Palaeontological Impact Assessment for the proposed development of a gravel quarry on Farm Sydenham 445, south of Bloemfontein, Free State Province

Site Visit/ Phase 2 Study

For

Heritage Contracts and Archaeological Consulting

11 December 2020

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Expertise of Specialist

The Palaeontologist Consultant is: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 31 years research; 23 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Heritage Contracts and Archaeological Consulting, 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

Signature: 

Executive Summary

A palaeontological Impact Assessment was requested for the proposed development of a gravel quarry on Farm Sydenham 445, south of Bloemfontein. 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 Phase 2 (site visit) Palaeontological Impact Assessment (PIA) was completed for the proposed project area.

The proposed site lies on the dolerites of the Jurassic extrusions and siltstones and fine grained sandstones of the Adelaide Subgroup (Beaufort Group, Karoo Supergroup). The latter could preserve vertebrates such as therapsids or reptiles. From the site visit survey there are NO fossils visible at the quarry. The site is very disturbed from previous quarrying activities and from dumping of rock and rubble. The existing rock profiles did not reveal any fossils and dolerite (non-fossiliferous) is pervasive.

Since there is a small chance that fossils could be discovered once quarrying activities commence, a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no palaeontological site visit is required unless the geologist or responsible person discovers fossils.

Table of Contents

1. Background

Kenrau (Pty) Ltd & Dolly Kenney Foundation Trust (hereafter referred to as the applicant) applied for a mining permit for the mining of gravel, 5 ha on the Remaining Extent of the farm Sydenham 445, Registration Division of Bloemfontein, Free State Province.

SITE DESCRIPTION
The Remaining Extent of the farm Sydenham 445, Registration Division of Bloemfontein RD, Free State Province, is situated approximately 10 km south of Bloemfontein. The area earmarked for the proposed mining falls on a section of the farm that was previously used as an existing quarry and the intention of this application is to increase the size of the quarry (Figure 1).

The proposed mining site will be an extension of the existing quarry pit previously mined for gravel. The mining method will make use of excavation by means of earth moving equipment. The material is then loaded and hauled to a crushing and screening plant. The gravel will be stockpiled and transported to clients via trucks and trailers. All activities will be contained within the boundaries of the site.

The proposed mining area is approximately 5 ha is extent and the applicant, intents to win material from the area for at least 2 years with a possible extension of another 3 years. The gravel to be removed from the quarry will be used for construction industry in the vicinity. The proposed quarry will therefore contribute to the upgrading / maintenance of road infrastructure and building contracts in and around the Bloemfontein area.

GEOLOGY & SOILS:
Sedimentary mudstones and layers of sandstone mainly of the Adelaide Subgroup (Beaufort Group, Karoo Supergroup). Volksrust Formation mudstones of the Ecca Group (also Karoo Supergroup) dominate the western part of the area. Deep (>300 mm) layer of red sand (aeolian origin) covers the more clayey B-horizons. Soil forms such as arable Hutton, Bainsvlei and Bloemdal occur here and are typical of the Ca land type. The Ea land type has shallow gravelly soils underlain by dolerite sills. Ca and Ae land types are nearly equally represented.

The SAHRA interim report, CaseID:15656 requested that a professional palaeontologist visit the site because it is indicated as very highly sensitive on the SAHRIS palaeosensivity map.

Most of the site is in palaeontologically very highly sensitive rocks so a Phase 2 (site visit) Palaeontological Impact Assessment was carried out on 07 December 2020 in order 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). The report with observations was completed for the proposed development and is presented here.

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 quarry expansion on Farm Sydenham 445 about 10km south of Bloemfontein. Map supplied by HCAC

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. (as reported herein);
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 site lies in the central-eastern part of the Main Karoo Basin and comprises rocks of the lower Karoo Supergroup, in particular the Adelaide Subgroup (Beaufort Group, Karoo Supergroup). There are large intrusions of dolerite dykes that were emplaced during the Jurassic and are associated with the massive basalt outpouring of the Drakensberg Mountains. The dykes do not preserve fossils because they are igneous in origin and, furthermore, tend to destroy fossils in their immediate vicinity. They will not be considered further.

The early Permian Volksrust Formation dark blue grey shales were deposited in deep water environments as the Karoo inland sea filled with meltwater from the receding glaciers from the mountainous region to the south. These are overlain by the siltstones and fine-grained sandstones of the Adelaide Subgroup that were deposited by braided streams, floodplain and overbank deposits as the environment dried out slowly.

Figure 2: Geological map of the area south of Bloemfontein 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 2926 Bloemfontein.

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

Symbol	Group/Formation	Lithology	Approximate Age
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Pa K3l	Adelaide Subgroup, Beaufort Group, Karoo SG	Siltstone, fine-grained sandstone and subordinate mudstone	Late Permian
Pvo	Volksrust Fm, Ecca Group, Karoo SG.	Dark blue-grey shale	Early Permian

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 3. The main lithology is the Adelaide Group (Figure 2, 3) and with outcrops of dolerite that would not preserve fossils as it is igneous in origin.

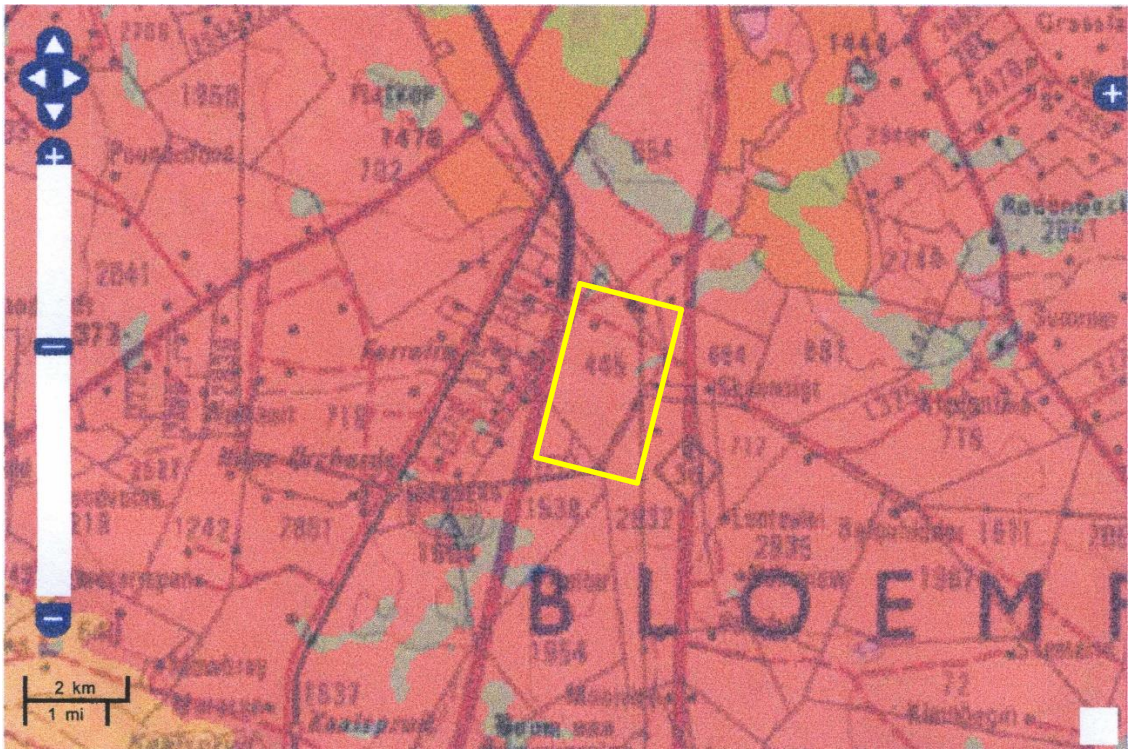


Figure 3: SAHRIS palaeosensitivity map for the proposed Quarry expansion on Syndenham 445, shown within the yellow rectangle. Background colours indicate the following degrees

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) and so a site visit was requested.

The Adelaide Subgroup is the dominant rock in this area and comprises grey mudstone, dark-grey shale that is carbonaceous in places, siltstone and sandstone. It has not been divided into any of the vertebrate biozones that are used for the Karoo as a whole which implies that that no vertebrate fossils have been found. Fossil vertebrates of this age are common and have been used for the biozonation of the Beaufort Group (Rubidge et al., 1995; updated in Smith et al., 2020). However, vertebrates seldom occur with the fossil plants. Five Assemblage Zones (AZ) are found in the Adelaide Subgroup (Beaufort Group) and they are from the base upwards: Eodicynodon AZ, Tapinocephalus AZ, Endiothiodon AZ, Cistecephalus AZ and Daptocephalus AZ (the latter name replacing the former Dicynodon Zone). The list of fossil taxa is long but the groups represented are the fish, amphibians, therocephalians, biarmosuchians, gorgonopsians dicynodonts and cynodonts. Nonetheless, in the field one is most unlikely to be able to identify any of the vertebrate fossils, but bone fragments are usually white.

Iii. Observations from site visit

The site was visited on 7 December and surveyed on foot. The northern section is mostly covered by rubble and rocks but the southern part had some profiles exposed so these were studied. Photographs were taken of the general aspect (Figure 4) and the rocks. No vertebrate fossils were found. Observations are given in Table 3 and the relevant photographs are referred to.

Figure 3: Panorama of the Syndenham 445 quarry site. Note the extensive dumping of rock and building materials and disturbed weed cover. Photograph taken by J van der Walt.

Table 3: Locations, observations and related figures from the site visit on 07 December 2020. Photographs taken by J van der Walt and colleagues.

Location	Observations	Figure
Southeastern corner	Looking northeast at the Adelaide Subgroup shales and mudstones that have been tilted and distorted by the underlying intrusive dolerite dyke	5a
	Close up of the distorted sediments. No fossils	5b
	Isolated block of cross-bedding with a clay overlay indicating a point bar and fluvial deposit	5c
S29° 11.972' E26° 11.705'	Possible root traces in the mudstone, southwestern corner, with random branching pattern	6a
	More possible root traces except that the branching is very angular is more likely to be chemical infilling in the cracked rocks.	6b
	Slab of dolerite with a few bubbles. No fossils	6c
Southern section	Natural profile with massive sandstone channel indicating a braided river setting	7a
	Laminated sandstone and siltstone block indicating a deep water lacustrine setting	7b
	Sandstone blocks and shale debris from the existing profile. No fossils	7c
Northern section	View to the southeast of a dolerite ridge	8a
	View to the southwest of another dolerite ridge	8b
	Much of the area has been disturbed and rubble dumps are very common. No fossils	8c

Figure 5 – Southeastern corner

A - Looking northeast at the Adelaide Subgroup shales and mudstones that have been tilted and distorted by the underlying intrusive dolerite dyke

B - Close up of the distorted sediments. No fossils

C - Isolated block of cross-bedding with a clay overlay indicating a point bar and fluvial deposit

Figure 6: Southeastern section

A - Possible root traces in the mudstone, with random branching pattern

B - More possible root traces except that the branching is very angular is more likely to be chemical infilling in the cracked rocks.

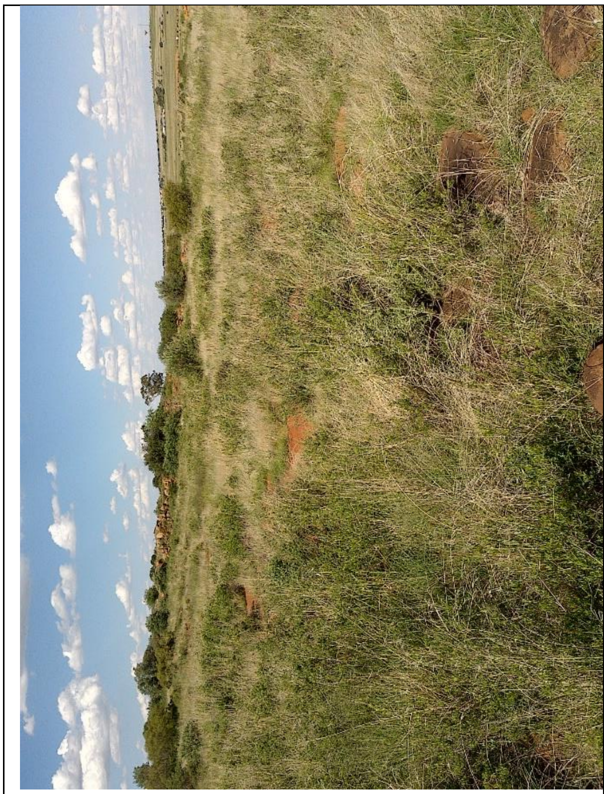
C - Slab of dolerite with a few bubbles. No fossils

Figure 7: Southern section

A - Natural profile with massive sandstone channel indicating a braided river setting

B - Laminated sandstone and siltstone block indicating a deep water lacustrine setting

C - Sandstone blocks and shale debris from the existing profile. No fossils



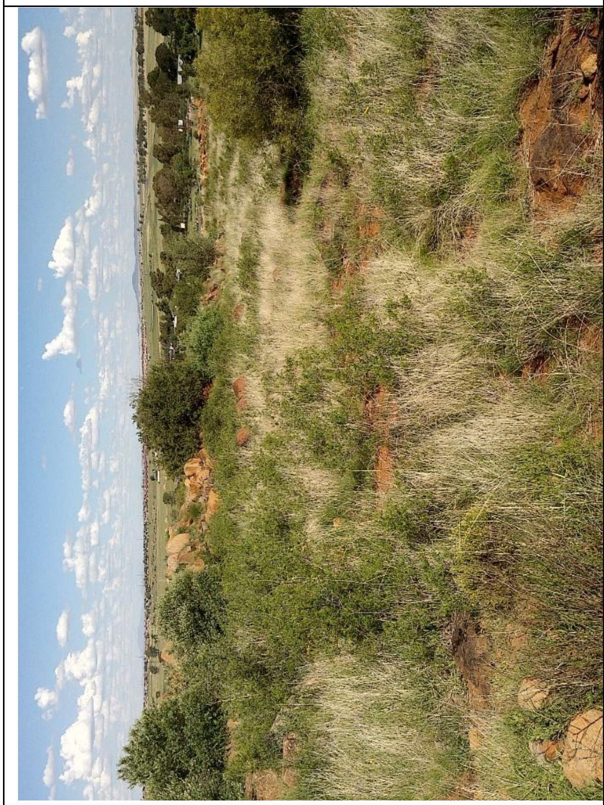


Figure 8: northern section
A - View to the southeast of a dolerite ridge
B - View to the southwest of another dolerite ridge
C - Much of the area has been disturbed and rubble dumps are very common. No fossils

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 4:

TABLE 4A: 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 4B: IMPACT ASSESSMENT

PART B: ASSESSMENT		
SEVERITY/NATURE	**H**	-
	M	Adelaide Subgroup vertebrate fossils might occur in this region but the surface is highly disturbed. The impact would be very unlikely. -
	L	-
	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 vertebrate fossils from the Adelaide Subgroup in the shales, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	No fossils were found in the soils of the site and dolerite is pervasive thus reducing the chance of any or quality fossils. There is a small chance that fossils are buried so a Fossil Chance Find Protocol should be added to the eventual EMPr
	L	-

Based on the site survey of the project site, there are no fossils in the surface soils or in the rocks that have been exposed by excavations and previous quarrying activities. According to

the geological maps and the SAHRIS map, the potential of finding fossils is high but the area is disturbed, dolerite is pervasive and furthermore, the area has not been subdivide into a finer scale of biozones, probably because no fossils have been found to date. Since there is a small chance that vertebrate fossils from the Adelaide Subgroup (Beaufort Group, Karoo Supergroup) well below the surface 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 dolomites, sandstones, shales and sands are typical for the country and could contain fossil plant, insect, invertebrate and vertebrate material. The dolerite does not preserve fossils. The sediments in the site are already very disturbed, and the site visit showed that there were no fossils. It can be assumed, based on the site survey of the whole quarry area, that fossils are very rare to absent..

6. Recommendation

Based on the site visit and experience and the lack of any previously recorded fossils from the area, it has been shown that there are no fossils preserved in the dolerite, sandstones, mudstones and shales of the quarry site. Therefore, to err on the side of caution, a Fossil Chance Find Protocol should be added to the EMPr: if 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

DeWit, M., and Linol, B., (eds). Origin and Evolution of the Cape Mountains and Karoo Basin. Springer International Publishing.

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.

Rubidge, B.S. (Ed), 1995. Biostratigraphy of the Beaufort Group (Karoo Supergroup). Biostratigraphy Series 1, South African Commission for Stratigraphy. Council for Geoscience, 46 pp.

Smith, R.M.H., Rubidge, B.S., Day, M.O., Botha, J., 2020. Introduction to the tetrapod biozonation of the Karoo Supergroup. South African Journal of Geology 123, 131-140. doi:10.25131/sajg.123.0009

8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations or quarrying commences.

1. The following procedure is only required if fossils are seen on the surface and when 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 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 Figures 4, 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 the site inspections by the palaeontologist will not be necessary.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

Appendix A – Examples of fossil vertebrates from the Adelaide Subgroup, Beaufort Group

Figure 9: Examples of vertebrate bones as they would appear in the shales – white colour.

Figure 10: Example of fossil bones in an excavated block – light brown structures with some symmetry,

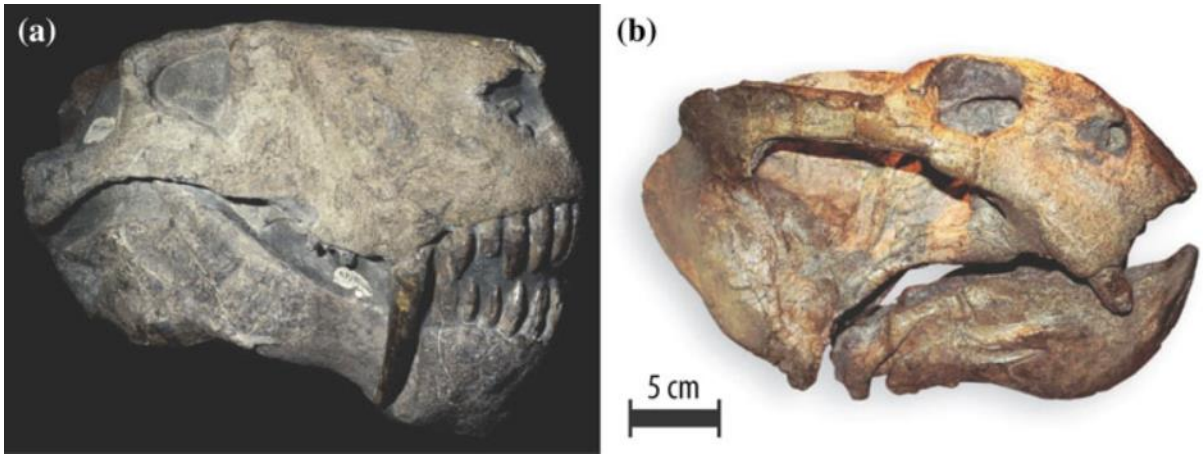


Figure 11: Therapsid skulls representative of two families that went extinct in the Permian: a - flesh eating gorgonopsian, and b - the herbivore dicynodont *Daptocephalus* (Photos supplied by Bruce Rubidge). In de Wit and Linol (2016) book Preface.

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD November 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 –

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
-

xi) Research Output

Publications by M K Bamford up to November 2020 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 = 36; -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)

Short CV for *Alisoun Valentine House*

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WORK HISTORY

Postdoc Fellow – Evolutionary Studies Institute
January 2017 – December 2019
Analysis of archaeological charcoal from Middle Stone Age and Early Iron Age sites
Host: Professor Marion Bamford

Sessional position – School of Animal, Plant and Environmental Sciences
March 2016 – November 2016
Academic support for postgraduate students

Short term internship – University of the Witwatersrand
August – November 2015

Assistant to Editor for 'Flora of the Witwatersrand' – University of the Witwatersrand
September 2008 – February 2010
Assisted with editing and preparing the Flora for publication

Tutor at the College of Science – University of the Witwatersrand
Academic years 2000 – 2003

EDUCATION
Doctor of Philosophy (PhD) University of the Witwatersrand (2015)
Title: Systematic Applications of Pollen Grain Morphology and Development in the Acanthaceae
Supervisor: Professor Kevin Balkwill

Master of Science (MSc) University of the Witwatersrand (1991)
Title: A developmental study of *Nephroselmis viridis* (Inouye, Suda et Pienaar) Prasinophyceae
Supervisor: Professor Richard Pienaar
Degree awarded with Distinction.

Bachelor of Science with Honours (B.Sc. Hon.) University of the Witwatersrand (1987)
Awarded the Florence D. Hancock prize for a Dissertation in Phycology (1988)

Higher Diploma in Education (Postgraduate) for Secondary Education University of the Witwatersrand (1985)
Teaching subjects: Biology and Science

Bachelor of Science (B.Sc.) University of Witwatersrand (1984)
Major: Botany; Sub-majors: Microbiology and Zoology

Matriculation Certificate Hyde Park High School (1979)
Subjects passed: English, Afrikaans, Biology, Mathematics, Geography, Home Economics

PUBLICATIONS
Young A.V. and Pienaar R.N. 1989. The ultra structure of a new species of *Nephroselmis* (Prasinophyceae). Proceedings of the Electron Microscopy Society of Southern Africa. 19: 113–114.

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PALAEONTOLOGICAL IMPACT FIELD EXPERIENCE

May 2018 – SARAO Williston and Carnarvon for Digby Wells
August 2019 – Idlanga Coal MR, Rietvlei, Vryheid area – Digby Wells
September 2019 – Schmidtsdrift PR for Thaya Environmental Specialist
September 2019 – Estcourt Pvt Hospital for EnviroPro