Palaeontological Impact Assessment for the Prospecting Right Application on portions of the Farm Stofbakkies 31, northeast of Prieska, Northern Cape Province

Desktop Study (Phase 1)

For

Archaeological and Heritage Services Africa (Pty) Ltd

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Expertise of Specialist

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Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Archaeological and Heritage Services Africa (Pty) Ltd, Fourways, 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 Prospecting Right application by Thunderflex 78 (Pty) Ltd for the Prospecting Right Application on Portion 4, Portion 5, Portion 7, Portion 9, Portion 13 and Remainder of the Farm Stofbakkies 31, near Prieska in the Siyathemba Local Municipality, Northern Cape 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 very highly sensitive Campbellrand Subgroup and Kuruman Formation (Asbestos Hills Subgroup), of the Transvaal Supergroup in the northwestern part that might preserve trace fossils such as stromatolites and microbialites. The rest of the area is on highly sensitive Tertiary-Quaternary calcretes and moderately sensitive Dwyka Group tillites and the Quaternary Gordonia Formation. The site visit verification confirmed that there were NO FOSSILS of any kind in the area visible on the surface. 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 contractor, environmental officer or other designated responsible person once excavations, drilling or mining activities have commenced. Since the impact will be low, as far as the palaeontology is concerned, the project should be authorised.

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1. Background

A Palaeontological Impact Assessment was requested for the Prospecting Right application by Thunderflex 78 (Pty) Ltd for the Prospecting Right Application on Portion 4, Portion 5, Portion 7, Portion 9, Portion 13 and Remainder of the Farm Stofbakkies 31 near Prieska in the Siyathemba Local Municipality, Northern Cape Province (Figures 1-3).

Part of the footprint is on palaeontologically very highly sensitive rocks so a site visit verification is required. The farm lies on the northern bank of the Orange River. Along the river are extensive irrigation projects but farther away from the river the land is open and covered by sparse vegetation.

A Palaeontological Impact Assessment was requested for the Stofbakkies 31 project. 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 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

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	Relevant section in report
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 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 landmarks. The Stofbakkies site is shown by the blue outline.

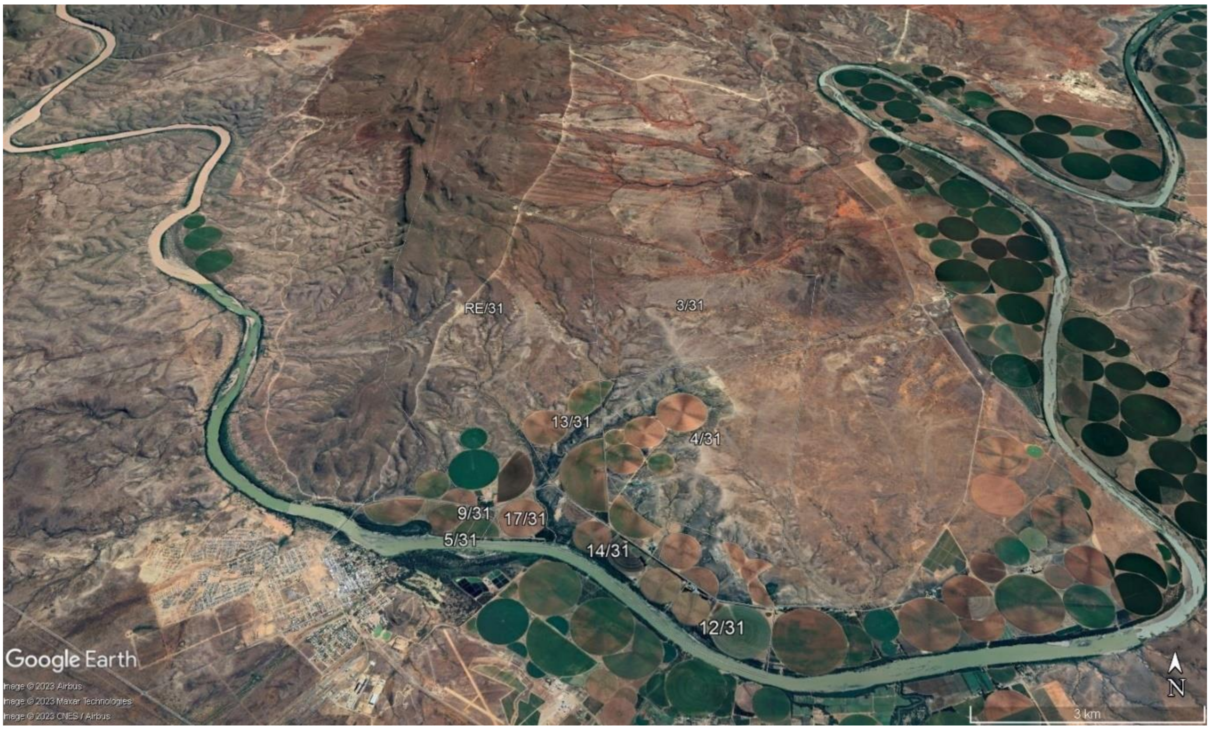


Figure 2: Google Earth Map of the proposed Prospecting right area on Farm Stofbakkies 31 with the portions as shown.

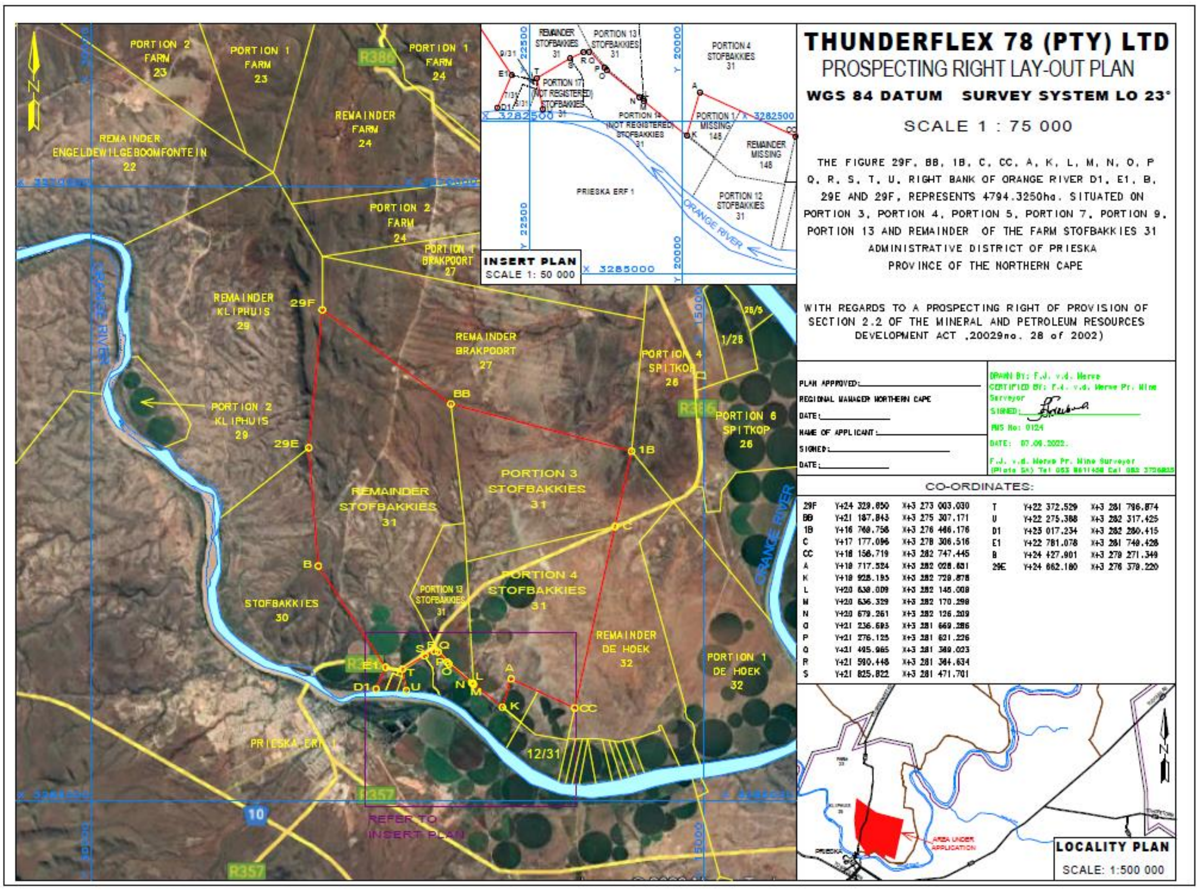


Figure 3: Annotated aerial map with the prospecting right area as indicated.

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 include 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 (*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 (*possibly 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 (*applicable to this assessment*).

3. Geology and Palaeontology

i. Project location and geological context

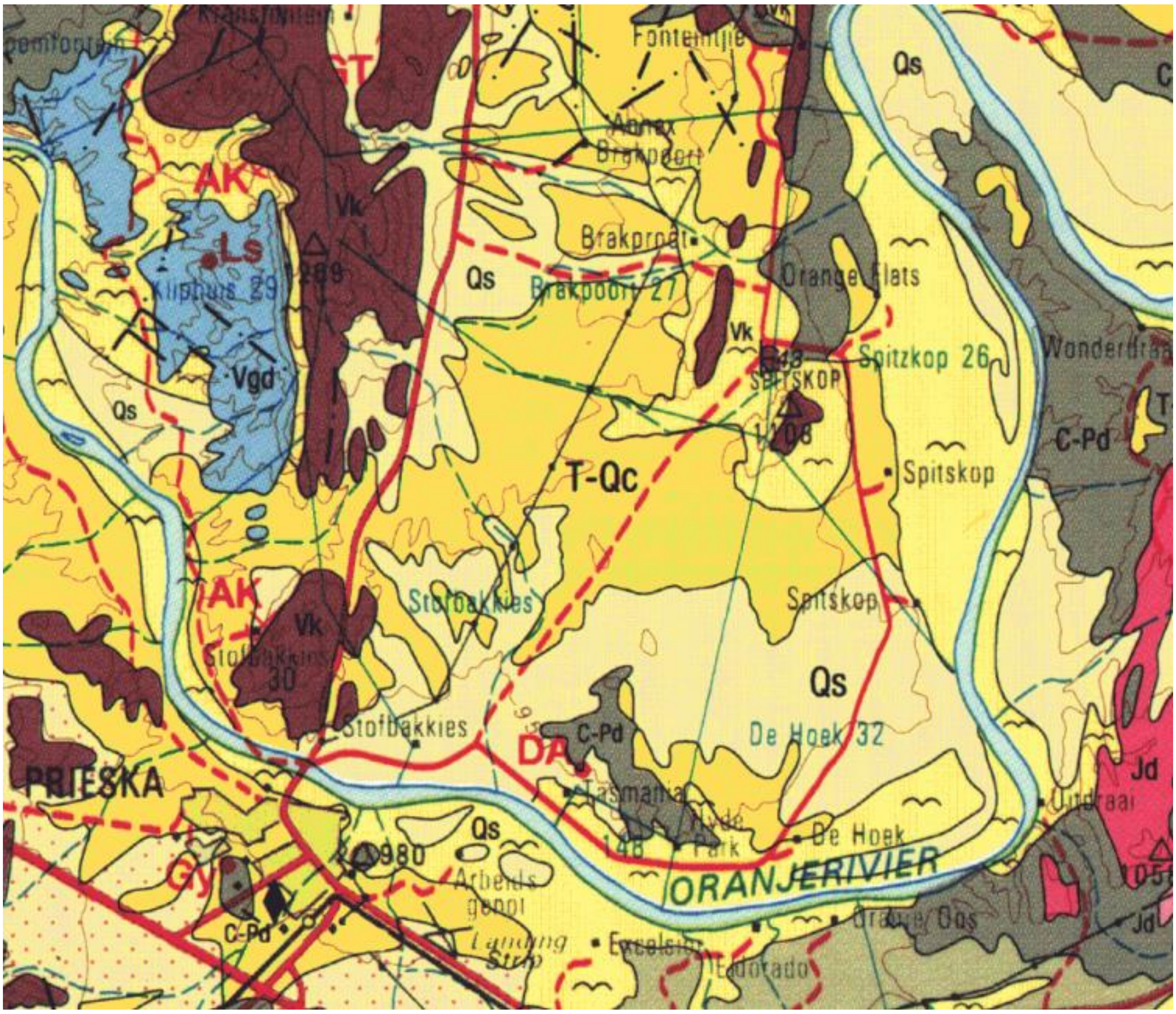


Figure 4: Geological map of the area around the Farm Stofbakkies 31. The location of the proposed project is indicated within the blue outline. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2922 Prieska.

Table 2: Explanation of symbols for the geological map and approximate ages (Eriksson et al., 2006. Johnson et al., 2006; McCarthy et al., 2006; Schier et al., 2018; Schroder et al., 2016). 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	Quaternary, ca 1.0 Ma to present
Qs/Qg	Gordonia Fm, Kalahari Group	Unconsolidated sand, red or white	Quaternary or Holocene; Post 1 Ma
Jd	Jurassic dolerite dyke	Dolerite	Jurassic Ca 183 Ma

Symbol	Group/Formation	Lithology	Approximate Age
C-Pd	Dwyka Group, Karoo SG	Tillites, diamictites, mudstones	Late Carboniferous to early Permian
Vk	Kuruman Fm, Asbestos Hills Subgroup, Ghaap Group, Transvaal SG	Banded ironstone	Palaeoproterozoic Ca 2460-2440 Ma
Vgd	Campbell Rand Subgroup, Ghaap Group, Transvaal SG	Carbonate, limestone	Palaeoproterozoic Ca 2602-2521 Ma

The project lies in the Prieska sub-basin of the Griqualand West Basin of the Transvaal Supergroup and is unconformably overlain by the Palaeozoic Karoo sequence and the Tertiary-Quaternary sands (Figure 4).

The Late Archaean to early Proterozoic Transvaal Supergroup is preserved in three structural basins on the Kaapvaal Craton (Eriksson et al., 2006). In South Africa are the Transvaal and Griqualand West Basins, and the Kanye Basin is in southern Botswana. The Griqualand West Basin is divided into the Ghaap Plateau sub-basin and the Prieska sub-basin. Sediments in the lower parts of the basins are very similar but they differ somewhat higher up the sequences. Several tectonic events have greatly deformed the south western portion of the Griqualand West Basin between the two sub-basins

The Transvaal Supergroup comprises one of world's earliest carbonate platform successions (Beukes, 1987; Eriksson et al., 2006; Zeh et al., 2020). In some areas there are well preserved stromatolites that are evidence of the photosynthetic activity of blue green bacteria and green algae. These microbes formed colonies in warm, shallow seas.

The Transvaal Supergroup rocks in the Griqualand West Basin can be correlated with the rocks in the Transvaal Basin, closely according to Beukes and colleagues, or not so closely according to Moore and colleagues. Nonetheless, these rocks represent on a very large scale, a sequence of sediments filling the basins under conditions of lacustrine, fluvial, volcanic and glacial cycles in a tectonically active region. The predominantly carbonaceous sediments are evidence of the increase in the atmosphere of oxygen produced by algal colony photosynthesis, the so-called Great Oxygen Event (ca 2.40 – 2.32 Ga) and precursor to an environment where diverse life forms could evolve. The Neoarchean-Paleoproterozoic Transvaal Supergroup in South Africa contains the well-preserved stromatolitic Campbellrand -Malmani carbonate platform (Griqualand West Basin – Transvaal Basin respectively), which was deposited in shallow seawater shortly before the Great Oxidation Event (GOE).

In the Prieska and Ghaap Sub-basins the Vryburg Formation directly overlies the Ventersdorp SG in the Griqualand West Basin. It has a basal transgressive conglomerate with quartzites, shales and subordinate stromatolitic carbonates, passing up in places into basaltic to andesitic amygdaloidal lavas dated to about 2642 Ma (Walraven and Martini, 1995; Eriksson et al., 2006). It has been interpreted as a fluvial to marine marginal deposit with material from the western to northwestern regions (Beukes, 1979 in Eriksson et al., 2006).

There are two Formations in the Schmidtsdrift Subgroup and occur in both of the sub-basins of the Griqualand West Basin. The lower Boomplaas Formation comprises stromatolitic and oolitic platform carbonates. Only the upper 100m is visible in surface outcrops but it extends another 185m in borehole core (Beukes, 1979, 1983). They represent deep lagoonal deposits, transported oolites and carbonate shelf rocks. The upper Clearwater Formation comprises shales, tuffites and BIF-like cherts and is interpreted as a transgressive deposit over the Boomplaas Formation (ibid; Eriksson et al., 2006).

Based on the earlier works of Button (1976) and Beukes (1980, 1987) and updated after the application of sequence stratigraphy, Sumner and Beukes (2004) have described the 2650-2500 Ma Campbellrand and Malmani subgroups as being correlative and they form an extensive carbonate platform. Today there are preserved outcrops that cover 190,000 km^2 but these carbonate platforms probably originally covered the entire Kaapvaal Craton, >600,000 km2 (ibid). The thick platform has predominantly peritidal facies in the north and east and deeper facies to the south and west. However, thinner basinal sediments and plaform slopes are preserved near Prieska. The ca 2.5 - 2.46 Ga Kuruman iron-formations conformably overlie the Campbellrand Subgroup and the Penge Formation overlies the Malmani Subgroup. Both the Kuruman Iron Formation and the lower Penge Iron Formation consist of deep water, microbanded iron formation that formed on a stable marine shelf below wave base and then shallowed to sea level (Sumner and Beukes, 2006).

The **Asbestos Hills Subgroup** has three formations, the lower Kliphuis Formation, the Kuruman Formation and the Danielskuil Formation. They are all banded iron formations and have vast economically important reserves,

Above the Asbestos Hills Subgroup is the Postmasburg Group. The Makganyene Formation has diamictites and shales from glacial conditions. Disconformably overlying these are the Ongeluk Formation basaltic andesitic lavas. According to Cornell et al. (1996) and Schroder et al. (2016) the Ongeluk Formation is equivalent to the lavas of the Hekpoort Formation in the Transvaal Basin.

Only the basal rocks of the Karoo Supergroup are exposed in this area. They are the **Dwyka Group** glacigene deposits: the diamictites, tillites and mudstones that were deposited in the meltwater of one of the phases of icesheet formation and melt when southern Africa was positioned over the South Pole during the Later Carboniferous to Early Permian (Johnson et al., 2006)

There were two large basins dominating southern Africa during the Cenozoic, with the Kalahari Basin to the west and the Bushveld basin to the east. Both basins are bounded along their southern extent by the more or less west-east trending Griqualand-Transvaal Axis (Partridge et al., 2006). These sediments are not easy to date but recent attempts are gradually filling in the history of the sands, sand dunes and inter-dunes (Botha, 2021).

Quaternary Kalahari sands cover large parts of the rocks in this region, especially to the west. This is the largest and most extensive palaeo-erg in the world (Partridge et al., 2006) and is composed of extensive aeolian and fluvial sands, sand dunes, calcrete, scree and colluvium. Periods of aridity have overprinted the sands, and calcrete and silcrete are common. Most geological maps indicate these sands simply descriptively (aeolian sand, gravelly sand, calcrete) or they are lumped together as the Gordonia Formation because the detailed regional lithostratigraphic work has not been done, Nonetheless, these sands have eroded from the interior and have been transported by wind or water to fill the basin. Reworking of the sands or stabilisation by vegetation has occurred. Probable ages of dune formation are around 100 kya (thousand years), 60 kya, 27-23 kya and 17-10 kya (in Botha, 2021).

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 4. The northwestern part of the area is in the very highly sensitive Campbellrand subgroup and Kuruman Formation (red). The rest of the area is on highly sensitive Tertiary-Quaternary calcretes (orange) and moderately sensitive Gordonia Formation sands (green).

According to the Palaeotechnical Report for the Northern Cape (Almond and Pether, 2008), the whole of the Vryburg Formation and all the formations in the Ghaap Group could have fossils, particularly stromatolites. For example, the Boomplaas Formation in some areas is composed of stromatolitic and oolitic platform carbonates (Beukes, 1979, 1983) or of shales and carbonates. The overlying Clearwater (or Lokamona) Formation is composed of shales, tiffites and BIF-like cherts does not have a fossil record to date.
Giant stromatolitic domes overlain by microbial laminites with fenestrae and carbonate argillites, shales and siltstones make up the Monteville Formation (Beukes, 1987; Eriksson et al. 2006). The thickest stratum is the overlying Reivilo Formation that is made up of dolomite with giant stromatolitic domes, columnar stromatolites and fenestral facies (Beukes, 1980a).

NOTE maps usually just indicate the Ghaap Group or Campbell Rand Subgroup, while each member has a slightly different type of dolomite, stromatolites and chert. Not all are fossiliferous. Banded Iron was formed by the oxidation of iron by the free oxygen released by the photosynthetic activity of algae in the shallow waters but the algae are not preserved so banded iron is a trace fossil.

Stromatolites are the trace fossils that were formed by colonies of green algae and blue-green algae (Cyanobacteria) that grew in warm, shallow marine settings. These algae were responsible for releasing oxygen via the photosynthetic process where atmospheric carbon dioxide and water, using energy from the sun, are converted into carbon chains and compounds that are the building blocks of all living organisms. The released carbon dioxide initially was taken up by the abundant reducing minerals to form oxides, e.g. iron oxide. Eventually free oxygen was released into the atmosphere and some was converted into ozone by the bombardment of cosmic rays. The ozone is critical for the filtering out of harmful ultraviolet rays.

These layers can be in the form of flat layers, domes or columns depending on the environment where they grew (Beukes, 1987). Some environments did not form stromatolites, just layers of limestone that later was converted to dolomite. The algae that formed the stromatolites are very rarely preserved, and they are microscopic so they can only be seen from thin sections studies under a petrographic microscope.

Aeolian sands and alluvium are fairly mobile and very porous so they not provide suitable conditions for preservation of organic matter (Cowan, 1995). Only in places where the sands have been waterlogged, such as palaeo-pans or palaeo-springs, is there any chance of fossilisation. For example, roots can be encased in calcium-rich or silica-rich sands and crusts, known as rhizoliths or rhizocretions, can form around the roots, invertebrates or bones around the margin of a pond, pan or spring (Klappa, 1980; Cramer and Hawkins, 2009; Peters et al., 2022).

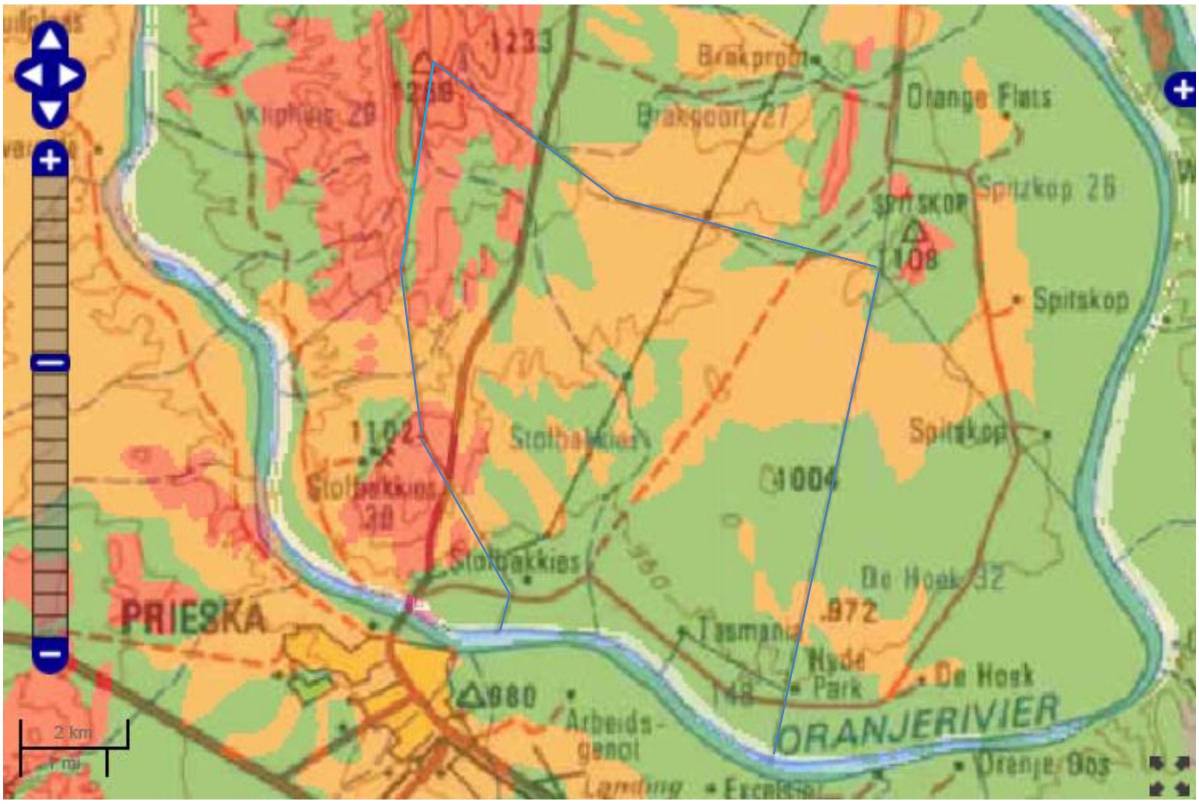


Figure 5: SAHRIS palaeosensitivity map for the site for the Farm Stofbakkies 31 Prospecting right shown within the blue outline. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

iii. Site visit verification and observations

The site was visited in the week of 26-29 June (winter). The whole area is gently rolling topography and sparsely vegetated so visibility was very good. Glacial tillites are well exposed in the southeastern section but apparent over much of the central area with reworked colluvium and gravels covering the rocks. The northwest section had very little dolomite exposed, and only reworked banded iron fragments in the alluvium and gravels. NO FOSSILS of any kind were seen on the surface or in the gullies. Photographs and observations are presented in Figures 6-14 below.

Figure 6: Southwestern section. On the slope of a glacial tillite spur shows deflated surface red gravels. On the top right-hand side is a shallow basin in which a river flows south (right) into the Orange River.

Figure 7: A shallow sand-filled basin between glacial tillite spurs.

Figure 8: Central section. An extensive elevated flat area between two river systems. Calcrete hardpan exposed in areas, otherwise there is a shallow layer of fine red gravels and calcrete waste.

Figure 9: Exposed calcrete in a northeast portion of the property.

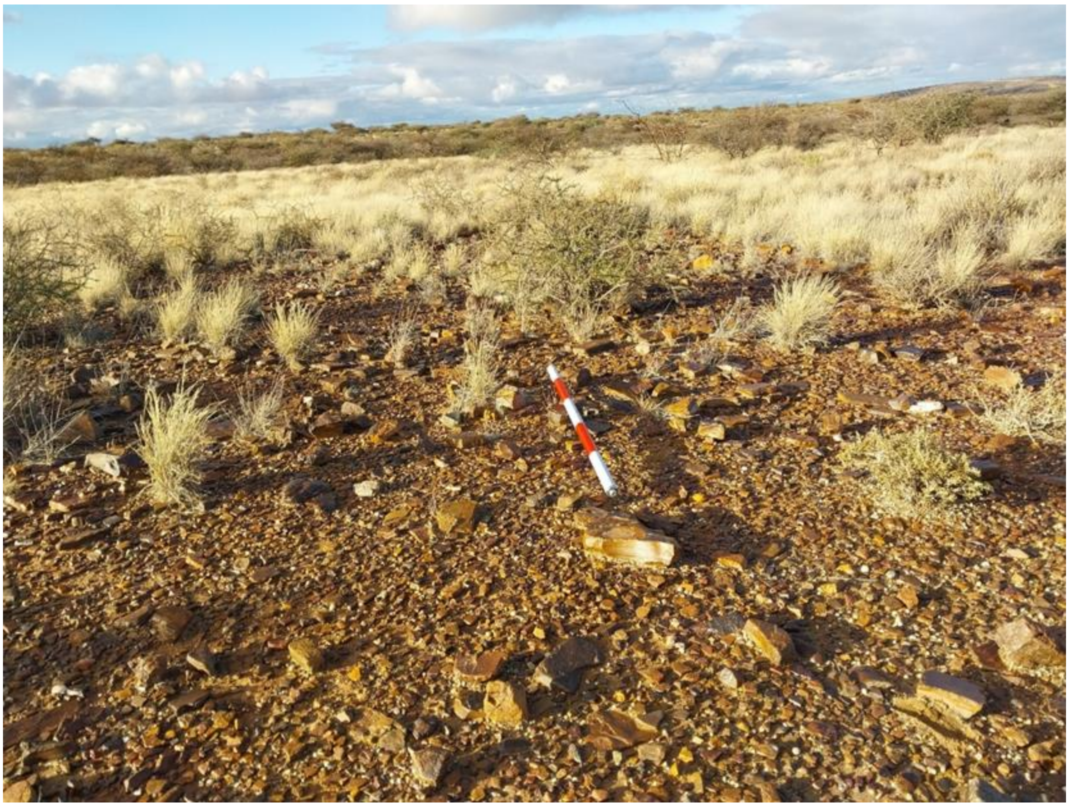
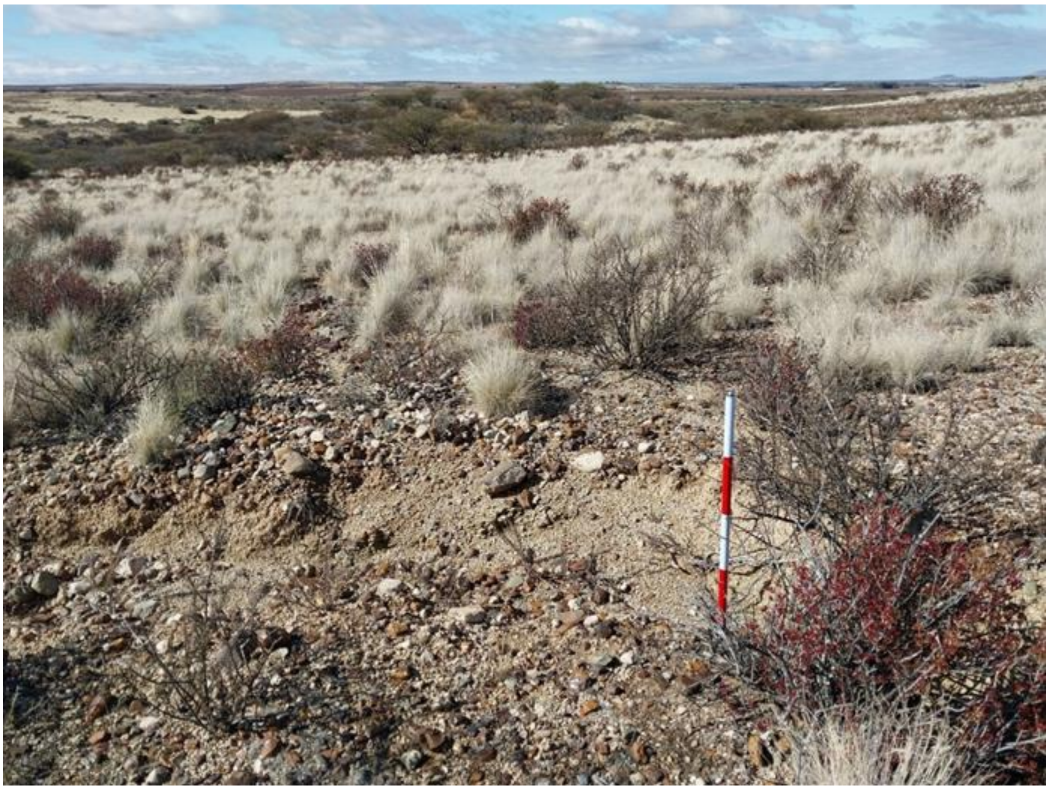


Figure 10: Northern limits of the property, banded ironstone and waste on the surface.

Figure 11: Riverbank profile shows alluvial accumulation of accrete with gravel and stone inclusion. The material is loose and unconsolidated. No fossils found. Lat: 29°38'11.50"S; Long: 22°46'07.40"E



12a

Figure 12a, b. Northwestern section. a - Shallow erosion gully running down an eastern slope of a glacial tillite spur. Deflated red gravels lie on top of a weathered unconsolidated mudstone. No Fossils found; b- close-up of the gravels. Lat: 29°38'10.70"S; Long: 22°45'59.5"E

13a

Figure 13a, b: Northwestern section. a - On the shoulder of a stream valley. Exposed dolomite (elephant skin surface texture) with quartz inclusions, not at all common in the area. No fossils found. Lat: 29°36'54.00"S Long: 22°46'25.20"E.

14a

Figure 14a, b: On the northern limits of the property, streambank profile with alluvial banded ironstone inclusions. A hard calcrete conglomerate with embedded stone exposed on the streambed. Lat: 29°35'37.5"S; Long: 22°46'04.20"E.

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 do not preserve fossils; so far there are no records from the Kuruman BIF or the Campbellrand subgroup trace fossils in this region so it is very unlikely that fossils occur on the site. The impact would be negligible
	L+	-
	M+	-

PART B: Assessment		
	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 trace fossils in the dolomites or limestone, 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 dolomites that likely will be avoided. 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 body fossils or might have trace fossils. Furthermore, the material to be mined will be the sands and this does not preserve fossils. Since there is an extremely small chance that fossils from the nearby Campbellrand Subgroup 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 only some might contain trace fossils, fossil plant, insect, invertebrate and vertebrate material. The sands of the Quaternary period would not preserve fossils. The site visit verification confirmed that were NO FOSSILS of any kind visible on the land surface. It is not known what lies below the ground surface.

6. Recommendation

Based on the site visit verification and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the sands and alluvium of the Quaternary. NO FOSSILS of any kind were seen on the land surface during the site visit walk-dawn and verification. There is a very small chance that trace fossils may occur below ground in the carbonates, dolomites and limestones of the Transvaal Supergroup so a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the environmental officer, or other responsible person once excavations and mining have 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 low to very low, so as far as the palaeontology is concerned, the prospecting right can be granted.

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8. Chance Find Protocol

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

1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations/mining commence.
2. When excavations begin the rocks and discard must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (stromatolites, plants, insects, bone or 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 trace fossils such as stromatolites in the dolomites or the Quaternary bones, rhizoliths, traces (for example see Figures 14-16). 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 or miners then a qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
6. Trace fossils, 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 Transvaal Supergroup and Tertiary-Quaternary sands.

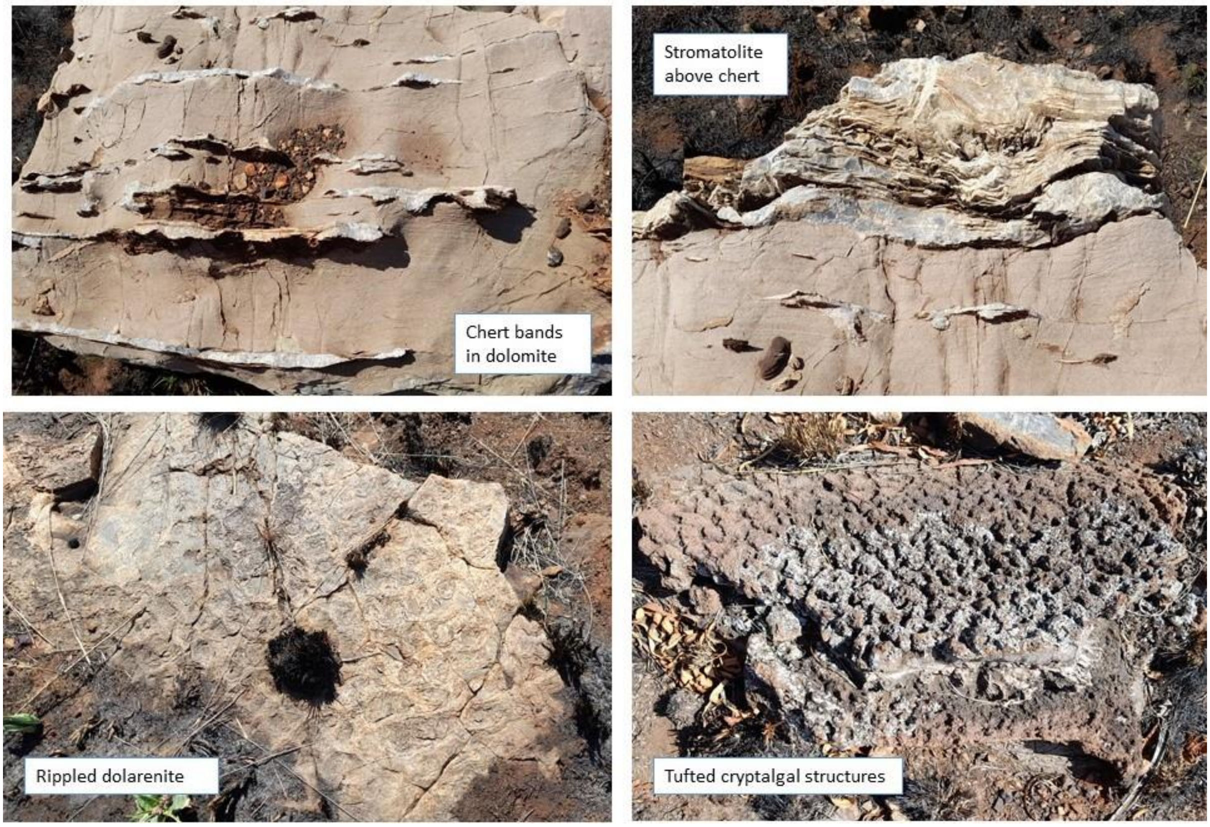

Figure 14: Photographs of various types of stromatolites in dolomite from the Malmani Subgroup.

Figure 15: Photographs of fragmentary but robust fossils recovered from Tertiary-Quaternary alluvium.

Figure 16: Photographs of rhizoliths or rhizocretions from stabilised dunes associated with a palaeo-pan.

10. Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
January 2023

Present employment :	Professor; Director of the Evolutionary Studies Institute. Member Management Committee of the NRF/DSI Centre of Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa
Telephone :	+27 11 717 6690
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

v) **Supervision of Higher Degrees**

All at Wits University

Degree	Graduated/completed	Current
Honours	13	0
Masters	13	3
PhD	13	7
Postdoctoral fellows	14	4

vi) **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 12 - 20 students per year.

vii) **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: Cretaceous Research: 2018-2020
Associate Editor: Royal Society Open: 2021 -
Review of manuscripts for ISI-listed journals: 30 local and international journals

viii) **Palaeontological Impact Assessments**
25 years' experience in PIA site and desktop projects

- Selected from recent projects only – list not complete:
- 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
- Glosam Mine 2022 for AHSA
- Wolf-Skilpad-Grassridge OHPL 2022 for Zutari
- Iziduli and Msenge WEFs 2022 for CTS Heritage
- Hendrina North and South WEFs & SEFs 2022 for Cabanga
- Dealesville-Springhaas SEFs 2022 for GIBB Environmental
- Vhuvhili and Mukondelei SEFs 2022 for CSIR
- Chemwes & Stilfontein SEFs 2022 for CTS Heritage
- Equestria Exts housing 2022 for Beyond Heritage
- Zeerust Salene boreholes 2022 for Prescali
- Tsakane Sewer upgrade 2022 for Tsimba
- Transnet MPP inland and coastal 2022 for ENVASS
- Ruighoek PRA 2022 for SLR Consulting (Africa)
- Namli MRA Steinkopf 2022 for Beyond Heritage

ix) **Research Output**
Publications by M K Bamford up to January 2022 peer-reviewed journals or scholarly books: over 170 articles published; 5 submitted/in press; 14 book chapters.
Scopus h-index = 30; Google Scholar h-index = 39; -i10-index = 116 based on 6568 citations.
Conferences: numerous presentations at local and international conferences.