Palaeontological Impact Assessment for the proposed prospecting rights on Farm Rietfontein 11 and 13, Prieska District, Northern Cape Province,

Desktop Study

For

Dr Edward Matenga

22 January 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; 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 Dr Edward Matenga, South Africa. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision making process for the Project.

Specialist: Prof Marion Bamford

Signature: 

Executive Summary

A palaeontological Impact Assessment was requested for the prospecting rights application for the Farm Rietfontein 11 Portions 9 and 13, near Prieska, Northern Cape Province. To comply with the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed project.

The geological structures suggest that the rocks are mostly too old or volcanic to contain fossils. Stromatolites (tracefossils) might occur in the Ghaap Group rocks. There is a small chance that the Dwyka Group mudstones could preserve fragment of the Glossopteris flora and invertebrates. Since there are potentially fossiliferous rocks in the vicinity a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is extremely low. No further palaeontological impact assessment is required.

Table of Contents

1. Background

A palaeontological Impact Assessment was requested for the prospecting rights application for the Remaining Extent of Portions 9 (Spring Puts C) of the Farm Rietfontein 11, and Portion 13 (a Portion of Portion 9) of the farm Rietfontein 11, near Prieska, Northern Cape Province. To comply with the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed project.

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 ii **Error! Reference source not found.**
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

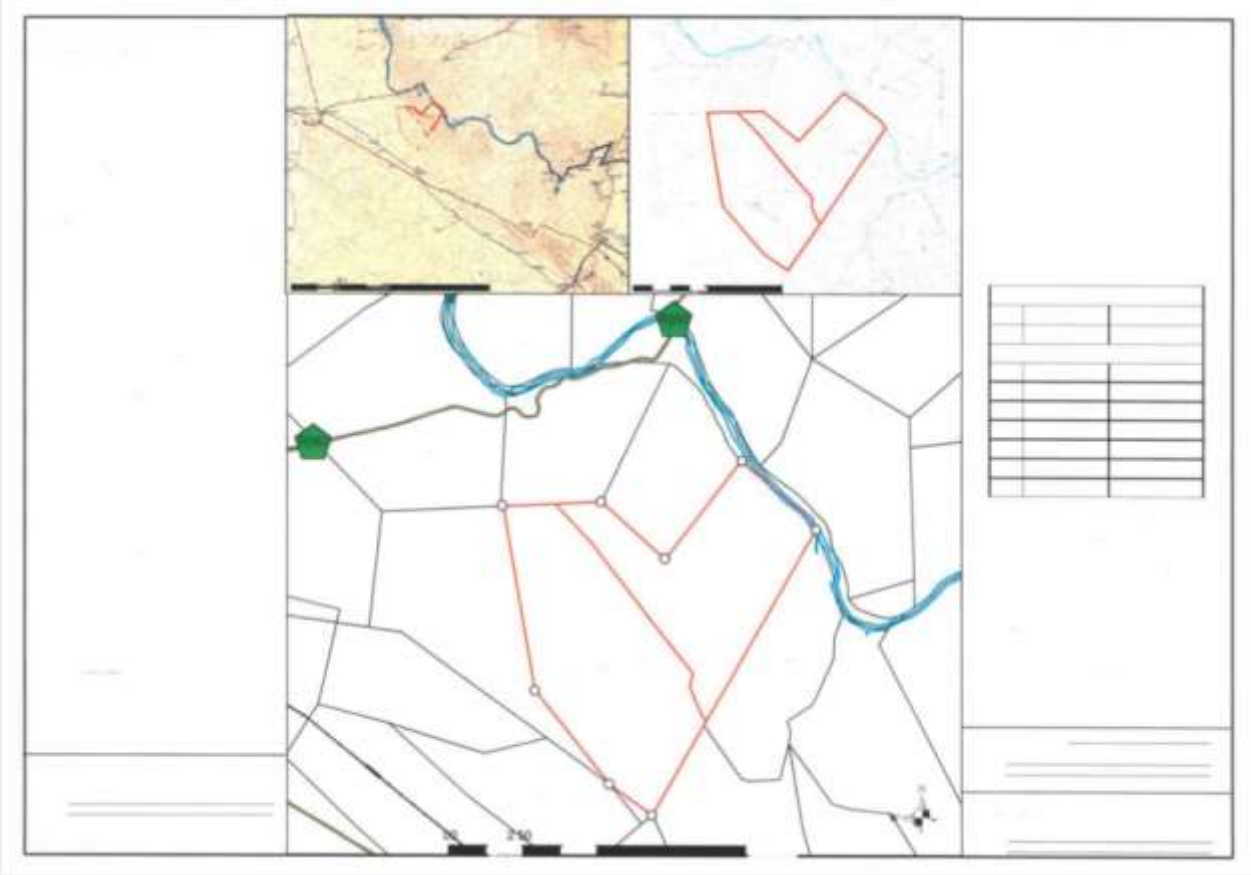


Figure 1: Map of the proposed site for the prospecting rights application on Remaining Extent of Portion 9 (Spring Puts C) of the Farm Rietfontein 11, and Portion 13 (a Portion of Portion 9) of the farm Rietfontein, with farm boundaries shown in red. Map supplied by Edward Matenga.

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

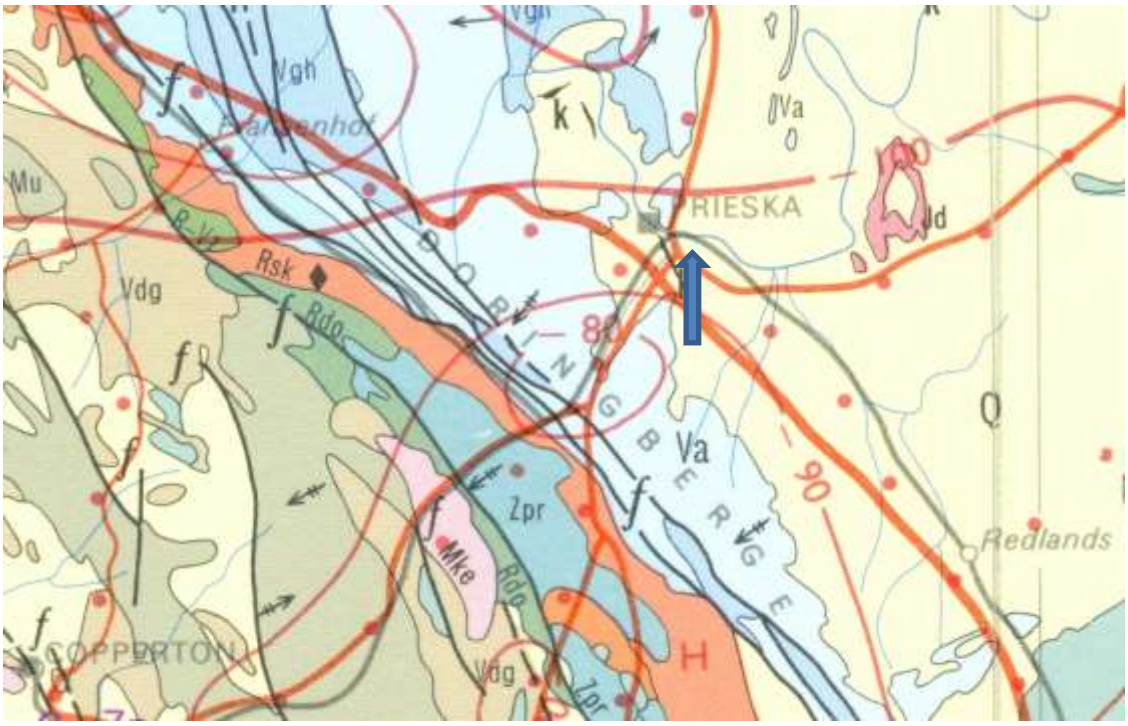


Figure 2: Geological map of the area around Prieska. The location of the proposed project is indicated with the arrow. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 1 000 000 map 1984.

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

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary	Alluvium, sand, calcrete	Neogene, ca 25 Ma to present
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
C-Pd	Dwyka Group, Karoo SG	Tillites, diamictites, shales, mudstones	Late Carboniferous to early Permian; ca 300 Ma
Vgh	Ghaap Group, Transvaal SG	Dolomite, limestone, chert	2642-2420 Ma
Va	Asbestos Hills Subgroup, Ghaap Group, Transvaal SG	Iron formation, jaspillite	2500 – 2432 Ma
Vsc	Schmidtsdrif Subgroup, Ghaap Group, Transvaal SG	Dolomite, shale	2642 – 2620 Ma
Vv	Vryburg Fm, Transvaal SG	Shale, sandstone, andesite	<2650 Ma
Val	Allanridge Fm, Ventersdorp SG	Andesite, Mafic lava, tuff, amygadaloidal	>2650 Ma
Zpr	Prieskapoort Supergroup Marydale Greenstone Belt	Conglomerate, greywacke, tuff, lavas, amphibolite	Ca 2853 Ma
Rsk	Skalkseput Granite	Biotite muscovite granite	Archean granitoid intrusion ca 3111-2930 Ma

There are some very old rocks in this region of the Archean Granitoid intrusion and the Marydale Greenstone Belt (Robb et al., 2006; Brandl et al., 2006). Although minerally rich they are too old to preserve fossils.

The Ventersdorp Supergroup is essentially made up of a number of lava flows that have been extensively altered as a result of greenschist facies metamorphism (van der Westerhuizen et al., 2006). At the top of this sequence is the Allanridge Formation with a variety of lavas. The prospecting site is predominantly on these rocks.

On top of these rocks is the Vryburg Formation which comprises a basal transgressive conglomerate, quartzites, shales and some stromatolitic carbonates, capped in some places by basaltic or andesitic lavas. The environment has been interpreted as a fluvial to marginal marine setting (van der Westhuizen et al., 2006). Above the Vryburg Fm in the Prieska and Ghaap Plateau sub-basins is the Schmidtsdrif Subgroup comprising the lower Boomplaas Formation (limestone) and upper Clearwater formation (shales, tuffites and banded ironstone-like cherts). Above this is the Campbell Rand Subgroup (not exposed here) and then the Asbestos Hills Subgroup which is the dominant rock type in the area.

The Asbestos Hills Subgroup, Transvaal Supergroup, is divided into three formations, the lowermost Kliphuis Formation, the Kuruman Formation and the upper Danielskuil Formation. They are all essentially banded ironstones so rich in haematite and other iron compounds.

Small outcrops of Dwyka Group tillites, diamictites, shales and mudstones occur in this area and are the deposits from receding glaciers, the meltwater of which formed the young Karoo sea during the Late Carboniferous and Permian. Younger intrusive Jurassic dolerites were formed during the massive Drakensberg volcanic outpourings.

Overlying much of the area are the Aeolian sands, the Kalahari Group. They are deep in some sections and have covered large areas of the north-western Cape; they are of Cenozoic age.

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 3. The site for prospecting rights application is in the Asbestos Hills Subgroup, Ghaap Group, but these rocks are not widely fossilifierous. Although the geological map does not differentiate the Ghaap Group deposits, some of the Formations are potentially fossiliferous as they contain stromatolites, in particular in the Vryburg Formation and the Schmidtsdrift Subgroup.

The Vryburg Formation stromatolitic carbonates are trace fossils of ancient algal colonies that formed in shallow marine settings. Although some stromatolites preserve the cells of the microscopic algae these are extremely rare and can only be seen under the microscope from petrographic thin sections. The limestones of the Boomplaas Formation, Schmidtsdrif Subgroup, are stromatolitic and oolitic platform carbonates and were also formed by algal colonies so there is a very small chance that the microscopic algae have been preserved in some facies.

Tillites, shales and mudstones of the Dwyka Group can potentially preserve body fossils and these have been recorded from isolated sites, for example from near Douglas, some 120km to the northeast of Prieska, also along the Orange River (Anderson and McLachlan, 1973; Johnson et al., 2006; McLachlan and Anderson, 1976). Marine fossils such as cephalopods, lamellibranchs and brachiopods, and terrestrial fossils such as early *Glossopteris* leaf impressions and silicified woods were recovered from Douglas.

The Dwyka Group is made up of seven facies that were deposited in a marine basin under differing environmental settings of glacial formation and retreat (Visser, 1986, 1989; Johnson et al., 2006). In the north these are called the Mbizane Formation, and the Elandsvlei Formation in the south. Described below are the seven facies (Johnson et al., 2006 p463-465):

The massive diamictite facies comprises highly compacted diamictite that is clast-poor in the north. It was deposited in subaqueous or subglacial positions.
The stratified diamictite comprises alternating diamictite, mudrock, sandstone and conglomerate beds. They are interpreted as being rapidly deposited, sediment gravity flows but with some possible reworking of the subglacial diamictites.

The massive carbonate-rich diamictite facies is clast-poor and was formed by the rainout of debris, with the carbonate probably originating by crystallisation from interstitial waters.
The conglomerate facies ranges from single layer boulder beds to poorly sorted pebble and granule conglomerates. The boulder beds are interpreted as lodgement deposits whereas the poorly sorted conglomerates are a product of water-reworking of diamicton by high-density sediment gravity flows.
The sandstone facies were formed as turbidite deposits.
The mudrock with stones facies represents rainout deposits in the distal iceberg zone.
The **mudrock facies** consists of dark-coloured, commonly carbonaceous mudstone, shale or silty rhythmite that was formed when the mud or silt in suspension settled. This is the only fossiliferous facies of the Dwyka Group.

The Dwyka *Glossopteris* flora outcrops are very sporadic and rare. Of the seven facies that have been recognised in the Dwyka Group fossil plant fragments have only been recognised from the mudrock facies. They have been recorded from around Douglas only (Johnson et al., 2006; Anderson and McLachlan 1976) although the Dwyka Group exposures are very extensive.

Jurassic intrusive dolerite dykes, part of the main Drakensberg volcanic activity, have destroyed any fossils in their immediate vicinity.

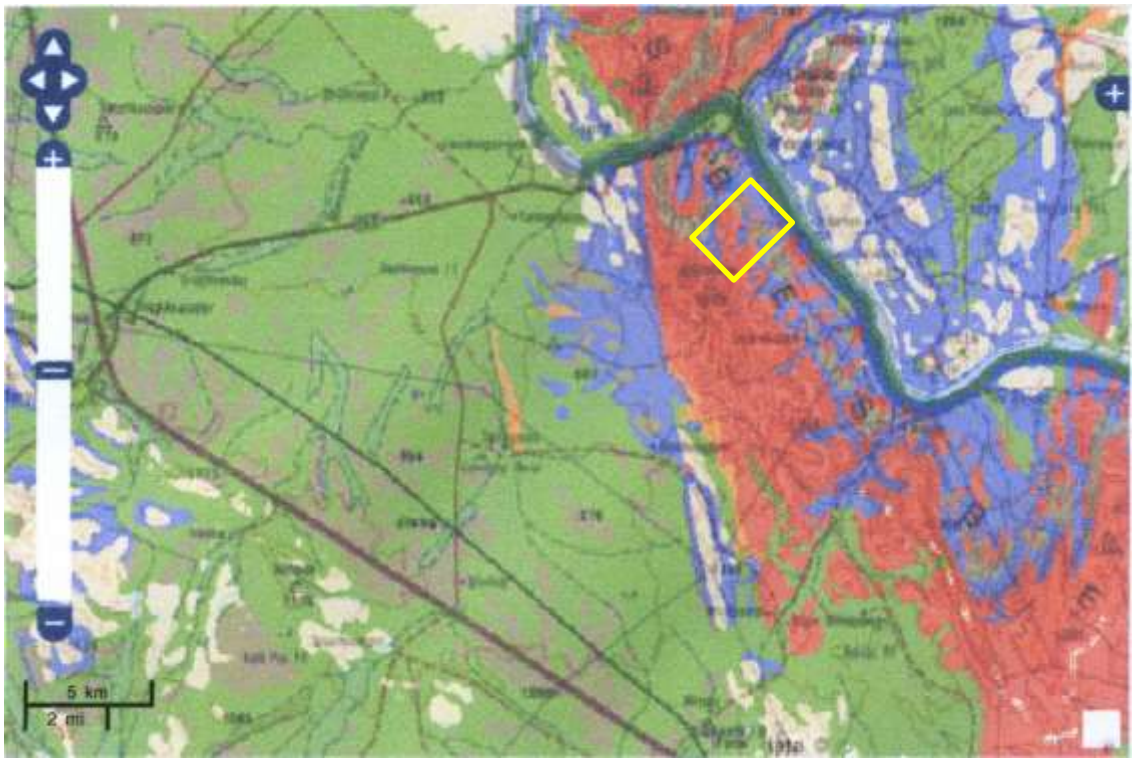


Figure 3: SAHRIS palaeosensitivity map for Rietfontein, adjacent to the Orange River, and the site for the proposed prospecting rights application is shown within the yellow

rectangle. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

From the SAHRIS map above the area is indicated as a mix of non-fossiliferous rocks with some palaeontologically highly sensitive rocks and the latter classification applies to the Dwyka Group outcrops. In the Karoo basin Dwyka outcrops are vast but they seldom preserve fossils becuase much of the sediment was deposited in deep water. Furthermore, the climate was very cold as it was covered in glacial ice for long periods, so there would have been minimal vegetation growth or none. The only terrestrial animal from the period was *Mesosaurus* (samples listed in Anderson and McLachlan, 1976). Aquatic fish and invertebrates were also rather rare. There are a few records of fossils from Dwyka deposits so for the exposures in the farm Rietfontein so there is a small chance of finding fossils.

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	The stromatolites are trace fossils and rarely preserve fossil algae; Dwyka tillites can preserve transported fossils; Kalahari sands do not preserve fossils; so far there are no records from this area so the impact would be very unlikely.
	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 trace fossils or fossil plant fragments from the *Glossopteris* flora in the mudstones, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	**-**
	L	It is unlikely that any fossils would be found in the ancient rocks but a very small chance that they occur in the Dwyka Group mudstones. Therefore a chance find protocol should be added to the eventual EMPr.

The geological structures suggest that the rocks are mostly too old or volcanic to contain fossils. Stromatolites (tracefossils) might occur in the Ghaap Group rocks. There is a small chance that the Dwyka Group mudstones could preserve fragment of the *Glossopteris* flora and invertebrates. Since there are potentially fossiliferous rocks in the vicinity a Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is extremely low.

5. Assumptions and uncertainties

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the lavas and dolerite dykes do not contain fossils but the dolomites, sandstones, mudstones shales and sands are typical for the country and could contain fossil plant, insect, invertebrate and very rarely vertebrate material in the Dwyka Group mudstones. The sands of the Quaternary period 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 sands of the Quaternary Kalahari or in the limestones and stromatolites of the Vryburg Formations or the Schmidtsdrif Subgroup. There is a very small chance that fossils may occur in the mudstones

of the Dwyka Group rocks so a Chance Find Protocol should be added to the EMPr: if fossils are found once prospecting has commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample. Prospecting may proceed as far as the palaeontology is concerned.

7. References

Anderson, A.M., McLachlan, I.R., 1976. The plant record in the Dwyka and Ecca Series (Permian) of the south-western half of the great Karoo Basin, South Africa. Palaeontologia africana 19, 31-42.

Brandl, G., Cloete, M., Anhauaeusser, C.R., 2006. Archaean Greenstone belts. 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 9-56.

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.

McLachlan, I.R., Anderson, A., 1973. A review of the evidence for marine conditions in southern Africa during Dwyka times. Palaeontologia africana 15(2), 37-64.

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 Bruiyn, 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.

Visser, J.N.J., 1986. Lateral lithofacies relationship sin the glacigene Dwyka Formationin the western and central parts of the Karoo Basin. Transactions of the Geological Society of South Africa 89, 373-383.

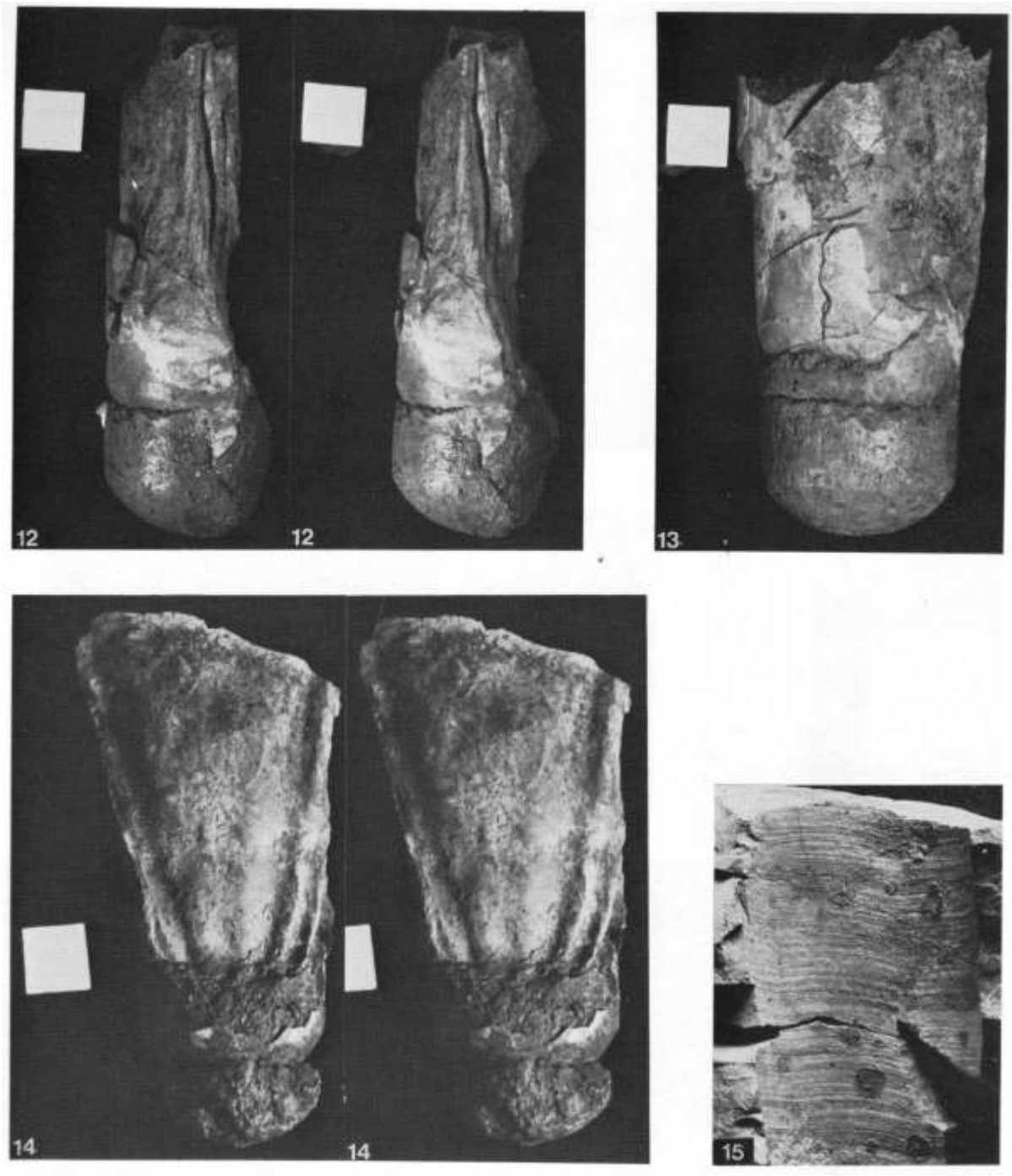
Visser, J.N.J., 1989. The Permo-Carboniferous Dwyka Formation of southern Africa: deposition by a predominantly subpolar marine icesheet. Palaeogeography, Palaeoclimatology, Palaeoecology 70, 377-391.

8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the prospecting begins.

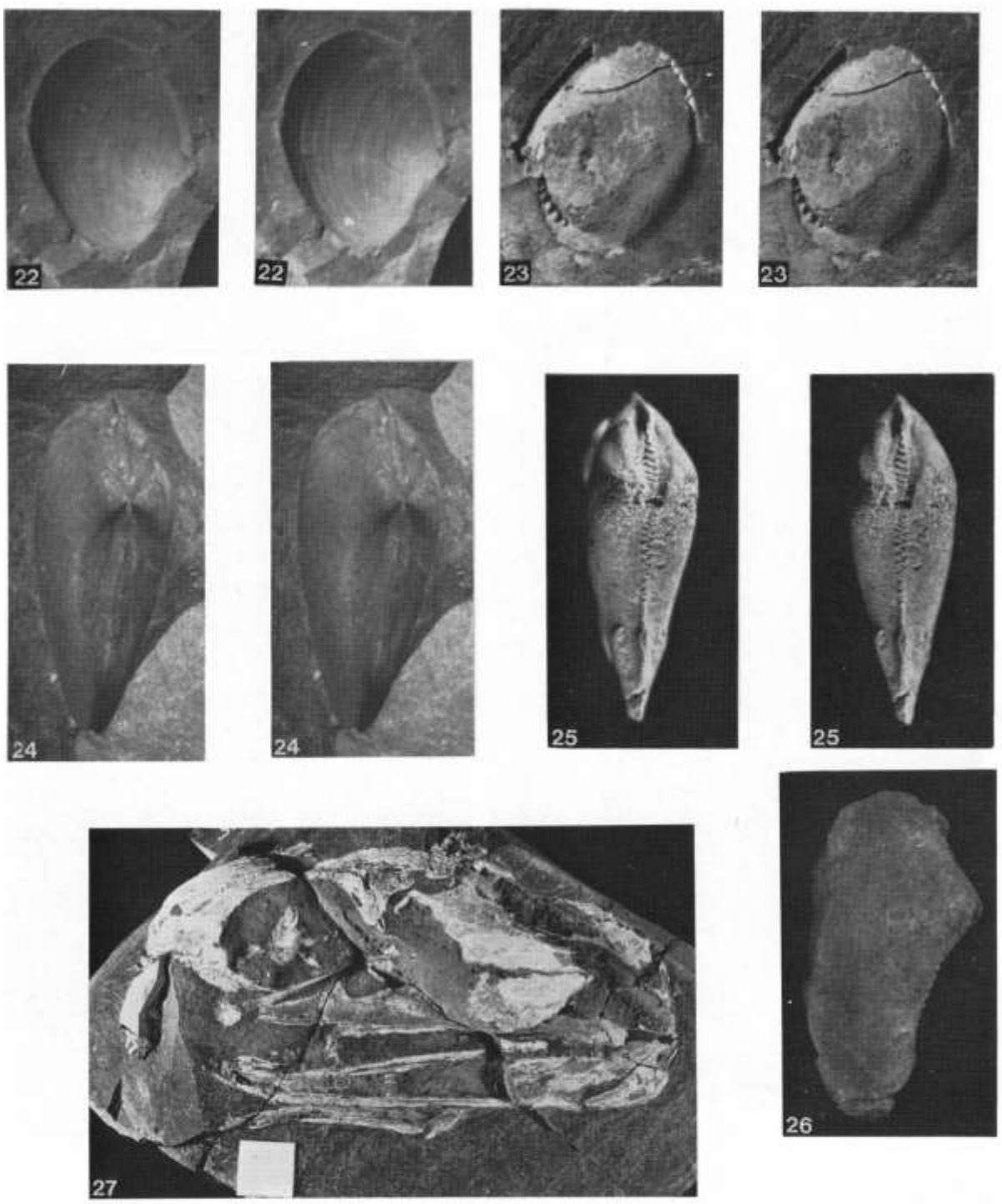
1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations/mining commence.
2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (shells, fish, plants, 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 fossils can be provided to the developer to assist in recognizing the various fossils in the shales and mudstones (for example see Figures 4-9). This information will be built into the EMP's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. If there is any possible fossil material found by the developer/environmental officer/miners then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
7. If no good fossil material is recovered then the site inspections by the palaeontologist will not be necessary. Annual reports by the palaeontologist must be sent to SAHRA.
8. If no fossils are found and the drilling or excavations have finished then no further monitoring is required.

Appendix A – Examples of invertebrate and plant fossils from the Dwyka deposits near Douglas. Figures from McLachlan and Anderson (1973), and Anderson and McLachlan (1976).



Orthocerid cephalopods—Blaauw Krantz
Figs. 12–14: Internal moulds of body chamber (x1).
Fig. 12—Lateral view I.3 (Stereopair x1).
Fig. 13—Dorsal view I.3 (x1).
Fig. 14—Ventral view I.3 (Stereopair x1).
Fig. 15: External mould, showing ornamentation I.4 (x2).

Figure 4: from Anderson and McLachlan (1973) showing invertebrates



Blaauw Krantz fauna
Figs. 22–26: Lamellibranchs (x5).
Fig. 22–*Nuculopsis* sp. External mould. Lateral view, I.39 (Stereopair).
Fig. 23–*Nuculopsis* sp. Internal mould. Lateral view, I.39 (Stereopair).
Fig. 24–*Phestia* sp. External mould. Dorsal surface I.38 (Stereopair).
Fig. 25–*Phestia* sp. Internal mould. Dorsal view I.38 (Stereopair).
Fig. 26–*Phestia* sp. Internal mould. Lateral view I.38.
Fig. 27: Palaeoniscoid fish skull in concretion. Lateral view P.15 (x1).

Figure 5: From Anderson and McLachlan (1973) showing more invertebrates

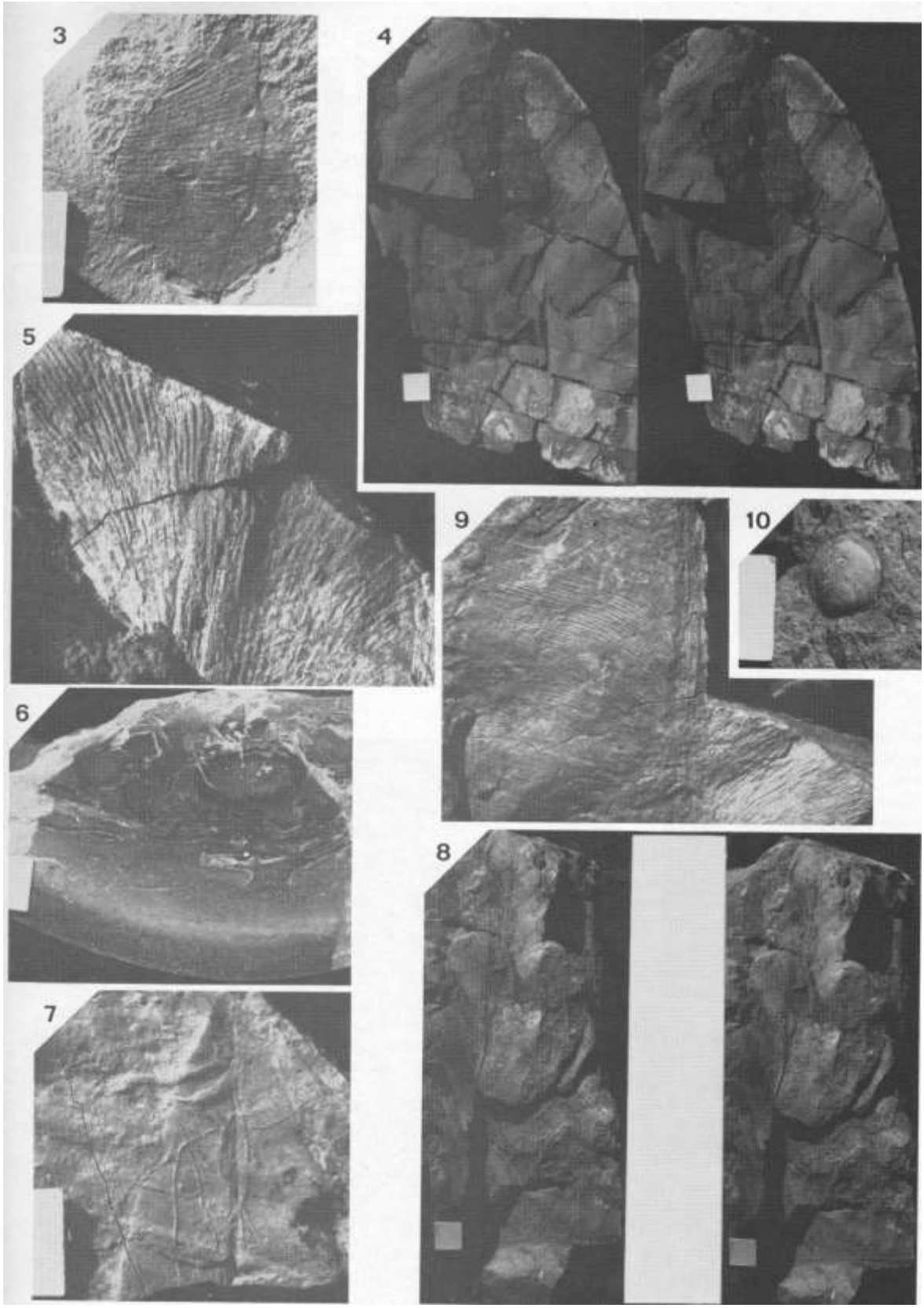


Figure 6: from McLachlan and Anderson (1976) – showing fragments of *Glossopteris* leaves. .

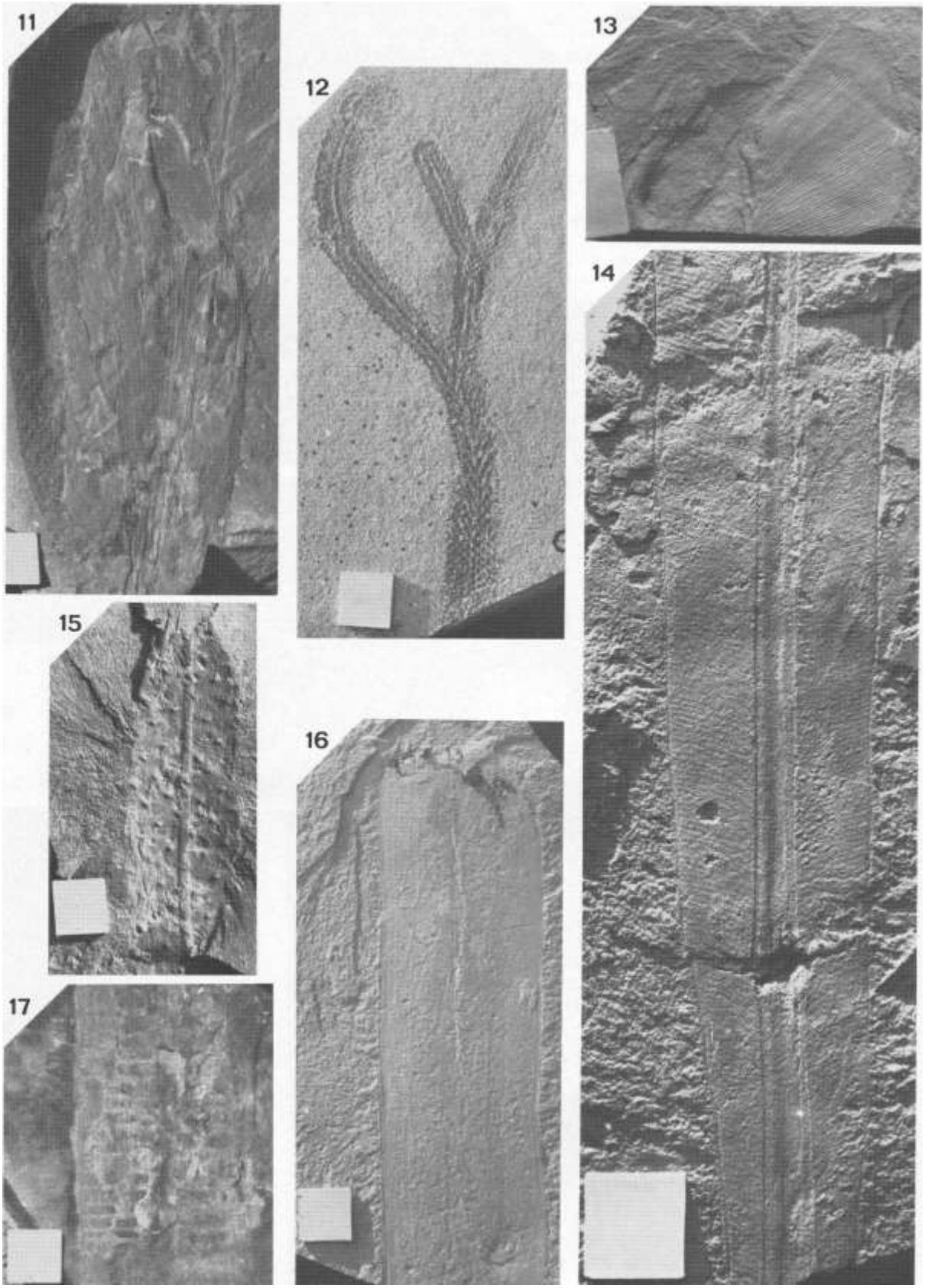


Figure 7: from McLachlan and Anderson (1976) – showing lycopod stems and other leaf impressions.

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	2
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
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xi) Research Output

Publications by M K Bamford up to January 2019 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)