

**Palaeontological Impact Assessment for the
Matsopa Prospecting Rights Application on
Farms Geluk 237 and Goudlaagte 238,
Free State Province**

Desktop Study (Phase 1)

For

Beyond Heritage

06 January 2022

Prof Marion Bamford

Palaeobotanist

P Bag 652, WITS 2050

Johannesburg, South Africa

Marion.bamford@wits.ac.za

Expertise of Specialist

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, mASSAf
Experience: 33 years research and lecturing in Palaeontology
25 years PIA studies and over 300 projects completed

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Beyond Heritage, Modimolle, 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

A handwritten signature in blue ink, appearing to read 'MKBamford', written over a horizontal line.

Signature:

Executive Summary

A Palaeontological Impact Assessment was requested for the Prospecting Rights Application for clay depoists on Farms Geluk 237 and Goudlaagte 238, between Vredefort and Koppies, northern Free State Province.

To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development.

The proposed site lies on the shales of the Volksrust Formation (Ecca Group, Karoo Supergroup) that potentially could have fossils of the *Glossopteris* flora although these would be transported and small fragments. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no further palaeontological impact assessment is required unless fossils are found by the developer/ environmental officer/ other designated responsible person once drilling activities have commenced. As far as the palaeontology is concerned, the project should be authorised because the impact would be very low.

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1. Background

The client intends to prospect for clay on the farms Geluk 237 and Goudlaagte 238, northwest of Koppies, southeast of Vredefort, Free State Province (Figures 1, 2). The prospecting activities involve the drilling of approximately 330 holes to a depth of 30m. There will also be a small contractor's camp on site for the duration of the drilling programme. These activities require a Prospecting Rights Application (PRA), and as part of this a Paleontological Impact Assessment (PIA).

A PIA was requested for the Matsopa PRA process in order to comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA). A desktop PIA was completed for the proposed development and is reported herein.

Table 1: National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and Environmental Impact Assessment (EIA) Regulations, 2014 (as amended) - Requirements for Specialist Reports (Appendix 6).

| | A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain: | Relevant section in report |
|-----|---|-----------------------------------|
| ai | Details of the specialist who prepared the report, | Appendix B |
| aii | The expertise of that person to compile a specialist report including a curriculum vitae | Appendix B |
| b | A declaration that the person is independent in a form as may be specified by the competent authority | Page 1 |
| c | An indication of the scope of, and the purpose for which, the report was prepared | Section 1 |
| ci | An indication of the quality and age of the base data used for the specialist report: SAHRIS palaeosensitivity map accessed – date of this report | Yes |
| cii | A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change | Section 5 |
| d | The date and season of the site investigation and the relevance of the season to the outcome of the assessment | N/A |
| e | A description of the methodology adopted in preparing the report or carrying out the specialised process | Section 2 |
| f | The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure | Section 4 |
| g | An identification of any areas to be avoided, including buffers | N/A |

| | A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain: | Relevant section in report |
|-----|--|-----------------------------------|
| h | A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers; | N/A |
| i | A description of any assumptions made and any uncertainties or gaps in knowledge; | Section 5 |
| j | A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment | Section 4 |
| k | Any mitigation measures for inclusion in the EMPr | Section 8, Appendix A |
| l | Any conditions for inclusion in the environmental authorisation | N/A |
| m | Any monitoring requirements for inclusion in the EMPr or environmental authorisation | Section 8, Appendix A |
| ni | A reasoned opinion as to whether the proposed activity or portions thereof should be authorised | Section 6 |
| nii | If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan | Sections 6, 8 |
| o | A description of any consultation process that was undertaken during the course of carrying out the study | N/A |
| p | A summary and copies of any comments that were received during any consultation process | N/A |
| q | Any other information requested by the competent authority. | N/A |
| 2 | Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply. | N/A |



Figure 1: Google Earth map of the general area to show the relative land marks. The Matsopa PRA site is shown by the pink rectangles.



Figure 2: Google Earth map of the proposed PRA area and boreholes for the Matsopa project with the sections shown by the red outlines and borehole locations. Map supplied by Beyond Heritage.

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

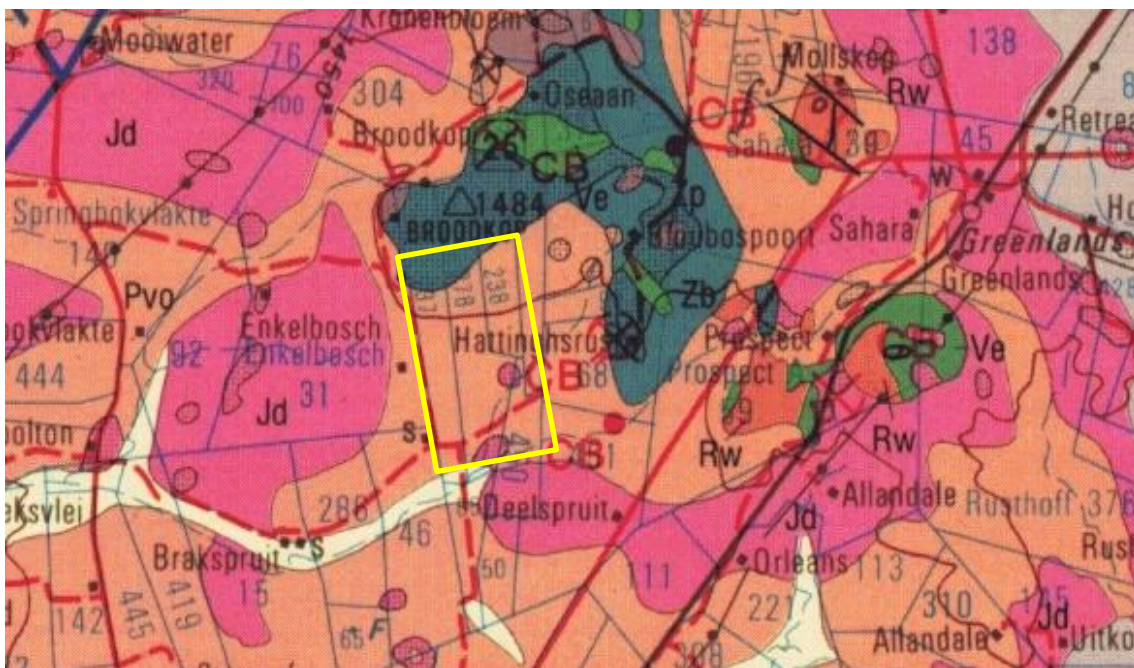


Figure 3: Geological map of the area around the Farms Geluk 237 and Goudlaagte 238 with the proposed project indicated within the yellow rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2726 Kroonstad.

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

| Symbol | Group/Formation | Lithology | Approximate Age |
|--------|------------------------------------|--------------------------------------|-------------------------------|
| Q | Quaternary | Alluvium, sand, calcrete | Neogene, ca 2.5 Ma to present |
| Jd | Jurassic dykes | Dolerite dykes, intrusive | Jurassic, approx. 180 Ma |
| Pvo | Volksrust Fm, Ecca Group, Karoo SG | mudstone, siltstone, shale | Early Permian, later Ecca |
| Pv | Vryheid Fm, Ecca Group, Karoo SG | Shales, sandstone, siltstone | Early Permian, Middle Ecca |
| Zb | Blaauwboschpunt Schist | Amphibole schist, amphibolite | Archaean |
| Zi | Inlandsee Gneiss | Quartz-feldspar gneiss | Archaean |
| Zs | Steynskraal Metamorphic Suite | Amphibolite, hypersthene gneiss, etc | Archaean Ca 3400 Ma |

The project lies in the north central part of the Karoo Basin where the Volksrust Formation is well exposed (Figure 3, Table 2). The Karoo sediments were deposited on an uneven basement of ancient rocks and in this area some of the Archaean granites and gneisses have a higher topography and so are exposed. The Steynskraal Metamorphic suite for example, comprises ancient igneous rocks that have been metamorphosed. There were no invertebrates, vertebrates nor plants present at 3 400 million years ago, just some microorganisms but they occurred in warm, shallow seas (Plumstead, 1969). Since these rocks are too old and of the wrong type there is no chance that they have any fossils at all.

The Karoo Supergroup rocks cover a very large proportion of South Africa and represent some 120 million years (300 – 183Ma). These sedimentary rocks have preserved a diversity of fossil plants, insects, vertebrates and invertebrates.

During the Carboniferous Period South Africa was part of the huge continental landmass known as Gondwanaland and it was positioned over the South Pole. As a result, there were several ice sheets that formed and melted, leaving fine-grained sediments in the large inland sea. These are the oldest rocks in the system and are exposed around the outer part of the ancient Karoo Basin, and are known as the Dwyka Group. They comprise tillites, diamictites, mudstones, siltstones and sandstones that were deposited as the basin filled (Johnson et al., 2006).

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

Associated with the massive basalt eruptions that formed the Drakensberg Group, which cap the Karoo Supergroup sediments and signalled the end of those cycles of

deposition, there were numerous intrusive dolerite sills and dykes through the Karoo sediments (Johnson et al., 2006). These volcanic rocks do not preserve any fossils, and in fact tended to destroy any fossils in the immediate vicinity. Dolerite dykes for the more resistant hills and ridges that are familiar today in the Karoo Basin. They are of Jurassic age.

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 4. The site for development is in the Volksrust Formation that is indicated a highly sensitive for palaeontology (orange). The Archaean rocks and Jurassic dolerite have no fossils and are indicated as grey.

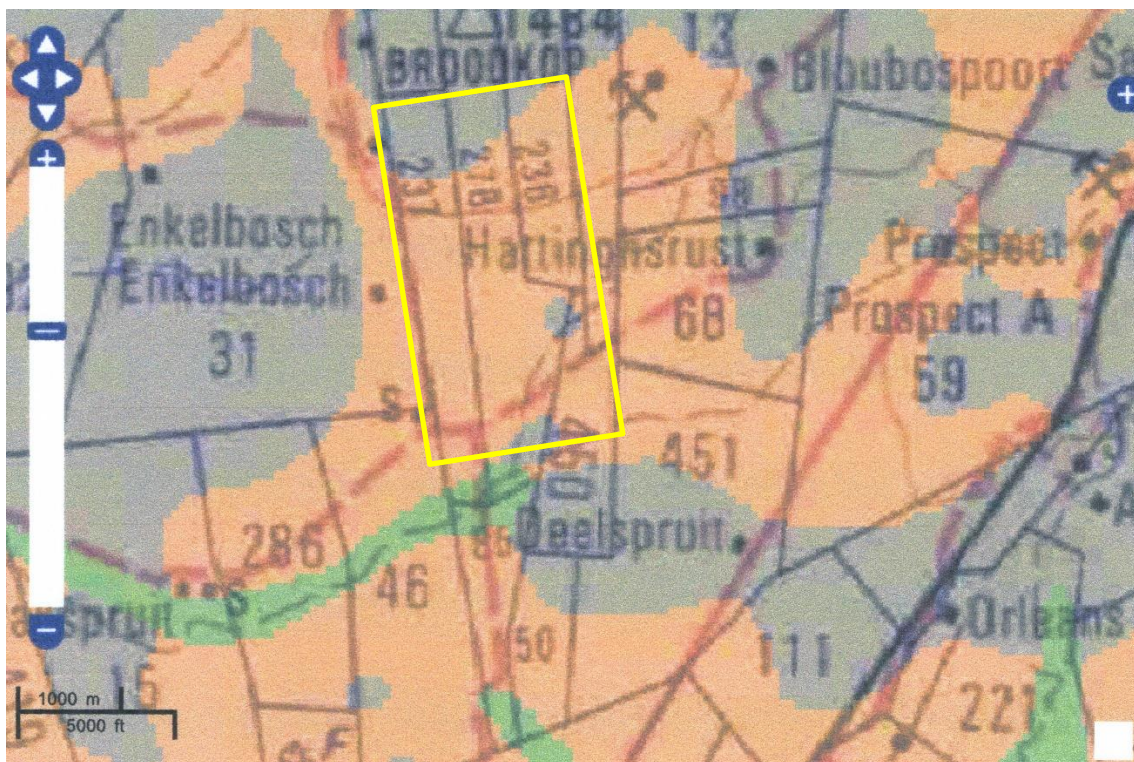


Figure 4: SAHRIS palaeosensitivity map for the site for the proposed Matsopa PRA shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

The Volksrust Formation is the upper part of the Ecca Group and is predominantly argillaceous and the grey to black silty shale with thin, usually with bioturbated siltstone or sandstone lenses and beds that occur mostly in the upper and lower boundaries. The very thick and fin-grained sediments represent an open shelf environment where muds were deposited from suspension with (Johnson et al., 2006) in a deepwater environment. It is not known if this was an inland sea or open marine setting but the discovery of the marine bivalve, *Megadesmus*, (albeit one instance) about 25km west southwest of

Newcastle in Volksrust Formation shales, points to a marine influence for at least part of the sequence (Cairncross et al., 2005).

The *Glossopteris* flora was present around the Karoo Basin during the time of the Volksrust Formation but as these are shallow to deepwater sediments, the terrestrial flora was very rarely incorporated into the sediments. Occasionally leaf fragments have been caught in mudflows (own obs.).

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 | Dolerites do not preserve fossils; so far there are no records from the Volksrust Fm of plant or animal fossils in this region so it is very unlikely that fossils occur on the site. The impact would be negligible |
| | L+ | - |
| | M+ | - |
| | H+ | - |
| | DURATION | L |
| M | | - |
| H | | Where manifest, the impact will be permanent. |
| SPATIAL SCALE | L | Since the only possible fossils within the area would be small fragments of fossil leaves in the shales, the spatial scale will be localised within the site boundary. |
| | M | - |
| | H | - |
| PROBABILITY | H | - |
| | M | - |
| | L | It is extremely unlikely that any fossils would be found in the loose soils and sands that cover the area or in the Volksrust Fm shales that will be drilled. Nonetheless, a Fossil 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 or represent deepwater facies. Since there is an extremely small chance that fossils from the Volsrust Formation may be disturbed a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is 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 not contain fossil plant, insect, invertebrate and vertebrate material. The overlying soils and sands of the Quaternary period would not preserve fossils. Archaean and Jurassic igneous rocks do not have any 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 Volksrust Formation. There is a very small chance that fragmentary and transported fossils may occur in the shales of the Permian Volksrust Formation so a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the contractor, environmental officer or other responsible person once drilling has commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample. The impact on the palaeontological heritage would be very low so as far as the palaeontology is concerned the project should be authorised

7. References

Anhaeusser, C.R., 2006. Ultramafic and Mafic Intrusions and the Kaapvaal Craton. 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 95-134.

Cairncross, B., Beukes, N.J., Coetzee, L.L., Rehfeld, U., 2005. The bivalve *Megadesmus* from the Permian Volksrust Shale Formation (Karoo Supergroup), northeastern Karoo Basin, South Africa: implications for late Permian Basin development. South African Journal of Geology 108, 547-556.

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.

8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations / drilling activities begin.

1. The following procedure is only required if fossils are seen on the surface and when drilling/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 project activities will not be interrupted.
3. Photographs of similar fossils must be provided to the developer to assist in recognizing the fossil plants, vertebrates, invertebrates or trace fossils in the shales and mudstones (for example see Figures 5, 6). 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 contractor/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 no site inspections by the palaeontologist will be necessary. A final report by the palaeontologist must be sent to SAHRA once the project has been completed and only if there are fossils.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

9. Appendix A – Examples of fossils from the Volksrust Formation

B. CAIRNCROSS, N.J. BEUKES, L.L. COETZEE AND U. REHFELD

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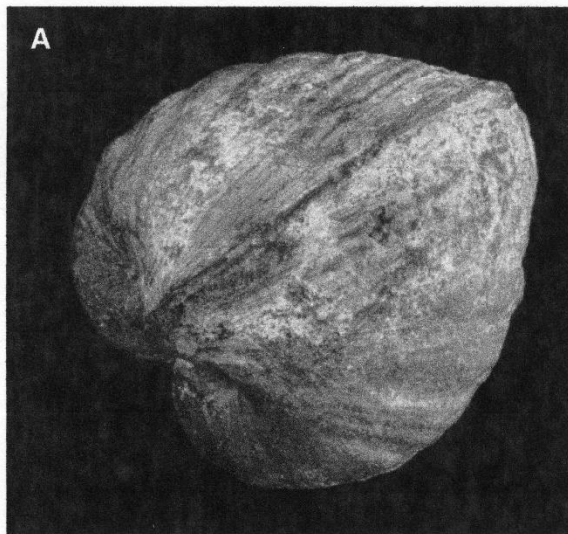


Figure 11. (A). Dorsal view of the *Megadesmus* bivalve. The fossil is 9 cm dorsal to ventral, and 8.4 cm lateral. See text for taxonomic details.

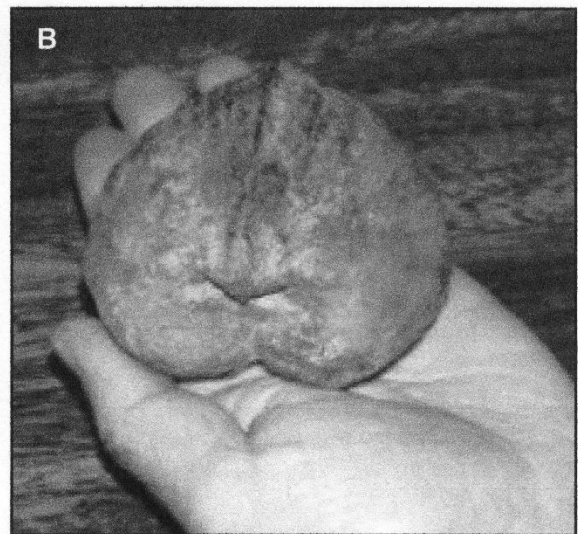


Figure 11. (B). Close-up of the anterior, dorsal section of the bivalve.

Figure 5: Photograph of the unique fossil bivalve *Megadesmus* (from Cairncross et al., 2005).



Figure 6: Photograph of a complete leaf of *Glossopteris*. (length 15cm).

10. Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD **January 2022**

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.
NRF Rating: C-2 (1999-2004); B-3 (2005-2015); B-2 (2016-2020); B-1 (2021-2026)

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 | 13 | 0 |
| Masters | 11 | 3 |
| PhD | 11 | 6 |
| Postdoctoral fellows | 15 | 1 |

viii) Undergraduate teaching

Geology II – Palaeobotany GEOL2008 – average 65 students per year
Biology III – Palaeobotany APES3029 – average 45 students per year
Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology;
Micropalaeontology – average 12-20 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 –
Associate Editor *Open Science UK*: 2021 -
Review of manuscripts for ISI-listed journals: 30 local and international journals
Reviewing of funding applications for NRF, PAST, NWO, SIDA, National Geographic,
Leakey Foundation

x) Palaeontological Impact Assessments

Selected from the past five years only – list not complete:

- Mala Mala 2017 for Henwood
- Modimolle 2017 for Green Vision
- Klippoortjie and Finaalspan 2017 for Delta BEC
- Ledjadja borrow pits 2018 for Digby Wells
- Lungile poultry farm 2018 for CTS
- Olienhout Dam 2018 for JP Celliers
- Isondlo and Kwasobabili 2018 for GCS
- Kanakies Gypsum 2018 for Cabanga
- Nababeep Copper mine 2018
- Glencore-Mbali pipeline 2018 for Digby Wells
- Remhoogte PR 2019 for A&HAS
- Bospoort Agriculture 2019 for Kudzala
- Overlooked Quarry 2019 for Cabanga
- Richards Bay Powerline 2019 for NGT
- Eilandia dam 2019 for ACO
- Eastlands Residential 2019 for HCAC
- Fairview MR 2019 for Cabanga
- Graspan project 2019 for HCAC
- Lielifontein N&D 2019 for EnviroPro
- Skeerpoort Farm Mast 2020 for HCAC

- Vulindlela Eco village 2020 for 1World
- KwaZamakhule Township 2020 for Kudzala
- Sunset Copper 2020 for Digby Wells
- McCarthy-Salene 2020 for Prescali
- VLNR Lodge 2020 for HCAC
- Madadeni mixed use 2020 for EnviroPro
- Frankfort-Windfield Eskom Powerline 2020 for 1World
- Beaufort West PV Facility 2021 for ACO Associates
- Copper Sunset MR 2021 for Digby Wells
- Sannaspos PV facility 2021 for CTS Heritage
- Smithfield-Rouxville-Zastron PL 2021 for TheroServe

xi) Research Output

Publications by M K Bamford up to January 2022 peer-reviewed journals or scholarly books: over 160 articles published; 5 submitted/in press; 10 book chapters.

Scopus h-index = 30; Google scholar h-index = 35; -i10-index = 92

Conferences: numerous presentations at local and international conferences.