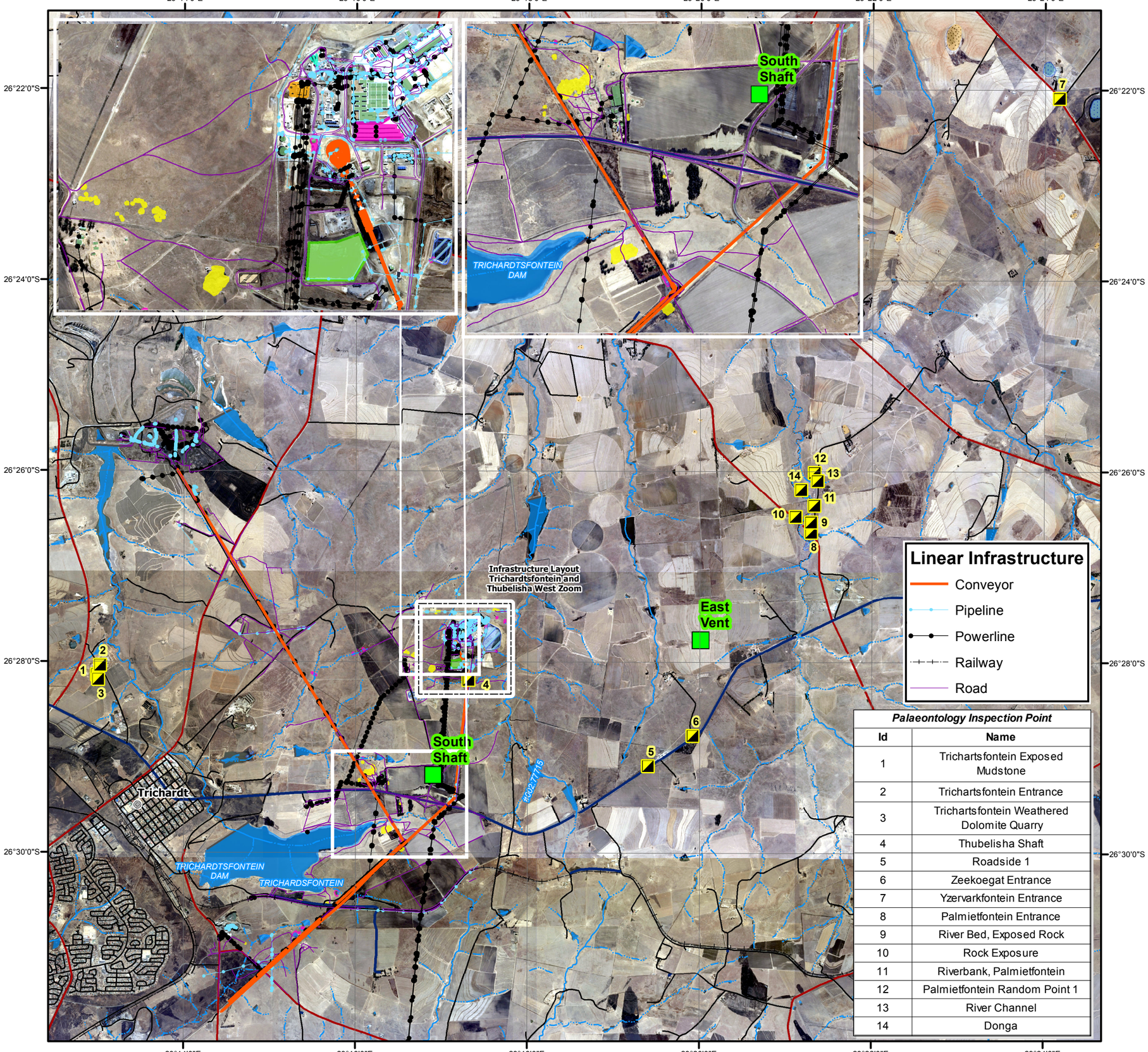
8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations for infrastructure or mining 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 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. Annual reports by the palaeontologist must be sent to SAHRA.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

Plan 1

Thubelisha Consolidated EMPR
Palaeontology Site Inspection Plan



Legend

- Paleontology Inspection Point
- Shaft Location
- Other Town
- National / Arterial Route
- Main Road
- Minor Route
- Railway Line
- Non-Perennial Stream
- Perennial Stream
- Dam Wall
- Dam / Lake
- Non-Perennial Pan
- Perennial Pan

Existing Infrastructure

- Dams
- 3rd Fan
- Buildings
- Explosives
- Quarry
- Surface Structures
- Stock Yard
- Substation

Linear Infrastructure

- Conveyor
- Pipeline
- Powerline
- Railway
- Road

Palaeontology Inspection Point

Id	Name
1	Trichartsfontein Exposed Mudstone
2	Trichartsfontein Entrance
3	Trichartsfontein Weathered Dolomite Quarry
4	Thubelisha Shaft
5	Roadside 1
6	Zeekoegat Entrance
7	Yzervarkfontein Entrance
8	Palmietfontein Entrance
9	River Bed, Exposed Rock
10	Rock Exposure
11	Riverbank, Palmietfontein
12	Palmietfontein Random Point 1
13	River Channel
14	Donga

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Appendix A – examples of fossils from the Vryheid Formation

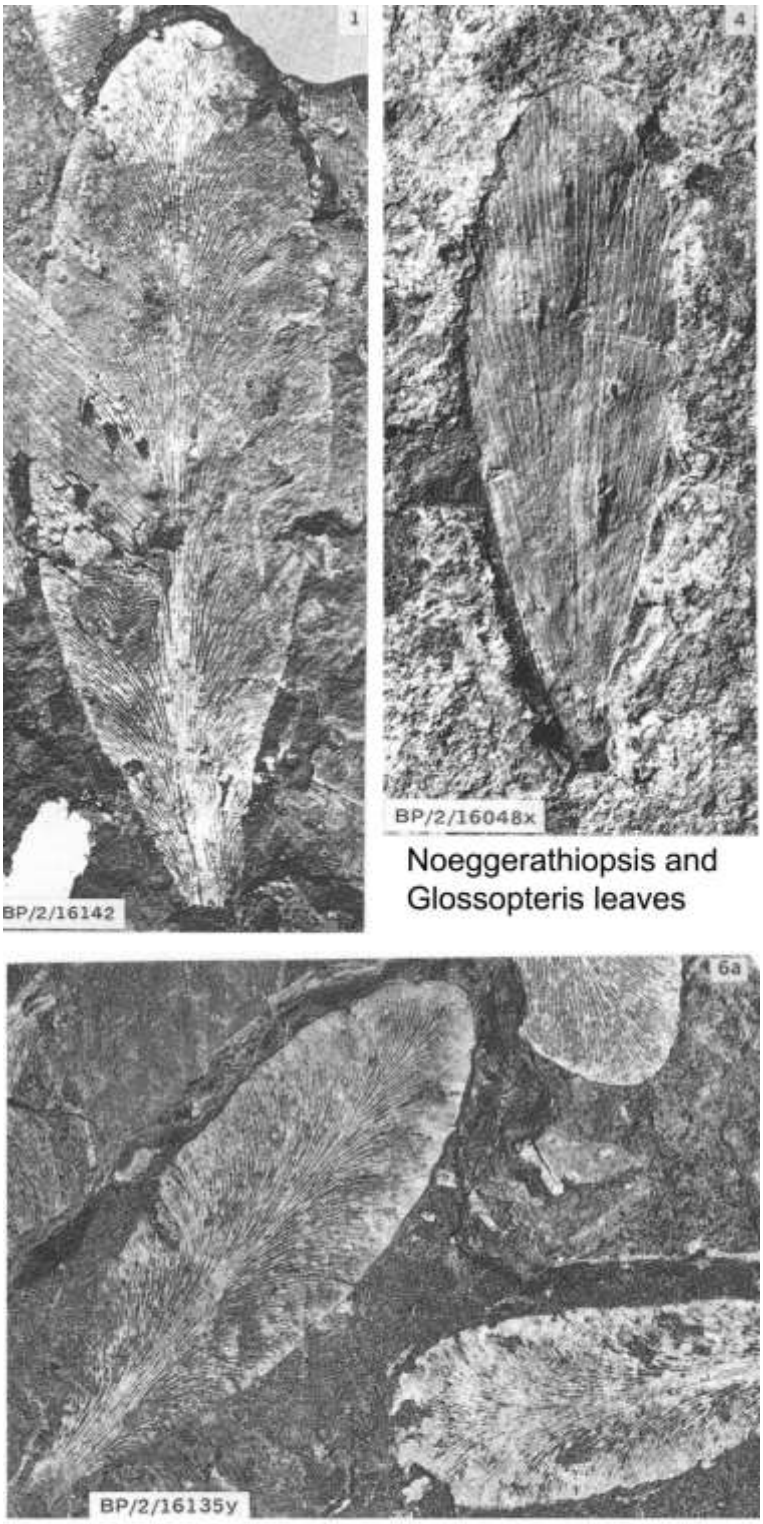

Figure 12: *Glossopteris* and cordaitalean leaves from Ecca sediments

Figure 13: appearance of vertebrate bones (white) embedded in the mudstone (grey, light brown). Paintbrush for scale.

Appendix B – Details of specialist

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
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 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)