

**Palaeontological Impact Assessment for the proposed
Salene Manganese MR on McCarthy 559,
Kathu, Northern Cape Province**

Site Visit (Phase 2) Report

For

Prescali Environmental Consulting (Pty) Ltd

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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 Prescali Environmental Consulting (Pty) Ltd, 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:

A handwritten signature in blue ink, appearing to read 'MKBamford', with a horizontal line underneath it.

Executive Summary

A palaeontological Impact Assessment was requested for the proposed expansion and Mining rights Application by Salene Manganese (Pty) Ltd for portions of the Farm McCarthy 559, south of Sishen and Kathu, Northern Cape Province.

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 site visit Palaeontological Impact Assessment (PIA) was completed for the project by palaeontologists Marion Bamford and Alisoun House on 05 October 2020.

The proposed site lies on the non-fossiliferous Kuruman Formation, Gamagara Formation and the potentially fossiliferous limestones of the Ghaap Group and Kalahari sands. From the site visit NO FOSSILS were found. No limestone and no palaeo-pan or palaeo-spring features were found so it is extremely unlikely that fossil occur on the property. Since the SAHRIS palaeosensitivity map indicates that these two strata are potentially fossiliferous a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no further palaeontological site visit is required unless fossils are found by the geologist when excavations or drilling commences.

From the impact assessment calculations the area has very low SFM (Significance Following Mitigation). The only mitigation requirement would be to remove fossils if found.

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1. Background

The mining rights Application by Salene Manganese (Pty) Ltd for Portions 2, 3, 4, 5 of the property Farm McCarthy 559, south of Sishen and Kathu, McCarthy 559 (Figures 1-3). This project requires an EIA and as part of this, the palaeontological heritage status must be assessed.

The project will consist of the establishment of:

- 1) Prospecting activities for undisclosed minerals;
- 2) Manganese and iron will not be prospected for;
- 3) Prospecting activities will focus on disturbed areas and existing dumps.

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 site visit survey Palaeontological Impact Assessment (PIA) was completed for the proposed development by Prof Marion Bamford and Dr Alisoun House on Monday 05 October 2020. The observations and recommendation are presented here.

Project details

- 1) New opencast pits as per plan and mine works plan
Three different opencast pits will be developed. Two of these will be Manganese Pits and one will be an Iron ore pit
- 2) New DMS plant (Crushing and Screening plant forms part of the new DMS plant)
A 100kt Dense Medium Separation (DMS) plant will be erected to beneficiate Iron Ore. The DMS plant will produce a Lumpy product (-30mm +6mm) and a Fines product (-6mm +1mm). Approximately 15% of the feed will report as ultra-fines which will be discarded as waste.
- 3) New Waste Rock dump as per plan and mine works plan - will be used for waste generated from the two Manganese pits and the Iron Ore pit
- 4) New access road as per plan
A new access road was established between the Salene offices and the contractor offices. This was done to avoid driving through the red permit area.
- 5) Increased groundwater abstraction – will be based on available yield
Groundwater abstraction will not necessarily increase. Salene successfully applied for a 150mm connection to the Sedibeng pipeline. Two 533m³ dams will be erected to supply water to the DMS and Manganese static plant.
- 6) New water storage reservoir – will cater for 2 weeks storage based on 300 kl/day requirement
Salene successfully applied for a 150mm connection to the Sedibeng pipeline. Two 533m³ dams will be erected to supply water to the DMS and Manganese static plant.
- 7) New Manganese static plant
A 60kt Static plant will be put in place to crush and screen Manganese ore. The static plant will consist of a Jaw crusher, screen, and a Cone crusher.
Attached to the static plant will be two Magnetic Separation (MagSep) units.
Permanent magnets of approximately 18-gauss will be used to separate ore and waste. Three different products will be produced:

1. -75 mm + 10mm
 2. -30mm + 6mm
 3. -10mm + 6mm
- 8) New workshop area for Almar
A workshop area will be put in place next to the contractor's offices. Mining and Plant equipment will be maintained in this area. Area will be dressed with fines.
- 9) New Topsoil dump as per plan and mine works plan
Topsoil will be removed and dumped on the topsoil dump. The position is in such an area that it would not impact on any future mining activity.
- 10) New sub-station for DMS plant
Various options are considered to supply power to the new DMS plant. Decision is still pending. A area of 300m x 300m is set out as a possible location.
- 11) New container offices for Almar Will there be a new septic tank too?
Not applicable anymore
- 12) New container onboarding facility
A three-classroom prefabricated building will be used as a training and onboarding facility. This facility will be placed next to the current Almar offices
- 13) Storm water infrastructure (plan being drafted). Storm water infrastructure will consist mainly of berms constructed with competent waste material

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
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix
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

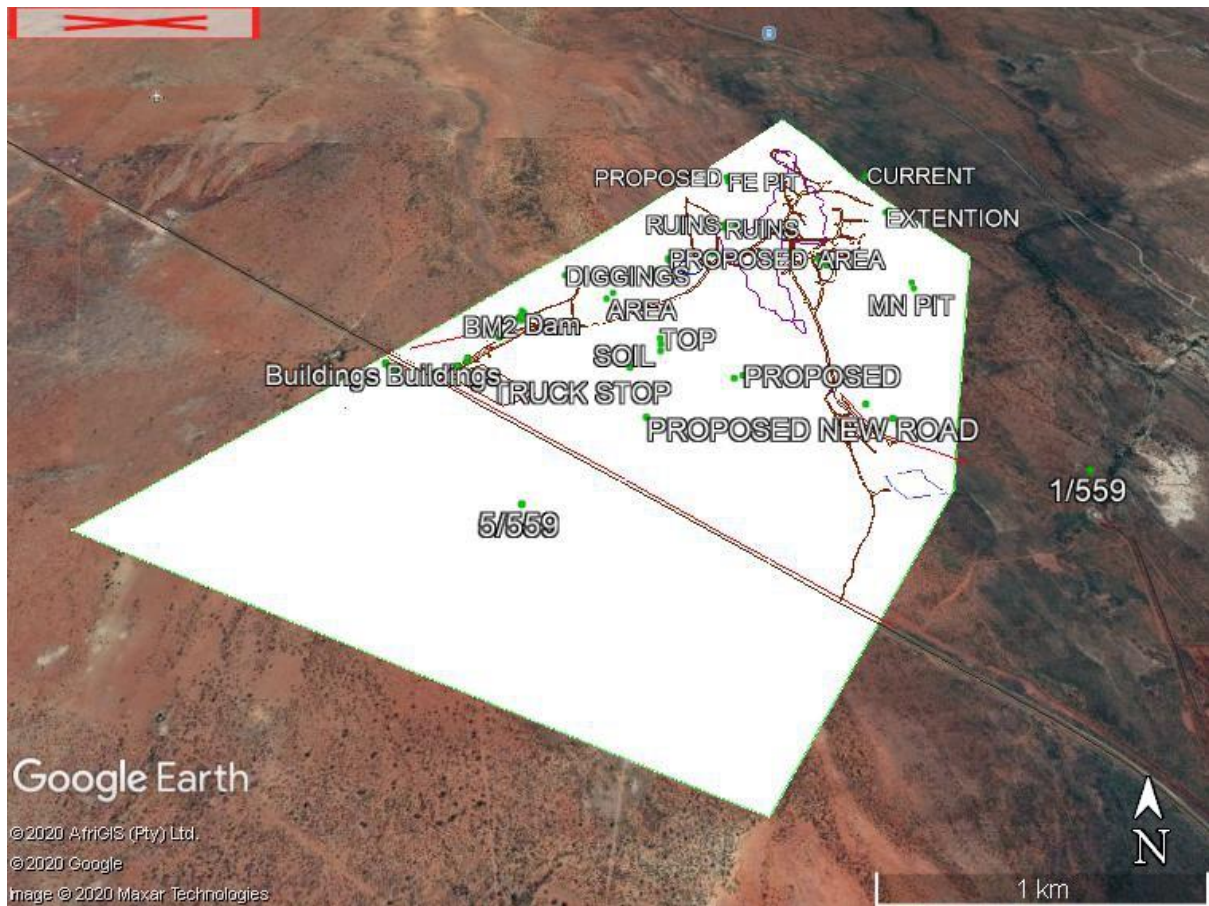


Figure 1: Google Earth map of the proposed development of McCarthy 559 by Salene Manganese with the sections shown by the white outline. Map supplied by Prescali.

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, and collect or rescue fossils if required);
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*as indicated in section 4 below*); and
4. Determination of fossils' representivity or scientific importance to decide if the fossils can be destroyed or a just a representative sample collected and housed in a recognised repository.

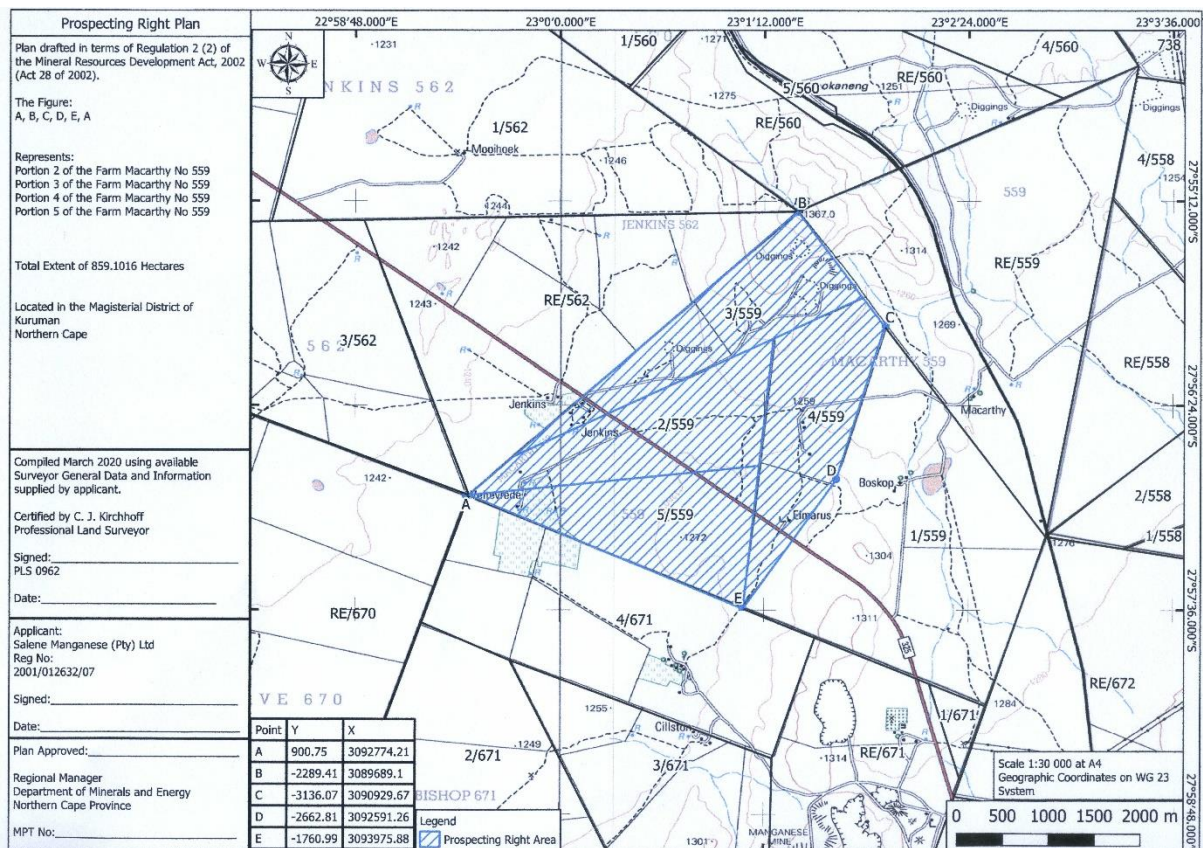


Figure 2: Topographic map showing the Farm portions related to the Salene Manganese Project.

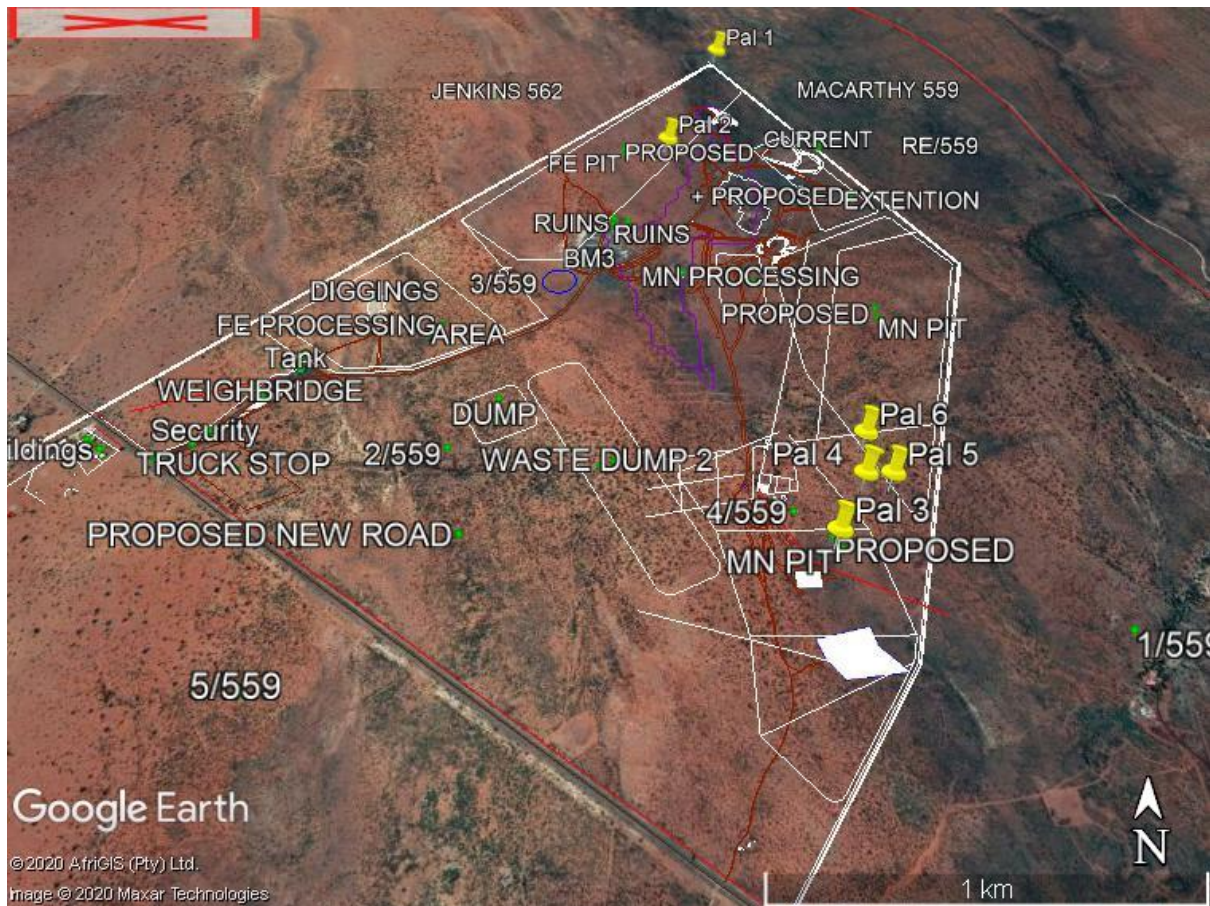


Figure 3: Google Earth map with the updated mining plans on McCarthy 559, and the yellow pins showing the sites visited on 05 October for the Palaeontology survey (see table 3 and figures 6-10).

3. Geology and Palaeontology

i. Project location and geological context

The mine area lies in the central part of the large Maremane Dome that is in the western side of the Griqualand West Basin. This basin is one of three large, ancient basins that contain sediments of the Transvaal Supergroup. Underlain by the Venterdorp Supergroup and overlain by the Olifantshoek Supergroup, the Transvaal Supergroup rocks preserve 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 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

Symbol	Group/Formation	Lithology	Approximate Age
Vm	Makganyene Fm, Postmasburg Group, Transvaal SG	Diamictites, banded jasper, siltstone, mudstone	Ca 2256 Ma
Vak	Kuruman Fm, Asbestos Hills Subgroup, Ghaap Group, Transvaal SG	Banded iron formation	Ca 2460 – 2440 Ma
Vgd	Ghaap Group, Transvaal SG	Dolomite, limestones, chert	2600 – 2400 Ma

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 were deposited in shallow seawater shortly before the Great Oxidation Event (GOE).

McCarthy 559 falls in the Postmasburg karst-hosted type of manganese deposits whereas the BIF-hosted Kalahari Manganese Field (KMF) is in the Hotazel area and has by far the largest of such deposits holding some 4,200 Mt of manganese metal that represents about 77% of the world's known land-based resource (Beukes et al., 2016). The ferruginous ore bodies of the Western Belt are less irregular and laterally more continuous and extensive than those of the Eastern Belt due to their apparent original deposition as surficial sediment in small lakes or depressions on the ancient pre-Gamagara karstic land surface (ibid). This is one reason why these deposits have been mined for a longer period (up to the early 1980s), at a relatively large scale, in mines such as Glosam, Lohatlha and Bishop in the centre of the Maremane dome (ibid).

To the east are dolomites, limestones and cherts of the Ghaap Group, according to the geological map (Figure 4) but these were not encountered during the survey. Overlying much of the area are the aeolian sands and alluvium of the Quaternary Kalahari Group.

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 5. Most of the area is indicated as moderately sensitive (green) and this applies to the Gamagara Formation shales and quartzites and the Kalahari sands. The former has been interpreted as a synsedimentary feature of the Maremane Anticline with localised erosion and redeposition (Moen, 2006). No fossils have been recorded from this lithology.

Very highly sensitive rocks are indicated along the eastern margin and this applies to the Ghaap Group, but no formations have been distinguished. This group is divided into the lower Campbell Rand Subgroup dolomites, limestones and cherts and upper Asbestos Hills Subgroup iron formation. Only the Campbell Rand dolomites and limestones can preserve trace fossils such as stromatolites that are layers of mineral sediments deposited by the photosynthetic activity of green and blue-green algal colonies. The algal cells, however, are very rarely preserved. A variety of types and forms of stromatolites have been described by Beukes (1987). Banded iron and haematite in the Asbestos Hills Subgroup were formed by the seasonal oxidation of iron but these are not a trace fossils. The SAHRIS mapping appears to have taken the conservative approach and indicated all of the Ghaap Group as potentially fossiliferous.

The map shows the Mookeng Dam area in the Northern Cape. A yellow diamond highlights the central region, including the dam and surrounding towns like Mookeng, Maseru, and Maseru. The map also shows the Orange River and the Maseru Dam. A scale bar indicates 2 km and 1 mile. A north arrow is present in the top left corner.

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Kalahari Group sands of Quaternary age are windblown and weathered so they do not preserve fossils. Only such features as palaeo-pans or palaeo-springs might entrap bones or robust plant material in the Later Tertiary and Quaternary settings (Goudie & Wells, 1995; Holmes et al., 2017; Walker et al., 2014).

lii Site visit observations

The palaeontological site visit and survey was carried on the 5th of October, 2020, focussing on the very highly sensitive areas (Figure 5) along the eastern part of the property, from north to south (Table 3). The area was walked in the north around the points (Pal 1-2) and in the southern cluster (Pal 3-6) but only a few GPS points were taken.

Table 3: Site visit observations

GPS coordinates	Observations	Figure
Site 1: 27° 55' 16" S 23° 01' 24" E	Northern corner (top of the hill). Only Fe-rich rock, haematite, occurs here.	Pal1 in Fig 3; 6a-d, 7a, b
Site 2: 27°56' 36" S 23° 01' 32" E	Predominantly iron-rich rocks, no dolomite or limestone and no fossils	Pal 2 in Fig 3; 7c, d
Site 3: 27°56' 38" S 23° 01' 32" E	Test drill hole. Transition rocks	Pal 3 in Fig 3; 8a, b
Site 4: 27° 56' 31" S 23° 01' 35" E	Water course and run off. Transition rocks	Pal 4 in Fig 3; 8c, d
Site 5: 27° 56' 31" S 23° 01' 38" E	Very small transition rocks and gravel on the surface	Pal 5 in Fig 3; 9a, b
Site 6: 27° 56' 48" S 23° 01' 36" E	Blue boulders are the Mn-rich rocks being mined. No dolomite or limestone and no fossils.	Pal 5 in Fig 3; 9c, d; 10a, b

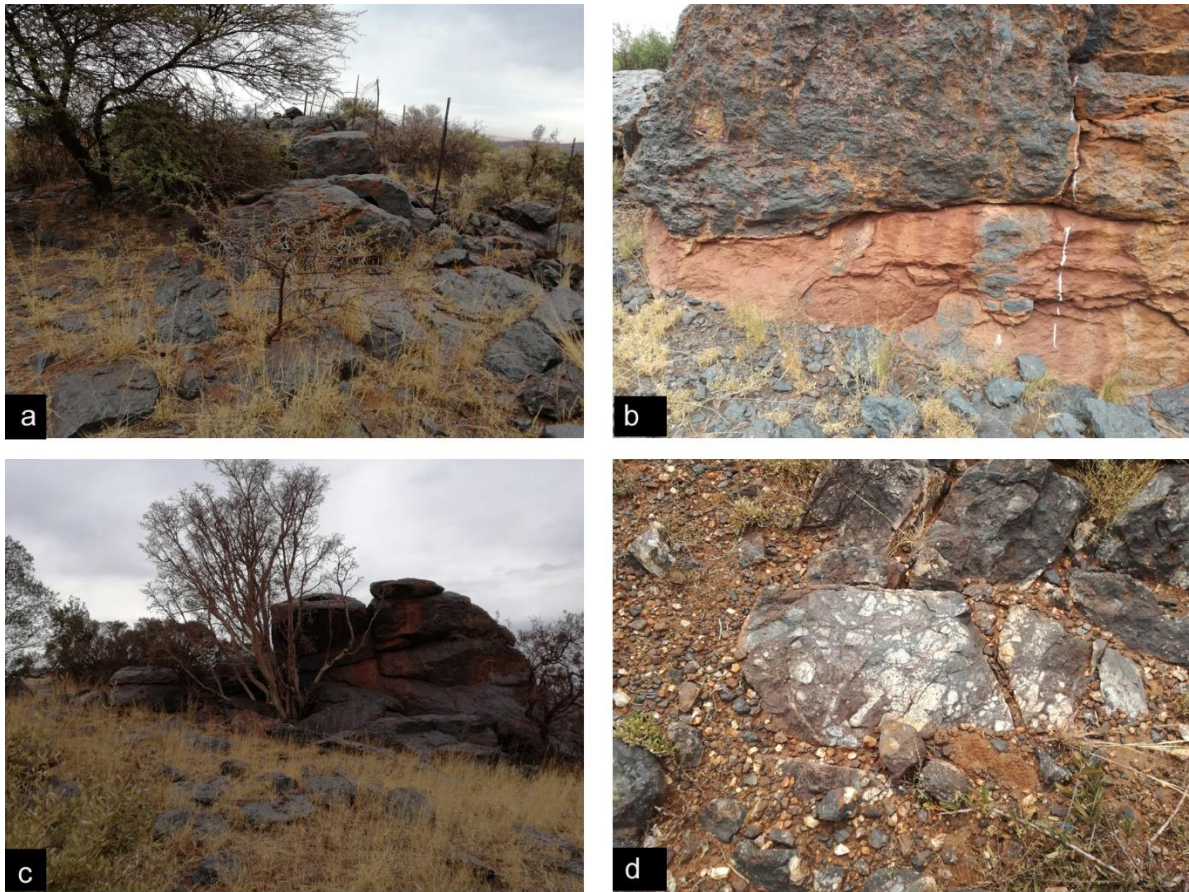


Figure 6: Site 1 – hilltop in northeastern corner of McCarthy. Only large boulders and ridges of haematite, very dark and amorphous (no banding or layering). A – view towards corner; B – close-up of boulders; C – another ridge with a fig tree growing in the cracks; D – about 50m southwards the iron-rich rocks have some white inclusions, possibly quartzite. No fossils.



Figure 7: A- view southwards from the corner hill (site 1) to the southern boundary on the far hill (site 6). B- view to the southwest from site 1 of the current iron ore mining site. C – Site 2 on the eastern margin with Kalahari sands covering the transition zone rocks – Fe-Mn, and D – closer view of the rocks, dark and light, but no dolomite or limestone and no fossils.

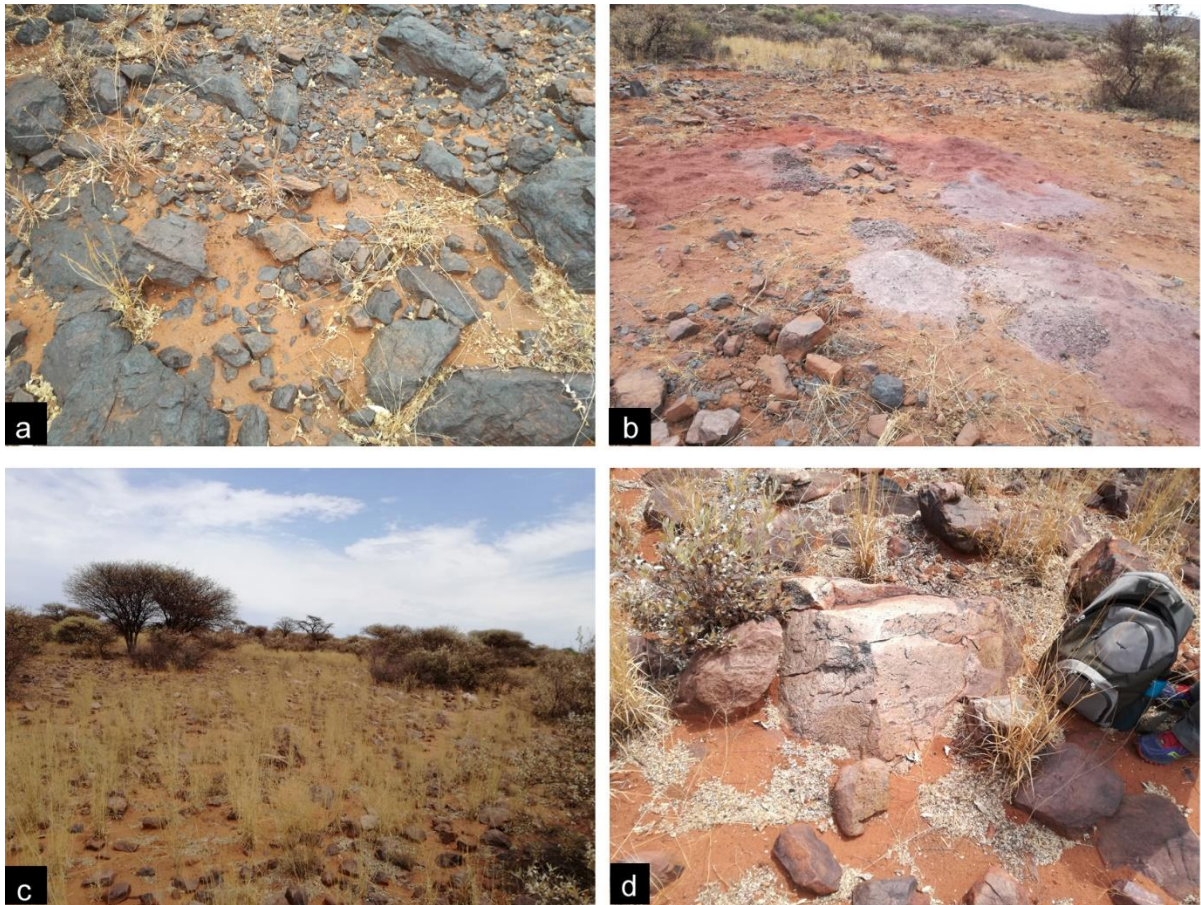


Figure 8: Site 3 in the central eastern margin alongside the ephemeral river, with transition rocks; B – drill hole remnants showing Fe-Mn rocks and powder residue. C – Site 4 farther south with the same Fe-Mn rocks and sand cover. D – Close-up of the rocks in the transition zone.



Figure 9: A - Site 5, closer to the old farmhouse/offices before the land slopes upwards in the southeastern corner and B – the more fragmentary rocks on the surface. C – Site 6 in the southeastern section where Mn-rich rocks are being mined. D – boulder over 1.5m diameter with distinctive blue-black sheen and no layering.



Figure 10: A - Site 6 and view southwards, B – gravel and undisturbed sand and vegetation interface at site 6. No fossils.

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Tables A-D. The criteria for the description and assessment of environmental impacts were drawn from the EIA Guidelines (DEAT, Environmental Impact Assessment Guidelines., 1998) and as amended from time to time (DEAT, Impact Significance, Integrated Environmental Management, Information series 5, 2002).

Table 4A: Impact Assessment Criteria

EXTENT	
Classification of the physical and spatial scale of the impact	
Footprint	The impacted area extends only as far as the activity, such as footprint occurring within the total site area.
Site	The impact could affect the whole, or a significant portion of the site.
Regional	The impact could affect the area including the neighbouring farms, the transport routes and the adjoining towns.
National	The impact could have an effect that expands throughout the country (South Africa).
International	Where the impact has international ramifications that extend beyond the boundaries of South Africa.
DURATION	
The lifetime of the impact that is measured in relation to the lifetime of the proposed development.	
Short term	The impact will either disappear with mitigation or will be mitigated through a natural process in a period shorter than that of the construction phase.
Short to Medium term	The impact will be relevant through to the end of a construction phase (1.5 years).
Medium term	The impact will last up to the end of the development phases, where after it will be entirely negated.
Long term	The impact will continue or last for the entire operational lifetime i.e. exceed 30 years of the development, but will be mitigated by direct human action or by natural processes thereafter.
Permanent	This is the only class of impact, which will be non-transitory. Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact can be considered transient.
INTENSITY	
The intensity of the impact is considered by examining whether the impact is destructive or benign, whether it destroys the impacted environment, alters its functioning, or slightly alters the environment itself. The intensity is rated as	
Low	The impact alters the affected environment in such a way that the natural processes or functions are not affected.
Medium	The affected environment is altered, but functions and processes continue, albeit in a modified way.
High	Function or process of the affected environment is disturbed to the extent where it temporarily or permanently ceases.
PROBABILITY	
This describes the likelihood of the impacts actually occurring. The impact may occur for any length of time during the life cycle of the activity, and not at any given time. The classes are rated as follows:	
Improbable	The possibility of the impact occurring is none, due either to the circumstances, design or experience. The chance of this impact occurring is zero (0 %).
Possible	The possibility of the impact occurring is very low, due either to the circumstances, design or experience. The chances of this impact occurring is defined as 25 %.
Likely	There is a possibility that the impact will occur to the extent that provisions must therefore be made. The chances of this impact occurring is defined as 50 %.
Highly Likely	It is most likely that the impacts will occur at some stage of the development. Plans must be drawn up before carrying out the activity. The chances of this impact occurring is defined as 75 %.
Definite	The impact will take place regardless of any prevention plans, and only mitigation actions or contingency plans to contain the effect can be relied on. The chance of this impact occurring is defined as 100 %.

Table 4B: Significance-Without Mitigation

NO SIGNIFICANCE	The impact is not substantial and does not require any mitigation action.
LOW	The impact is of little importance, but may require limited mitigation.
MEDIUM	The impact is of importance and is therefore considered to have a negative impact. Mitigation is required to reduce the negative impacts to acceptable levels.

HIGH	The impact is of major importance. Failure to mitigate, with the objective of reducing the impact to acceptable levels, could render the entire development option or entire project proposal unacceptable. Mitigation is therefore essential.

Table 4C: Significance- With Mitigation

NO SIGNIFICANCE	The impact will be mitigated to the point where it is regarded as insubstantial.
LOW	The impact will be mitigated to the point where it is of limited importance.
LOW TO MEDIUM	The impact is of importance, however, through the implementation of the correct mitigation measures such potential impacts can be reduced to acceptable levels.
MEDIUM	Notwithstanding the successful implementation of the mitigation measures, to reduce the negative impacts to acceptable levels, the negative impact will remain of significance. However, taken within the overall context of the project, the persistent impact does not constitute a fatal flaw.
MEDIUM TO HIGH	The impact is of major importance but through the implementation of the correct mitigation measures, the negative impacts will be reduced to acceptable levels.
HIGH	The impact is of major importance. Mitigation of the impact is not possible on a cost-effective basis. The impact is regarded as high importance and taken within the overall context of the project, is regarded as a fatal flaw. An impact regarded as high significance, after mitigation could render the entire development option or entire project proposal unacceptable.

Table 4D: Description of assessment parameters with its respective weighting. The pink indicates the results for the palaeontology only

EXTENT	DURATION	INTENSITY	PROBABILITY	WEIGHTING FACTOR (WF)	SIGNIFICANCE RATING (SR)
Footprint	1 Short term	1 Low	1 Probable	1 Low	Low 0-19
Site	2 Short to Medium	2	2 Possible	2 Low to Medium	Low to Medium 20-39
Regional	3 Medium term	3 Medium	3 Likely	3 Medium	Medium 40-59
National	4 Long term	4	4 Highly Likely	4 Medium to High	Medium to High 60-79
International	5 Permanent	5 High	5 Definite	5 High	High 80-100
MITIGATION EFFICIENCY (ME)		SIGNIFICANCE FOLLOWING MITIGATION (SFM)			
High		0.2	Low		0 - 19
Medium to High		0.4	Low to Medium		20 - 39
Medium		0.6	Medium		40 - 59
Low to Medium		0.8	Medium to High		60 - 79
Low		1.0	High		80 - 100

Identifying the Potential Impacts Without Mitigation Measures (WOM)

Following the assignment of the necessary weights to the respective aspects, criteria are summed and multiplied by their assigned weightings, resulting in a value for each impact (prior to the implementation of mitigation measures).

Equation 1:

$$\begin{aligned}\text{Significance Rating (WOM)} &= (\text{Extent} + \text{Intensity} + \text{Duration} + \text{Probability}) \times \text{Weighting Factor} \\ &= (1 + 1 + 5 + 2) \times 3 \\ &= 27\end{aligned}$$

Identifying the Potential Impacts With Mitigation Measures (WM)

In order to gain a comprehensive understanding of the overall significance of the impact, after implementation of the mitigation measures, it was necessary to re-evaluate the impact.

1.1.1.1.1. Mitigation Efficiency (ME)

The most effective means of deriving a quantitative value of mitigated impacts is to assign each significance rating value (WOM) a mitigation efficiency (ME) rating (refer to Table D). The allocation of such a rating is a measure of the efficiency and effectiveness, as identified through professional experience and empirical evidence of how effectively the proposed mitigation measures will manage the impact.

Thus, the lower the assigned value the greater the effectiveness of the proposed mitigation measures and subsequently, the lower the impacts with mitigation.

Equation 2:

$$\begin{aligned}\text{Significance Rating (WM)} &= \text{Significance Rating (WOM)} \times \text{Mitigation Efficiency} \\ \text{or WM} &= \text{WOM} \times \text{ME} \\ &= 27 \times 0.2 \\ &= 5.4\end{aligned}$$

Significance Following Mitigation (SFM)

The significance of the impact after the mitigation measures are taken into consideration. The efficiency of the mitigation measure determines the significance of the impact. The level of impact is therefore seen in its entirety with all considerations taken into account.

SFM = 0 – 19 (green) = LOW

Mitigation = removal of any fossils found once drilling or excavations have commenced.

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 of the wrong kind to contain fossils in the case of the Kuruman and Gamagara Formations, or no trace fossils were found in this site, in the case of the Ghaap Group. Furthermore, the material to be targeted is not in the limestones of the Ghaap Group. Since there is an extremely small chance that trace fossils from the nearby Ghaap Group limestones may be disturbed a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, and the impact assessment in Tables 4A-D, 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 banded iron, dolomites, sandstones, shales and sands are typical for the country and do not contain fossil plant, insect, invertebrate and vertebrate material. Only the limestones might preserve trace fossils. There were no palaeo-pan or palaeo-spring features in the site, therefore, the sands and soils of the Quaternary period would not preserve fossils.

6. Recommendation

Based on the site visit survey and observations and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the Ghaap Group limestones or soils and loose sands of the Quaternary. There is a very small chance that fossils may occur in the limestones so a Fossil Chance Find Protocol should be added to the EMPr: if fossils are found once mining has commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample.

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Walker, S.J.H., Lukich, V., Chazan, M., 2014. Kathu Townlands: A High Density Earlier Stone Age Locality in the Interior of South Africa. PLoS ONE 9(7): e103436. doi:10.1371/journal.pone.0103436

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 excavations/mining commence.
2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (stromatolites, plants, insects, bone) should be put aside in a suitably protected place. This way the mining activities will not be interrupted.
3. Photographs of similar fossil plants must be provided to the developer to assist in recognizing the fossil plants in the shales and mudstones (for example see Figure 11-12). This information will be built into the EMP's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. If there is any possible fossil material found by the developer/environmental officer/miners then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
7. If no good fossil material is recovered then no site inspections by the palaeontologist will not be necessary. A final report by the palaeontologist must be sent to SAHRA once the project has been completed and only if there are fossils.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

Appendix A – Examples of fossils that could be found



Figure 11: Stromatolites from the Malmani Subgroup as seen from the surface



Figure 12: Fragments of bones from a Pleistocene palaeoan site in the Free State.

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD July 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	9	2
Masters	9	5
PhD	11	5
Postdoctoral fellows	10	4

viii) Undergraduate teaching

Geology II – Palaeobotany GEOL2008 – average 65 students per year
 Biology III – Palaeobotany APES3029 – average 25 students per year
 Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology;
 Micropalaeontology – average 2-8 students per year.

ix) Editing and reviewing

Editor: Palaeontologia africana: 2003 to 2013; 2014 – Assistant editor
 Guest Editor: Quaternary International: 2005 volume
 Member of Board of Review: Review of Palaeobotany and Palynology: 2010 –
 Cretaceous Research: 2014 –

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 July 2020 peer-reviewed journals or scholarly books: over 150 articles published; 5 submitted/in press; 8 book chapters.

Scopus h index = 29; Google scholar h index = 36;

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)

CV of Alisoun Valentine House

084 5870023

alisoun.house@wits.ac.za

KEY SKILLS AND ATTRIBUTES

- The stamina and ability to work effectively under pressure.
- Highly developed social and interpersonal skills.
- Good communication skills, both oral and written.
- The ability to be creative and innovative and to find workable strategies to achieve stated aims.
- Excellent organisational skills.
- The ability to analyse situations, behaviour and thinking and respond with patience and understanding.
- Research and scientific writing.

WORK HISTORY

Postdoc Fellow – Evolutionary Studies Institute

January 2019 – December 2020

January 2018 – December 2018

January 2017 – December 2017

Analysis of archaeological charcoal from an 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

Responsibilities included teaching general biology to first and second year students in the College of Science; as well as marking essays and assignments.

P.A. to Director/Manager of Cowling Davies (Small Advertising/Design Studio)

April 1992 – December 1992

Responsibilities included reception work; office administration; preparation of quotations; booking media advertisements and general assistance.

Herbarium Technician - University of the Witwatersrand

October 1991 – March 1992

Responsibilities included identification, pressing and mounting of plant specimens; capturing and maintaining data in the Herbarium computer system; maintaining the

collection; filing; acting as librarian for the reference book collection and assisting students with research.

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.

House A. and Balkwill K. 2013. FIB-SEM: An Additional Technique for Investigating Internal Structure of Pollen Walls. Microscopy & Microanalysis 19: 1535–1541.

House A. and Balkwill K. 2014. FIB-SEM: A new technique for investigating pollen walls. Microscopy: advances in scientific research and education (A. Méndez-Vilas, Ed.) 1: 54–58. © FORMATEX.

House A. and Balkwill K. 2016. Labyrinths, columns and cavities: new internal features of pollen grain walls in the Acanthaceae detected by FIB-SEM. Journal of Plant Research 129: 225–240.

House A. and Balkwill K. 2017. FIB-SEM enhances the potential taxonomic

significance of internal pollen wall structure at the generic level. *Flora-Morphology, Distribution, Functional Ecology of Plants* 236–237C: 44–57.

House A. 2017. FIB-SEM: a new method for examining pollen grain walls and palaeontological specimens in 3D. *Proceedings of the 21st diennial conference of the South African Society of Quaternary Research. Palaeontologia Africana*, 52:21–22. ISSN 2410-4418.

House A. and Balkwill K. 2019. Development and expansion of the pollen wall in *Barleria obtusa* Nees (Acanthaceae). *South African Journal of Botany* 125: 188–195.

House, A., Bamford, M.K., 2019. Investigating the utilisation of woody plant species at an Early Iron Age site in KwaZulu-Natal, South Africa, by means of identifying archaeological charcoal. *Archaeological and Anthropological Sciences* 11, 6737–6750. <https://doi.org/10.1007/s12520-019-00939-9>

House, A., Bamford, M.K., Chikumbirike, J., (in press). Charcoal from Holocene deposits at Wonderwerk Cave, South Africa: A source of palaeoclimate information. Special issue on WW, in *Quaternary International* <https://doi.org/10.1016/j.quaint.2020.10.039>

Esteban, I., Bamford, M.K., Miller, C.S., Neumann, F.H., Schefuß, E., House, A., Pargeter, J., Cawthra, H., C., Fisher, E.C., in press. Palaeoenvironments of hunter-gatherers from MIS 3 to the Holocene 1 in coastal Pondoland (South Africa): a biochemical and palaeobotanical approach. *Quaternary Research*.

McCullum DA, House AV, Balkwill K (Eds). *The Flora of the Witwatersrand*. (Vol. 2). Dicotyledons – Piperaceae to Ebenaceae. NiSC. IN PRESS, (Publishing date- December 2019).

McCullum DA, House AV, Balkwill K (Eds). *The Flora of the Witwatersrand*. (Vol. 3). Dicotyledons – Oleaceae to Compositae. NiSC IN PRESS, (Publishing date- December 2019).

House A. and Bamford M.K. (in press). Furnaces, hearths, rituals and construction: investigating the utilisation of woody plant species at an Early Iron Age site by means of identifying archaeological charcoal. (In Preparation).

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

September 2019 – Vulindlela BWS for KSEMS

November 2019 – Derseley outfall sewer for Digby Wells

June-Nov 2020 – Frankfort-Windfield 88kV line for Eskom and 1World.