# Palaeontological Impact Assessment for the proposed residential development on 57A North Beach Road, Westbrook, KwaZulu Natal Province

**Desktop Study (Phase 1)**

**For**

**Confluence Environmental**

**09 June 2021**

**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, ASSAf
Experience: 32 years research; 24 years PIA studies

# Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Confluence Environmental, 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 residential development “House du Plessis” for Siebren du Plessis on the vacant property 57A North Beach Road, Westbrook, KwaZulu Natal.

In order to comply with 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 potentially very highly sensitive rocks of the Vryheid Formation (Ecca Group, Karoo Supergroup) that could preserve fossils of the *Glossopteris* flora. The site however, is close to the beach with destructive sea, windblown sand and natural vegetation. Furthermore, this location is in the extreme eastern extent of the main Karoo Basin and would have been below the sea during the Early Permian and such conditions are not conducive to the growth of terrestrial plants. For these reasons, it is extremely unlikely that any fossils occur in the project footprint. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. Based on the information it is recommended that no palaeontological site visit is required unless fossils are revealed once excavations for foundations and amenities have commenced.

# Table of Contents

# 1. Background

The property owner, Mr Siebren du Plessis, is proposing to develop the property on 57A North Beach Road, Westbrook, KwaZulu Natal. The project, "House du Plessis" will be a residential development comprising a home, garages and cottage. The site is vacant but is thickly vegetated with coastal bush and there already are buildings and infrastructure adjacent to this property along the North Beach Road (Figure 1). Therefore, the site is disturbed.

A Palaeontological Impact Assessment was requested for the House du Plessis project because it lies on potentially very highly sensitive rocks. 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 and is presented herein.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (amended 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 | Section 6, 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 7, 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 development of House du Plessis on 57A North Beach Road, Westbrook, shown by the red outline. Map supplied by Confluence.

# 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

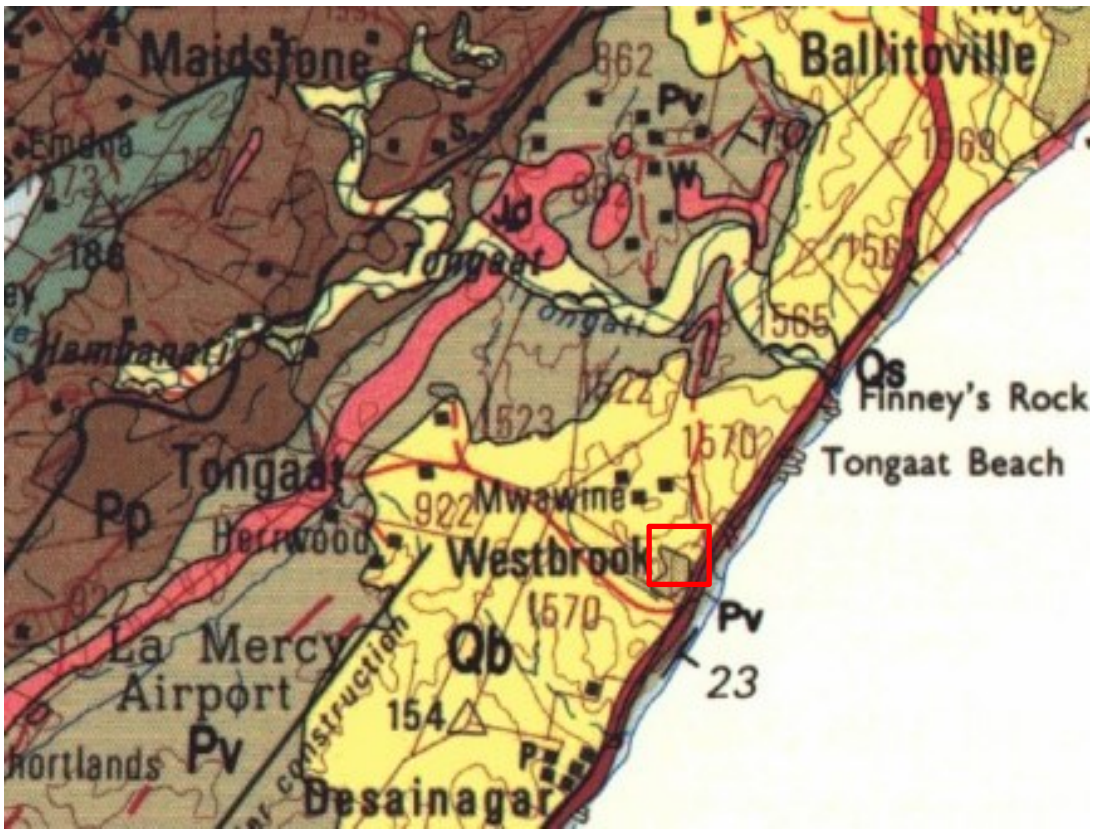


Figure 2: Geological map of the area around Westbrook on the KwaZulu Natal north coast. The location of the proposed project is indicated within the red rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2930 Durban.

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

| Symbol | Group/Formation | Lithology | Approximate Age |
|---|---|---|---|
| Qb | (Berea Fm) Umkwelane Fm, Uloa Subgroup, Maputaland Group | Red sand, subordinate other sands | Middle Miocene to Pliocene Ca 10 – 2.5 Ma |
| Qbl | (Bluff Fm) Umkwelane Fm, Uloa Subgroup, Maputaland Group | Calcarenite, highly calcareous sandstone | Middle Miocene to Pliocene Ca 10 – 2.5 Ma |
| Jd | Jurassic dykes | Dolerite dykes, intrusive | Jurassic, approx. 180 Ma |
| Pv | Vryheid Fm, Ecca Group, Karoo SG | Shales, sandstone, coal | Early Permian, Middle Ecca |
| Pp | Pietermaritzburg Fm, Ecca Group, Karoo SG | Dark grey shales, siltstone, sandstone | Early Permian, Early Ecca |

The site is on the sandstones and shales of the Vryheid Formation in the eastern-most extent of the Main Karoo Basin. It is overlain by much younger sands of the Maputaland Group.

Meltwaters from the Carboniferous glacial ice sheets filled in the Main Karoo Basin, forming an ancient inland sea. Sediments from the surrounding highlands then gradually filled in the basin, and as the continent of Gondwana moved northwards and away from its position over the South Pole, vegetation became established around the margins and deltas. These are known as the Karoo Supergroup rocks. Dwyka Group diamictites, tillites and mudstones form the basal strata and are overlain by the Ecca Group mudstones, siltstones and shales. This group is divided into the Pietermaritzburg, Vryheid and Normandien Formations in the eastern part of the basin. As the climate continued to warm up and dried out, the Beaufort Group sediments were deposited, topped by the Stormberg Group and finally capped by the Drakensberg basalts. All these sediments represent about 120 million years of earth history (300 – 180 Ma).

Much more recently, the Maputaland Group sands and calcarenites were deposited along the coast. More detailed mapping and dating techniques have resulted in the stratigraphy of this group being revised, and the older names are given in brackets because they are used in the geological map. An overview of the various terms used and the newer terms have been collated by Botha (2018).

Much younger Maputaland Group sands cover much of the coastal surface. The aeolianites of the Umkwelane Formation are part of the early Miocene marine transgression that was followed by epeirogenic uplift, then a eustatic marine regression, starting in the middle Miocene (Botha, 2018). This marine regression deposited littoral marine sediments on the marine planed coastal platform that had incised across the entire range of rock types that were exposed along the eastern seaboard of southern Africa (ibid). As these sands were stabilised they have been covered by dense coastal thicket and forest so the root mats have penetrated the sands, formed soils and further stabilised the coastal sediments.

ii. Palaeontological context

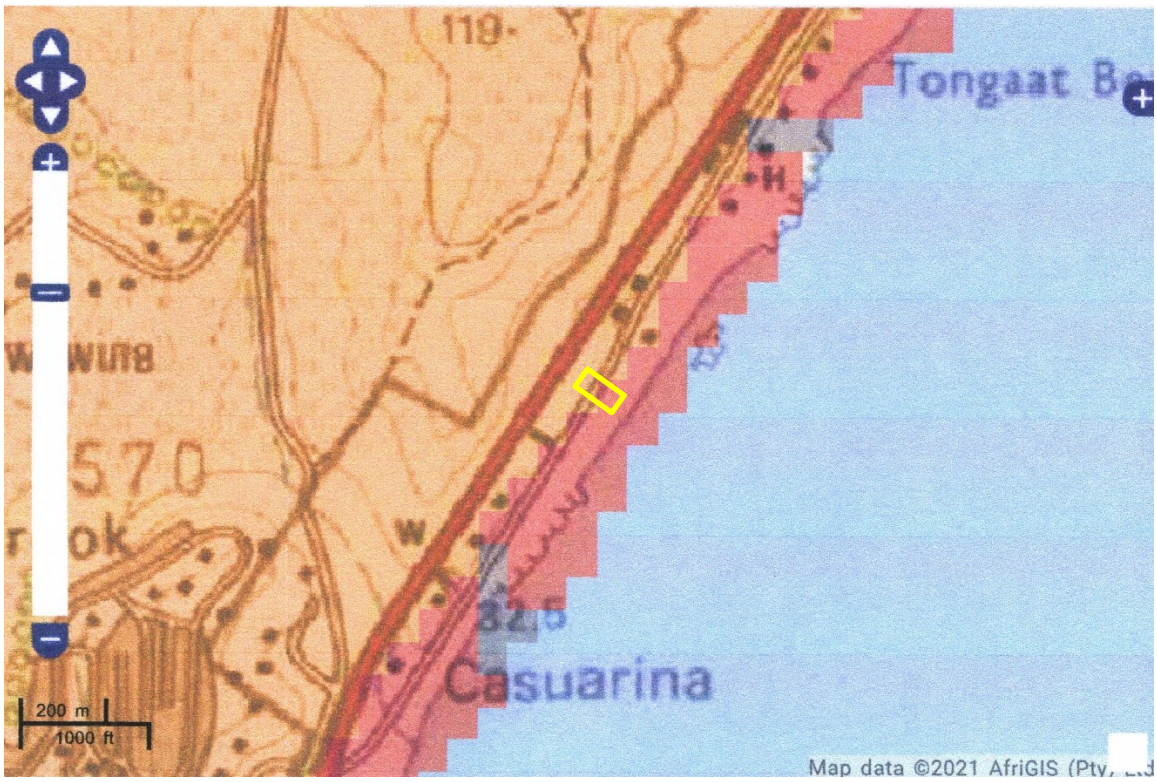


Figure 3: SAHRIS palaeosensitivity map for the site of the proposed House du Plessis shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

From the SAHRIS map above the area is indicated as very highly sensitive (red) so an impact assessment is required.

# 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** | Sands and soils do not preserve any fossils; so far there are no records from the Vryheid formation of plant or animal fossils in this region so it is very unlikely that fossils occur on the site. 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 fossil plants from the *Glossopteris* flora 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 sand and soils that are heavily vegetated. The site is in the extreme eastern extent of the Karoo Basin and would have been affected by the ancient sea and by the present sea and wave action. 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 the correct age and type to preserve fossil plant impressions of the *Glossopteris* flora in the Vryheid Formation. However, four factors count against this possibility. First, the position is on the extreme eastern margin of the current landmass but during the early Permian the future KZN coastline was below water in the Karoo or Ecca Sea and so no plants grew there (Figure 4; Cadle et al., 1993; McCarthy and Rubidge, 2005). When the super-continent of Gondwana broke apart and Africa separated from Antarctica, starting around Triassic to Jurassic times 140 Ma (McCarthy and Rubidge, 2005; Ashwal, 2019) it was a protracted and

violent activity. This breakup has been described as having a rifting stage, wrench stage, active transform margin phase and finally a thermal subsidence phase from 92–0 Ma (Baby et al., 2018). Second, the Pliocene uplift and erosion concomitant with sea-level changes (Maud and Botha, 2000), will have further eroded and affected the coastal rocks, especially softer shales that might have had fossils. Third, the present day natural vegetation that has stabilised the sediments with deep penetrating and acid-producing roots, has broken down the layers and strata. Finally, urban activities and amenities along the coast have affected the integrity of the strata.

Therefore, it is extremely unlikely that any Vryheid Formation fossil plants were present in the first place or could have remained, nonetheless, 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.

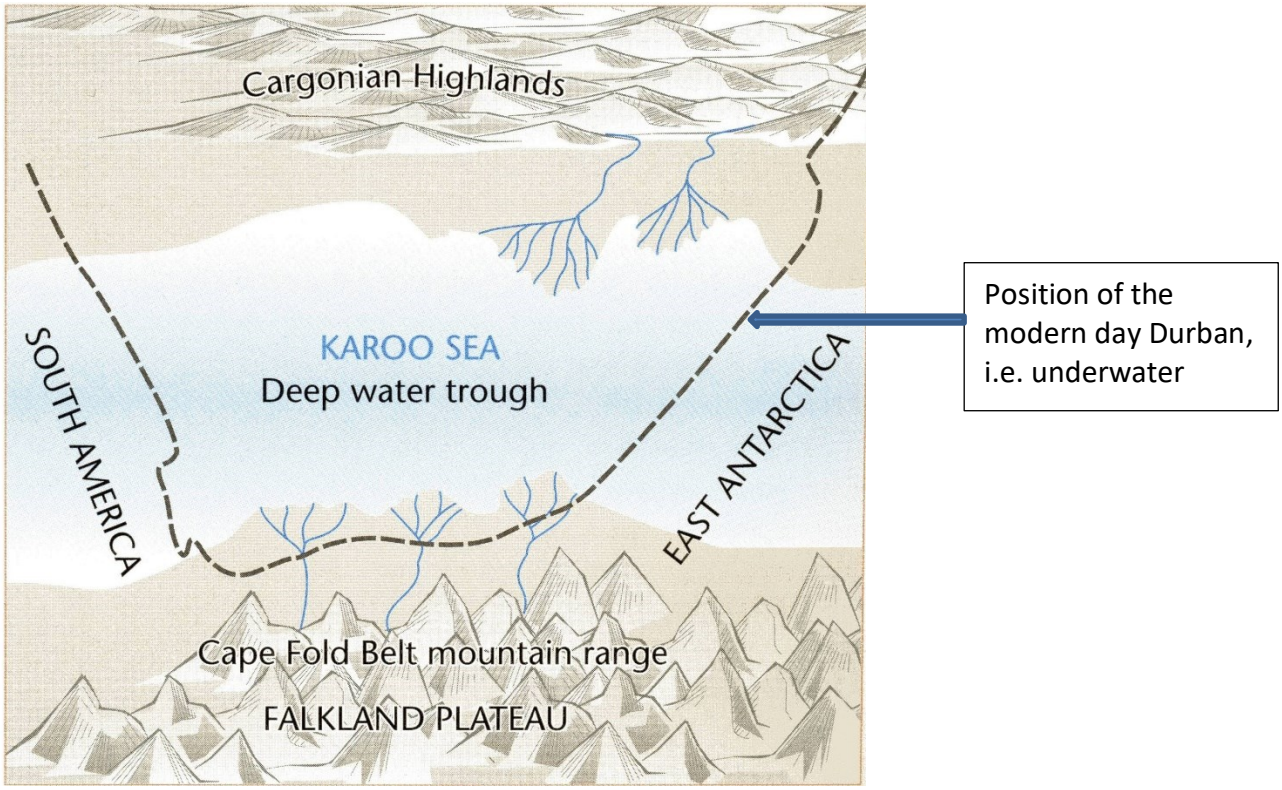


Figure 4: Diagram to show the extent of the Karoo Sea during the early Permian (Ecca) times when the Vryheid Formation was deposited. From McCarthy and Rubidge, 2005, fig 7.21)

# 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 sandstones, shales and sands are typical for the country and could potentially preserve fossil plant, insect and invertebrate in some parts of the basin. It is unlikely that the Vryheid Formation strata in the Durban and coastal areas

would have terrestrial fossils because this region was under water (Figure 4). The soils and 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 of the *Glossopteris* flora would be preserved in the small outcrop of Vryheid Formation (Ecca Group, Karoo Supergroup) in this narrow coastal setting because at the time of its deposition the area was underwater in the Karoo Sea. Very few vertebrates had evolved by this time and fist were rare. In addition, the area has undergone rifting and wrenching during the breakup of the super continent Gondwana, and uplift, erosion and changing sea levels during the Pliocene. Present day natural vegetation has further disturbed the strata. Nonetheless, there is a very small chance that fossils may occur in the below ground shales of the early Permian Vryheid Formation so a Fossil Chance Find Protocol should be added to the EMPr: if fossils are found once excavations for foundations 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.

Ashwal, L.D., 2019. The 35th Alex Du Toit Memorial Lecture for 2018: Wandering continents of the Indian Ocean. South African Journal of Geology 122, 397-420.

Baby, G., Guillocheau, F., Boulogne, C., Robin, C., Dall'Asta, M., 2018. Uplift history of a transform continental margin revealed by the stratigraphic record: The case of the Agulhas transform margin along the Southern African Plateau. Tectonophysics 731-732, 104-130.

Cadle, A.B., Cairncross, B., Christie, A.D.M., Roberts, D.L., 1993. The Karoo basin of South Africa: the type basin for the coal bearing deposits of southern Africa. International Journal of Coal Geology 23, 117-157.

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

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.

Maud, R.R., Botha, G.A., 2000. Deposits of the south eastern and southern coasts. In:

Partridge, T.C., Maud, R.R. (Eds.). The Cenozoic of Southern Africa. Oxford University Press, New York, pp. 19–32.

McCarthy, T., Rubidge, B., 2005. The History of Earth and Life. A southern African perspective on a 4.6-billion-year journey. Struik Publishers, Cape Town, 333 pp.

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 Figure 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 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 Vryheid Formation farther inland

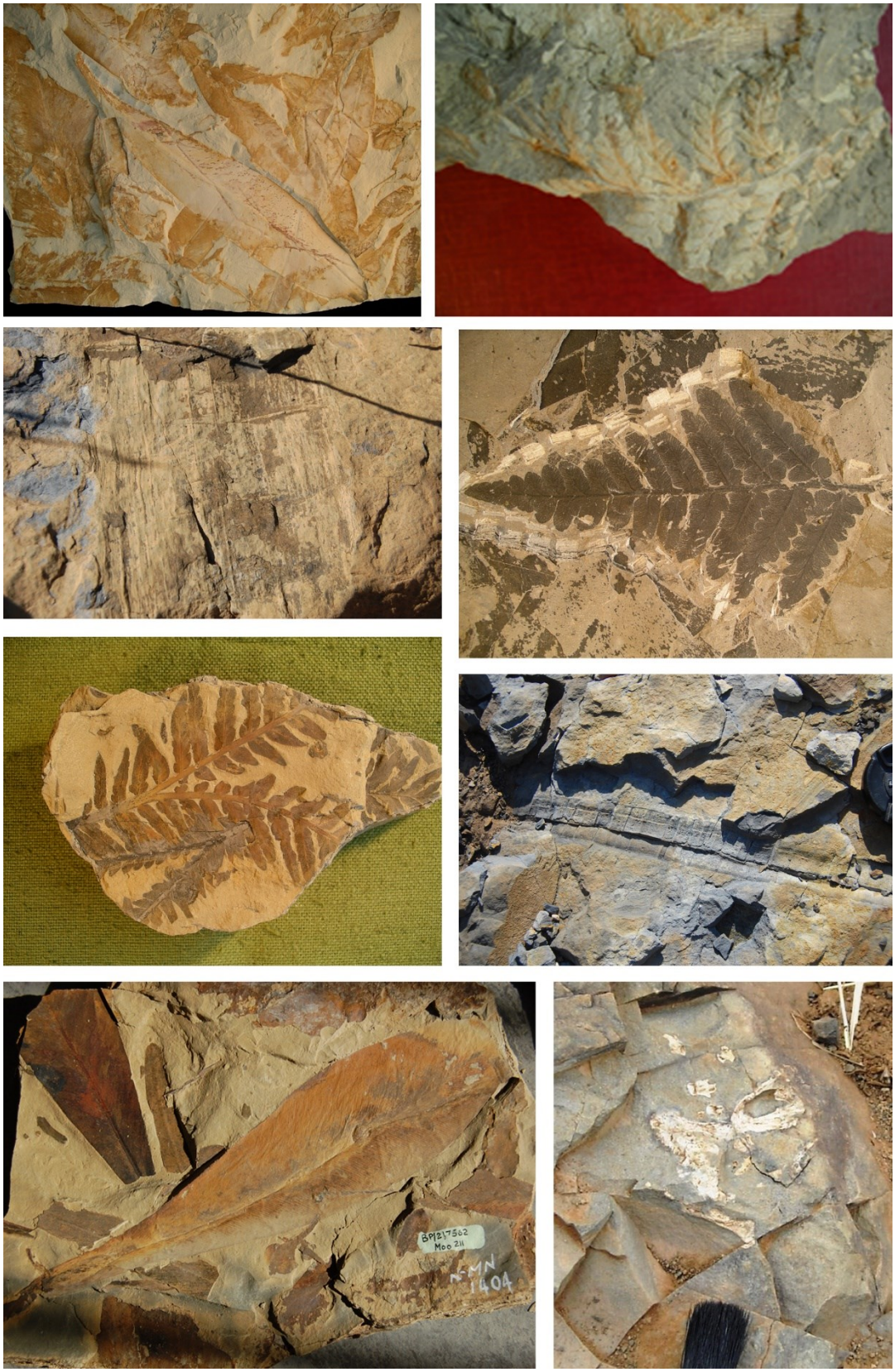


Figure 5: A selection of fossil plant impressions from the *Glossopteris* flora from the Vryheid Formation near Johannesburg. Bottom right shows fossil bones in situ from the lower Beaufort Group.

## Appendix B – Details of specialist

# Curriculum vitae (short) - Marion Bamford PhD
# January 2021

### 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 | 11 | 0 |
| Masters | 10 | 4 |
| PhD | 11 | 4 |
| Postdoctoral fellows | 10 | 5 |

**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 –

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
- 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

**xi) Research Output**

Publications by M K Bamford up to December 2019 peer-reviewed journals or scholarly books: over 150 articles published; 5 submitted/in press; 10 book chapters.
Scopus h-index = 29; Google scholar h-index = 35; -i10-index = 92
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)