

**Palaeontological Impact Assessment for the proposed
mining rights on Farm Kransfontein 19, Prieska,
Northern Cape Province**

Desktop Study

For

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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 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 mining prospecting on the Farm Kransfontein 19, Prieska area. The client is submitting a mining right application, along with the required environmental authorisation application. 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 development of a sand mining area.

The proposed farm lies on the sands of the Quaternary group and rocks of the Dwyka Group with underlying non-fossiliferous basement rocks. The Dwyka Group comprises seven facies of glacial diamictites, conglomerates, sands and mudrocks that were deposited in a marine basin. Only one of these facies, the mudrock facies, has preserved pollen, plant and fish fragments at a locality 50km away. No fossils have been recorded from here but since there is a very small chance of finding fossil plant fragments a Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no palaeontological site visit is required and a mining right be granted.

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1. Background

A Palaeontological Impact Assessment was requested for the mine prospecting rights on a portion of the remaining extent of the Farm Kransfontein 19 and portion 2 of the Farm Kransfontein, Prieska, Northern Cape. The area of interest is 4640 ha and the location is 29°17'12.85" S, 23°21'22.68" E, (Figure 1). The client is submitting a mining right application, along with the required environmental authorisation application. 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 development of a sand mining area. Other minor minerals may be mined in the same site.

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 Error! Reference source not found. 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	Section 8

authorisation	
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 site for the mine prospecting (red rectangle, lower left). Map supplied by E. 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

The area for the proposed mine prospecting is on the north bank of the Vaal River that cuts into overlying sands of the Quaternary. Exposed along the river are outcrops of Dwyka Group diamictites, mudstones and conglomerates of Late Carboniferous to early Permian (or Pennsylvanian - Cisuralian) age. The Dwyka Group (basal Karoo Supergroup) unconformable overlies glaciated Precambrian bedrock here in the northern basin.

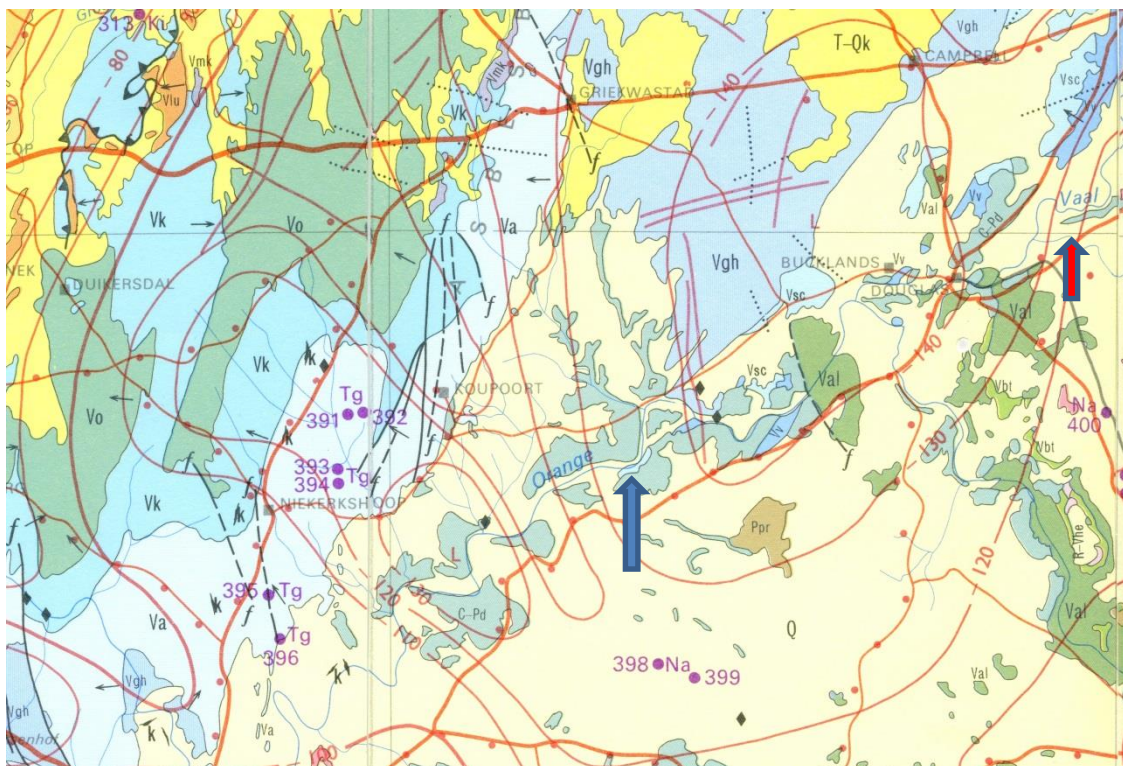


Figure 2: Geological map of the area along the Vaal River south west of Douglas. The location of the proposed project is indicated with the blue arrow. (The red arrow indicates the farm Blaauw Kranz where Dwyka fossils have been found). Abbreviations of the rock types are explained in Table 2. Map enlarged 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; McCarthy et al., 2006; Robb et al., 2006; van der Westhuizen et al., 2006). SG = Supergroup; Fm = Formation.

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary	Alluvium, sand, calcrete	ca 2.5 Ma to present
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Ppr	Prince Albert Fm, Ecca Group, Karoo Supergroup	Shales	Lower Permian, Middle Ecca
C-Pd	Dwyka Group, Karoo Supergroup	Tillite, sandstone, mudstones, shales	Upper Carboniferous
Vo	Ongeluk Fm, Postmasburg Group, Prieska Sub-Basin	Andesite	2420 Ma
Vk	Koegas Subgroup, Postmasburg Group, Prieska Sub-Basin	Mudstone, iron formation riebekilite	2222 Ma
Va	Asbestos Hills Subgroup, Ghaap Group, Prieska Sub-Basin	Iron formation, jaspilite	2500 - 2425 Ma
Vgh	Ghaap Group, Prieska Sub-Basin	Dolomite, lime-stone, shale	2642 – 2425 Ma
Vsc	Schmidtsdrift Subgroup, Ghaap Group, Prieska Sub-Basin	Dolomite, shale	2642 – 2620 Ma
Vbr	Black Reef Fm,	Quartzite, conglomerate, shale, basalt	Ca 2650 – 2640 Ma
Val	Allanridge Fm, Ventersdorp Supergroup	Andesite	Ca 2700 Ma

In the Prieska Sub-Basin this basement rock comprises a number of formations (Table 2) of quartzite, andesite, dolomite, shale and iron formation that range in age from about 2700 to 2430 Ma.

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.

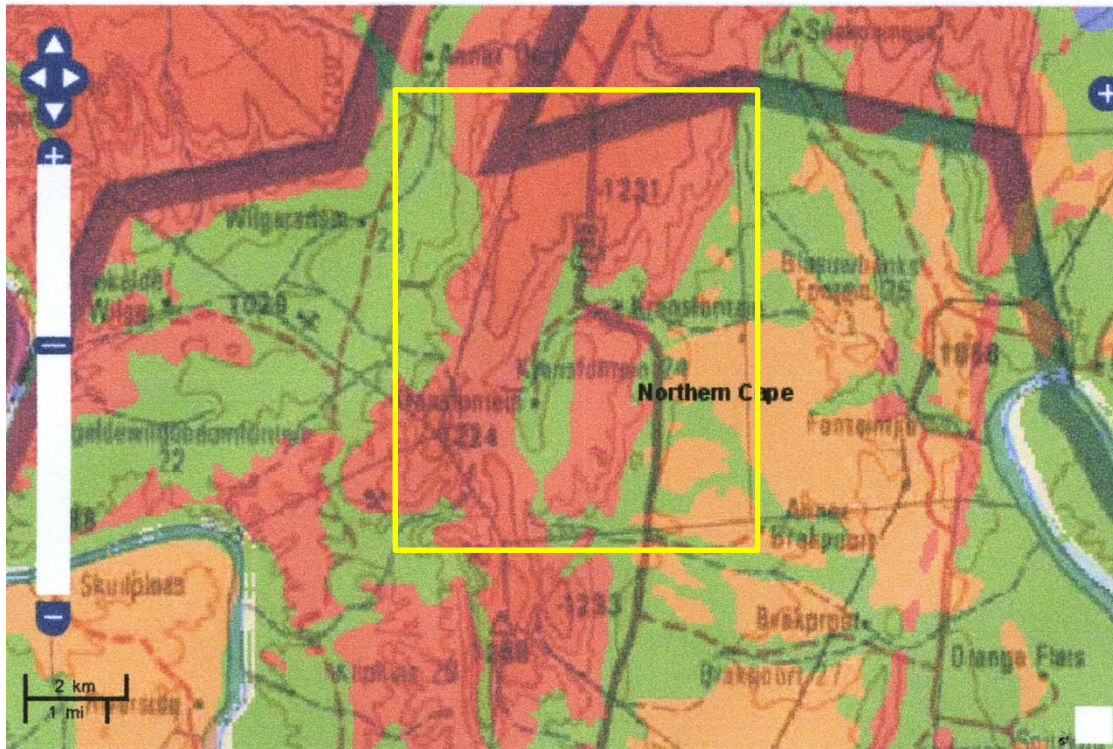


Figure 3: SAHRIS palaeosensitivity maps for the site for the proposed sand mine shown within the yellow rectangle. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 3. The basement rocks of the Ventersdorp Supergroup and the Ghaap and Postmasberg Groups are not fossiliferous as they are too old and mostly of the wrong type of rock. The only potentially fossiliferous rocks in the area are the Dwyka Group, and within this only one of the seven facies, namely the mudrock facies.

Fossils have been reported from the farm Blaauw Kranz along the Vaal River but just west of Douglas which is about 50km to the northwest of Kransfontein. Anderson and McLachlan

(1976) found spores, pollen and plant fragments that had likely been deposited in sediment fallout so would have been far from source, and arthropod trackways and fish tracks (Anderson, 1981) that would have been in situ. These are the reports to date of fossils in the northern Dwyka indicating that they are extremely rare, but not surprising as the sediments were deposited in subaqueous and glacial conditions.

From the SAHRIS map above the area is indicated as highly sensitive (red), moderately sensitive (orange) and requiring a desktop study (green). The Dwyka outcrops are the sensitive areas so there a chance of finding fossils during prospecting, but the chance is very small because the fossils of this age are so rare.

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	Loose sands of the Quaternary do not preserve plant fossils; Diamictites, shales and conglomerates of this age do not preserve fossils either; only the mudrock facies of the Dwyka Groups could potentially preserved fossil fragments. so far there are no records from here so it is very unlikely that fossils occur on the site. The impact would be very unlikely.
	L+	-

PART B: ASSESSMENT		
	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 fragments in the mudrock facies, 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 most of the Dwyka deposits, only a small chance in the mudstones so a chance find protocol should be added to the eventual EMPr.

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 either much too old to contain fossils. Only one of seven facies of the Dwyka Group could potentially contain transported fossil material. If this mudstone facies occurs in the project site there is an extremely small chance that fossils could be preserved. Therefore a Chance find protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is very 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 diamictites, dolomites, sandstones, shales, conglomerates and sands are typical for the country and do not contain fossil plant, insect, invertebrate and vertebrate material. Only the mudrock facies of the Dwyka Group could potentially contain ex site fossil material. 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 Dwyka Group diamictites but there is a very small chance that the mudrocks, if occurring there, could contain fossils. Since there is very small chance that fossils may occur, a Chance Find Protocol should be added to the mine prospecting plan: if fossils are found once mining has commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample.

7. References

- Anderson, A.M., 1981. The *Umfolozia* arthropod trackways in the Permian Dwyka and Ecca Series of South Africa. *Journal of Palaeontology* 55, 84-108.
- 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.
- 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.
- 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.
- 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.
- Visser, J.N.J., 1986. Lateral lithofacies relationship in the glaciogenic Dwyka Formation in 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 ice sheet. *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 or trenching commence.
2. When excavations begin the rocks must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (plants, wood, bone fragments) 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 4). 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 excavations have finished then no further monitoring is required.

Appendix A – examples of Dwyka fossils.

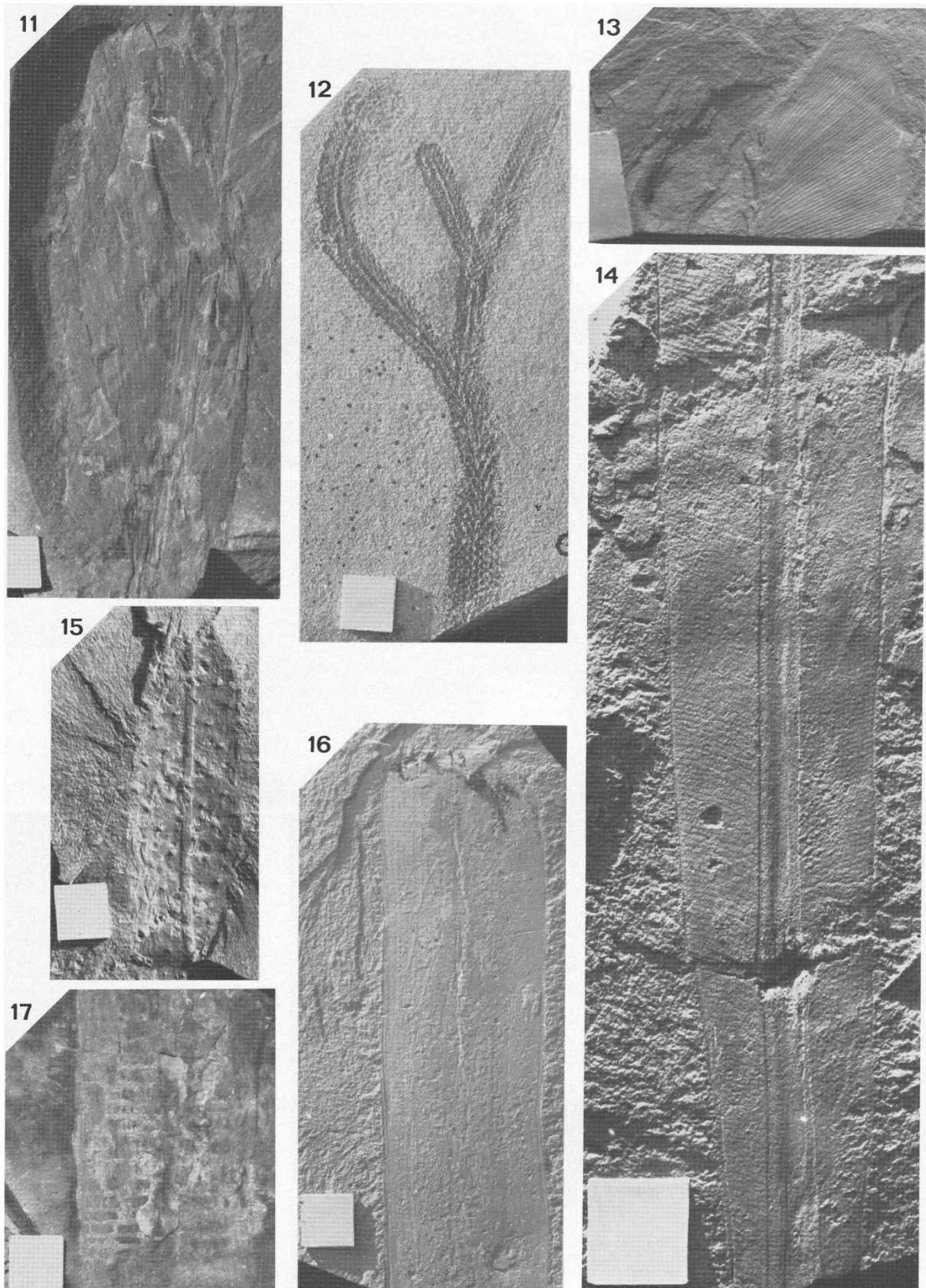


Figure 4 (from Anderson and McLachlan, 1976, plate 2). Examples of plant fragments that have been recovered from the Dwyka Group on the Farm Blaauwkranz, northeast of Douglas).

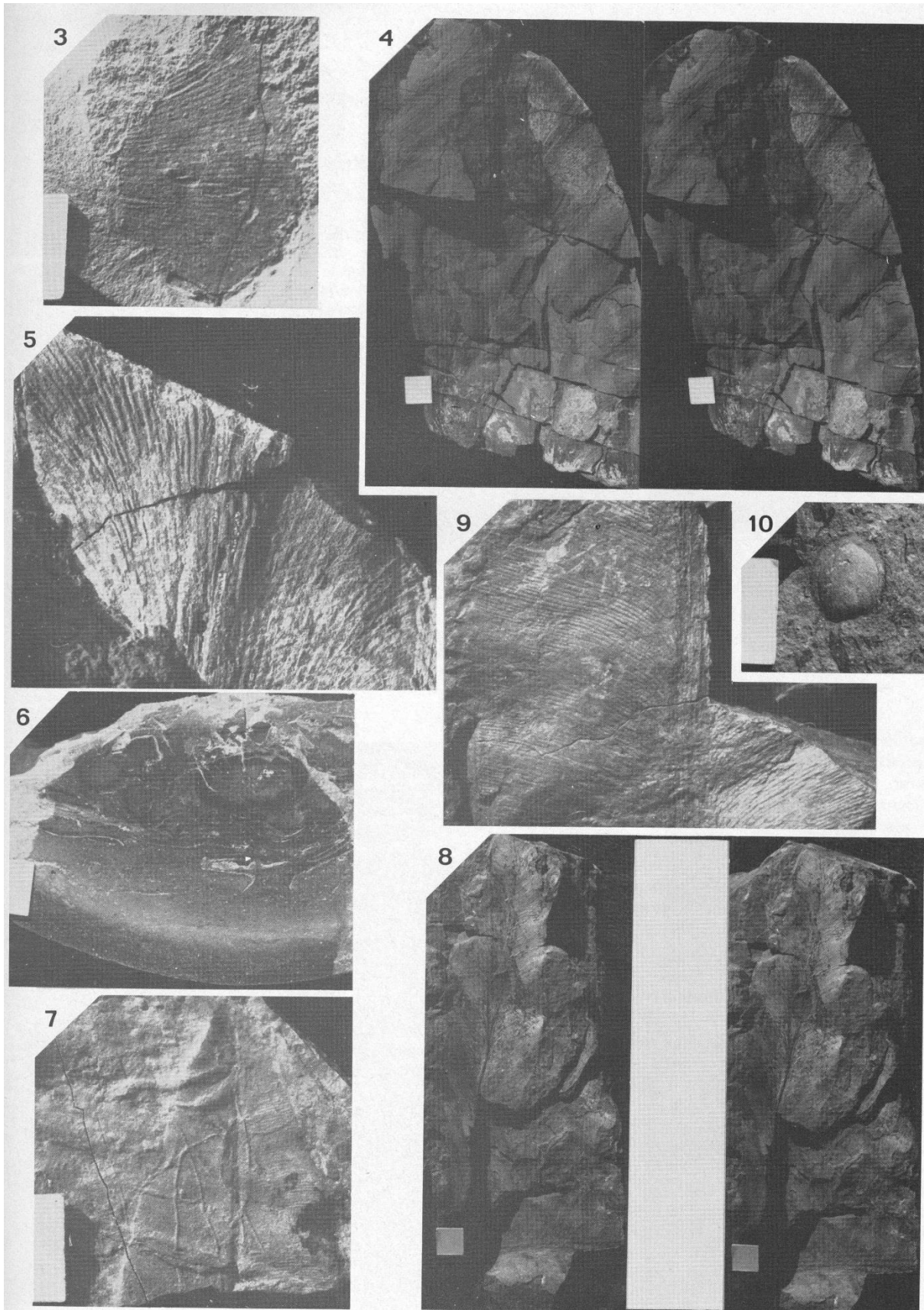


Figure 5 (from Anderson and McLachlan, 1976, plate 1). Examples of fossils from Farm Blaauw Kranz.

Curriculum vitae (short) - Marion Bamford PhD June 2018

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-
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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	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
-

xi) Research Output

Publications by M K Bamford up to June 2018 peer-reviewed journals or scholarly books: over 120 articles published; 5 submitted/in press; 8 book chapters.

Scopus h index = 26; Google scholar h index = 28;

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)