# Palaeontological Impact Assessment for the proposed construction of Northdale pump station, Maidstone, KwaZulu Natal Province

**Desktop Study**

**For**

**EnviroPro**

**10 April 2020**

**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 EnviroPro, Kloof, 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 proposed construction of a pump station at Northdale, Maidstone, north of Durban, to replace the existing sewer system.

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.

The site lies on the deep to shallow water shales of the Pietermaritzburg Formation (Ecca Group, Karoo Supergroup). Only very rarely are plant fragments found in these sediments, or microbioturbated shoreline facies of invertebrate burrows. Furthermore, the area is covered with soils that have been disturbed for agriculture and urban development. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. As far as the palaeontology is concerned the project may proceed.

# Table of Contents

# 1. Background

The construction of a new Northdale Pump Station and Rising Main to replace the existing sewer infrastructure has been proposed. The project is in Maidstone north of Durban.

A Palaeontological Impact Assessment was requested for the project. 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 and is presented herein.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (2017)

| | **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 |
| 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 | 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 | Appendix A |
| ni | A reasoned opinion as to whether the proposed activity or portions thereof should be authorised | N/A |
| 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 | N/A |
| 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 if any comments that were received during any consultation process | N/A |
| q | Any other information requested by the competent authority. | N/A |


Figure 1: Google Earth map of the proposed replacement of the existing sewer system, new pump station and rising main at Northdale, (white lines). Map supplied by EnviroPro.

# 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

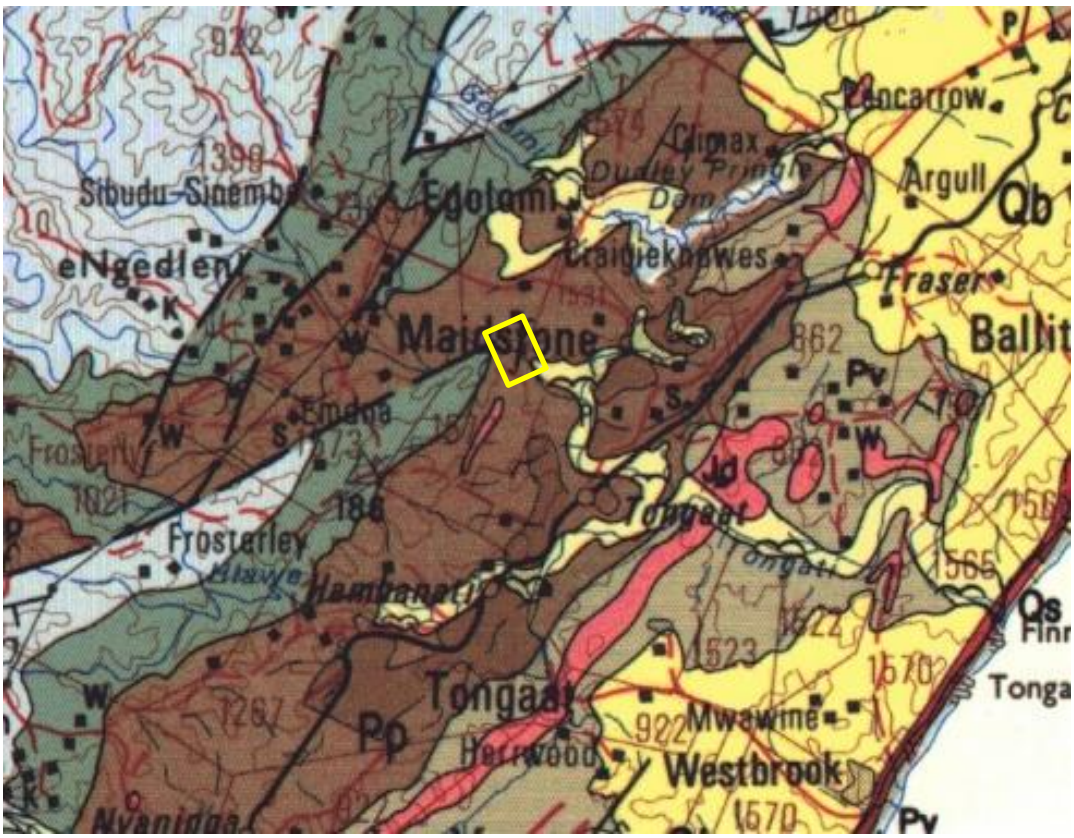


Figure 2: Geological map of the area around Maidstone. The location of the proposed project is indicated within the blue rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2930 Durban.

Table 2: Explanation of symbols for the geological map and approximate ages (Johnson et al., 2006; McCarthy et al., 2006; Porat and Botha, 2008; Botha, 2018). SG = Supergroup; Fm = Formation; Ma = million years; shading = formations impacted by the project.

| Symbol | Group/Formation | Lithology | Approximate Age |
|---|---|---|---|
| Qb | Berea type sands in the Umkwelane Fm, Uloa Subgroup, Maputaland Group | Alluvium, sand, calcrete | Mid Miocene to Pliocene |
| Jd | Jurassic dykes | Dolerite dykes, intrusive | Jurassic, approx. 180 Ma |
| Pv | Vryheid Fm, Ecca Group, Karoo SG | Shales, sandstone, coal | Lower Permian, Middle Ecca |
| Pp | Pietermaritzburg Fm, Ecca Group, Karoo SG | Blue-grey shales | Lower Permian, Early Ecca |
| C-Pd | Dwyka Group, Karoo SG | Tillites, diamictites, mudstones | Late Carboniferous to Early Permian |

The project site is in the eastern part of the Main Karoo Basin. The exposed rocks are those of the basal-most Late Carboniferous to Early Permian Dwyka Group tillites, diamictites and mudstones, the overlying Pietermaritzburg Formation shales, followed by the Vryheid Formation shales, siltstones, sandstones and coal seams. Dolerite dykes of Jurassic age have intruded through the Karoo sequence. Gondwanaland and South Africa in particular were covered by ice sheets during the Carboniferous Period because they were positioned over the South Pole. As the continent moved northwards the ice sheet melted and the deposited diamictites and tillites are known as the Dwyka Group rocks (Visser, 1986; Johnson et al., 2006). The meltwaters from the ice sheets filled up the large inland sea in the Karoo Basin during the early Permian. The fine-grained blue-grey shales that form the basal infill are known as the Pietermaritzburg Formation in the eastern part of the Karoo Basin (or the Collingham and Whitehill Formations in the western part of the basin). These shales represent shallow to deep water lacustrine deposits. As the climate warmed dense vegetation covered the lake margins, rivers and deltas. In some areas peats formed and were eventually buried and altered by increasing pressure and temperatures, ultimately forming the shales and coals of the Vryheid Formation (Plumstead, 1969; Anderson and Anderson, 1985).

The Karoo rocks are unconformably overlain by the much younger Berea-type sands of the Maputaland Group, Quaternary age. In older references and the AMAFA Palaeotechnical Report for KwaZulu Natal (Groenewald, 2012) the term Berea Formation is used but the lithostratigraphy has been updated after detailed mapping and OSL dating (Botha and Porat, 2007). The current scheme shows that “Berea-type sands” form a lower part of the Umkwelane Formation, Uloa Subgroup, Maputaland Group and have been dated at mid Miocene to Pliocene (Botha, 2018).

## ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 3. The site lies on the shales of the Pietermaritzburg Formation (Ecca Group, Karoo Supergroup). These sediments only very rarely preserve fossil pant fragments that have been transported from the land and deposited. In the shoreline there are rare trace fossils of invertebrate burrows, but theses have been microbioturbated (Johnson et al, 2006) so their structures are unrecognisable. The much more fossiliferous shales of the Vryheid formation are not within the project footprint. According to the SAHRIS palaeosensitivity map (Figure 3) the site is indicated as moderately sensitive (green), however it is in a dully developed urban area so the soils have been disturbed. Soils do not preserve fossils because they are naturally weathered sediments that have been vegetated.

Jurassic Dolerite dykes are volcanic in origin and do not preserve any fossils. They intruded through the Karoo Basin sediments at about the same time as the massive Drakensberg Basaltic outpourings, and destroyed any fossils in their immediate vicinity.


Figure 3: SAHRIS palaeosensitivity map for the site for the proposed Northdale pump station and rising Main, shown as the black lines. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

From the SAHRIS maps the proposed site is indicated as moderately sensitive (green). This sensitivity applies to Pietermaritzburg shales but they very rarely preserve fossils of plant fragments or vertebrate burrows. There are no vertebrate fossils from this formation.

# 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** | Soils do not preserve plant fossils. The Pietermaritzburg Fm shales very rarely preserve fossil plant fragments or bioturbated shoreline facies. 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 fragmented fossils from the Pietermaritzburg Fm, the spatial scale will be localised within the site boundary. |

| PART B: ASSESSMENT | | |
|---|---|---|
| | **M** | - |
| | **H** | - |
| **PROBABILITY** | **H** | **-** |
| | **M** | **-** |
| | **L** | It is unlikely that any fossils would be found in the soils or in the deepwater shales of the Pietermartitzburg Fm. Nonetheless, a Fossil Chance Find protocol should be added to the eventual EMPr. |

Based on the nature of the project, surface activities will not impact upon the fossil heritage if preserved in the development footprint, because soils are very weathered sediments and do not preserve fossils. Since there is a small chance that there might be fragments of plant fossils or invertebrate burrows in the Pietermaritzburg Formation and 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 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 deep and shallow water shales and sands are typical for the country and might contain transported fossil plant fragments or microbioturbated shoreline facies in the Pietermaritzburg Formation. The whole area, however, is covered in soils that have been ploughed for agriculture or excavated for urban development. Soils and dolerite do not preserve fossils. It is unknown if there are fossils below ground.

# 6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is very unlikely that any fossils would be preserved in the soils of the Pieermaritzburg Formation (Ecca Group Group). Since there is a small chance that fossil fragments could be found below the surface, only to be revealed once excavations begin, a Fossil Chance Find Protocol should be added to the EMPr: if recognisable 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.

Botha, G.A., 2018. Lithostratigraphy of the late Cenozoic Maputaland Group. South African Journal of Geology 121, 95-108.

Groenewald, G. 2012. Palaeontological Technical Report for KwaZulu Natal. Report for Heritage KwaZulu Natal. AMAFA. 61pp.

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.

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

# 8. Chance Find Protocol

**Monitoring Programme for Palaeontology – to commence once the excavations for foundations, roads and amenities begin.**

1. The following procedure is only required if fossils are seen on the surface and when 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, 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 1.5). 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 no site inspections by the palaeontologist will not 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.

## Appendix A – Examples of fossils from the Pietermaritzburg and Vryheid Formations in the Main Karoo Basin

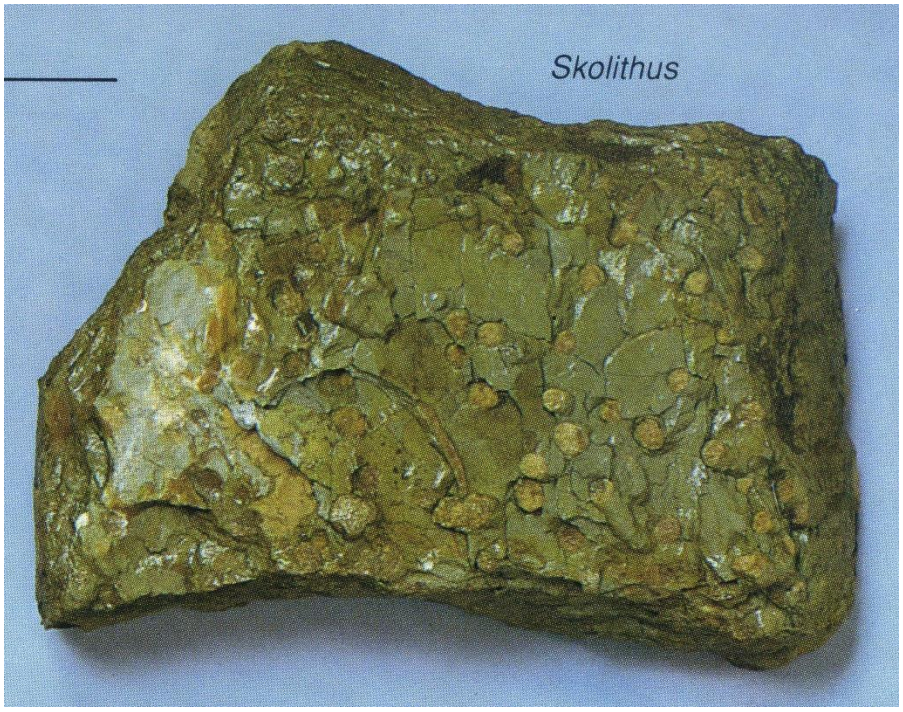


Figure 4: Example of some shallow marine or lacustrine trace fossils of invertebrate burrows.

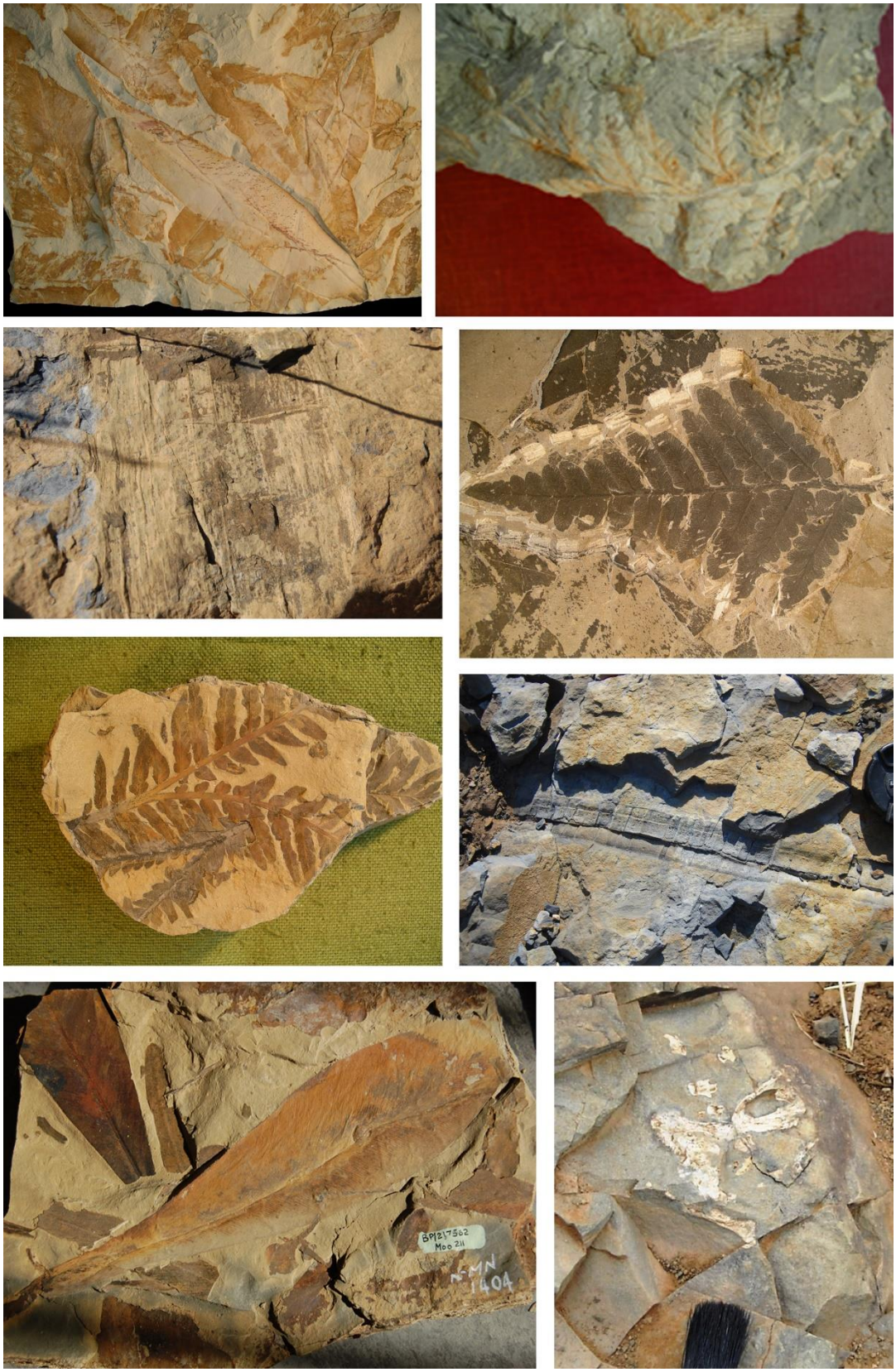


Figure 5: Photographs of fossils from the Vryheid Formation

## Appendix B – Details of specialist

# Curriculum vitae (short) - Marion Bamford PhD
# January 2020

### 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 | 7 | 0 |
| Masters | 10 | 4 |
| PhD | 12 | 5 |
| Postdoctoral fellows | 10 | 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 –
Journal of African Earth Sciences: 2020 -

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
- 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
- Lieliefontein N&D 2019 for Enviropro
-

## xi) Research Output

Publications by M K Bamford up to December 2019 peer-reviewed journals or scholarly books: over 140 articles published; 5 submitted/in press; 8 book chapters.
Scopus h-index = 27; Google scholar h-index = 32; -i10-index = 80
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)