Palaeontological Impact Assessment for the proposed clearing of vegetation for agriculture on Farms Doornhoek 451 and Kaspersnek 481, Ohrigstad, Mpumalanga Province

Site Visit (Phase 2) Report

For

Eco 8 Environmental Planners

13 March 2021

Prof Marion Bamford
Palaeobotanist
P Bag 652, WITS 2050
Johannesburg, South Africa
Marion.bamford@wits.ac.za

Expertise of Specialist

The Palaeontologist Consultant is: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 32 years research; 24 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Kudzala, 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: MKBamford

Executive Summary

A palaeontological Impact Assessment was requested for the proposed clearing of indigenous vegetation for the purpose of agricultural development (citrus orchard) on the Farms Doornhoek 451 and Kaspersnek 481, east of Ohrigstad, Mpumalanga 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 site visit (phase 2) Palaeontological Impact Assessment (PIA) was completed for the proposed project.

The site visit and survey on foot was carried out on 09 March 2021 by Prof Marion Bamford and Dr Alisoun House, and **no fossils were found in the project area**.

The proposed sites lie on the Quaternary alluvium along the road and river that is non fossiliferous. More or less parallel to that is the potentially fossiliferous Malmani Subgroup (Chuniespoort Group, Transvaal Supergroup) dolomites, limestones and cherts that could potentially preserve trace fossils such as stromatolites but based on the site visit observations the dolomite outcrops are very rare and occur where the land is too rocky and too steep for cultivation. Away from the river valley is the Timeball Hill quartzites but no fossils were found there either. Nonetheless, 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 stromatolites are found once the vegetation is cleared.

Table of Contents

1. Background

Kaspersnek Fruits proposes to extend their citrus orchards on Farms Doornhoek 451 and Kaspersnek 481 in the valley along the Kweta River. There are established and new orchards in the valley and mostly along the southwestern side of the river on land with a gentle slope. The valley sides rise steeply away from the river and valley floor.

There are five sections to be investigated: Doornhoek sections 1 – 4 (Figure 1) and Kaspersnek section that was used for cattle, and currently used for game (Figure 2). All sections are planned for clearing and cultivation of citrus orchards.

A Palaeontological Impact Assessment was requested for the above 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 site visit (phase 2) Palaeontological Impact Assessment (PIA) was completed for the proposed development and the observations and recommendations are presented herein.

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

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
ai	Details of the specialist who prepared the report	Appendix
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	N/A

	buffers;	
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

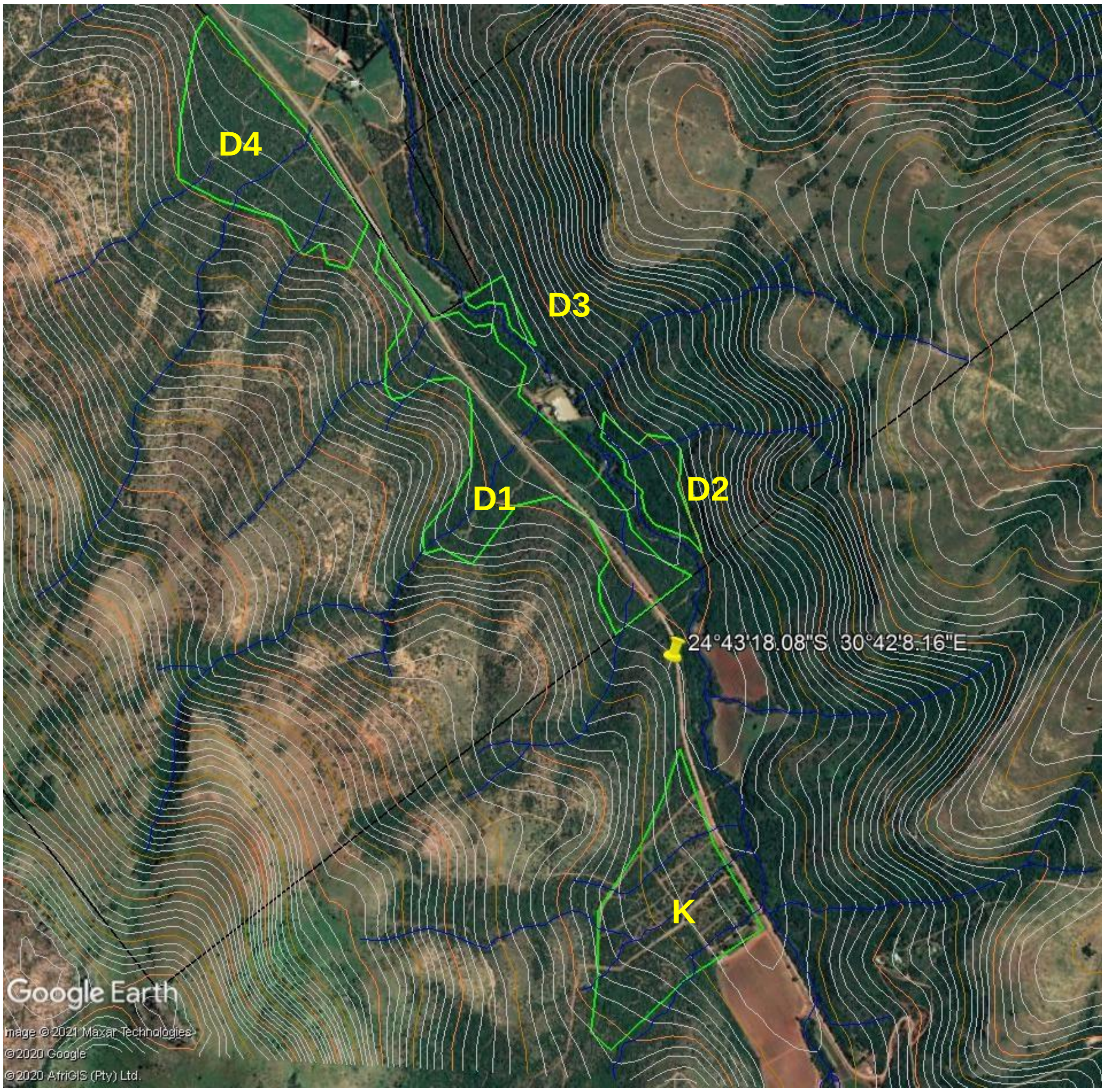

Figure 1: Google Earth map with overlaid contour lines of the Farms Doornhoek and Kaspersnek shown by the green outlines. K = section on Farm Kaspernek (and updated detail in Figure 2). D1 – D4 = separate sections on Farm Doornhoek.

Figure 2: Google Earth map of the Kaspersnek Farm section boundary of the proposed area for clearing of vegetation and planting an orchard, with the sections shown by the blue outline. Map supplied by Kudzala.

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.

3. Geology and Palaeontology

i. Project location and geological context

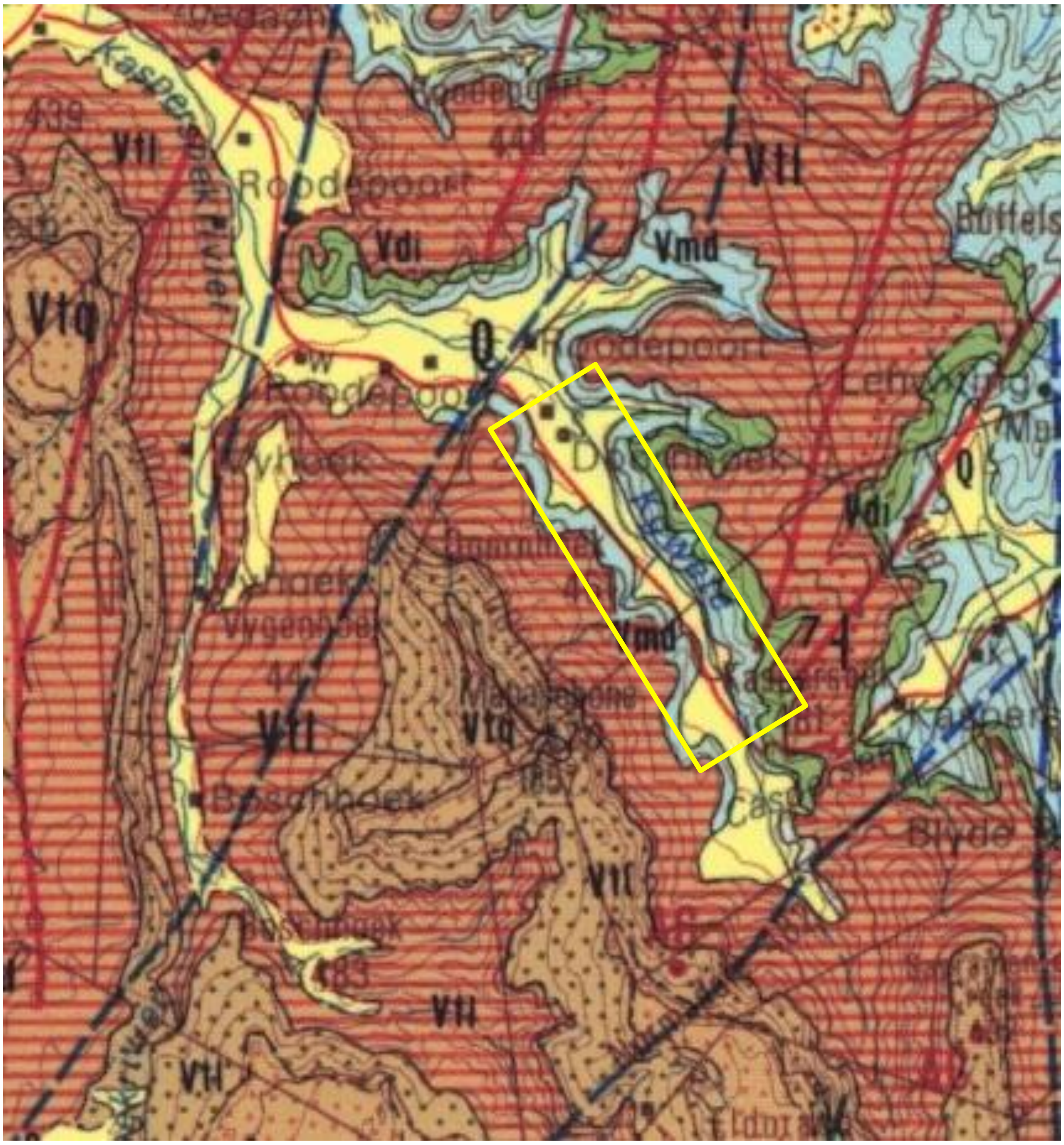

Figure 3: Geological map of the area around the Farms Doornhoek and Kaspersnek, northeast of Ohrigstad. The location of the proposed project is indicated within the yellow rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2430 Barberton.

Table 2: Explanation of symbols for the geological map and approximate ages (Eriksson et al., 2006, 2012; Zeh et al., 2020). 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	Neogene, ca 2.5 Ma to present
Di	Diabase	Intrusive volcanic diabase	<2089 Ma
Vt	Timeball Hill Fm, Pretoria Group, Transvaal SG	Quartzite (Klapperkop Mbr), mudstone, conglomerate (top)	2316 - 2266 Ma
Vm	Malmani Subgroup, Chuniespoort Group, Transvaal SG	Dolomite, limestone, chert	Ca 2585 - 2480 Ma
Vbr	Black Reef Fm, Transvaal SG	Quartzite, conglomerate, shale, basalt	>2585 Ma

The site lies in the eastern part of the Transvaal Basin that is filled with rocks of the Transvaal Supergroup, and in particular, on rocks of the Malmani Subgroup, Timeball Hill Formation and overlying alluvium of Quaternary age (Figure 3, Table 2).

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 three 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.

In the Transvaal Basin the Transvaal Supergroup is divided into two Groups, the lower Chuniespoort Group and the upper Pretoria Group (with ten formations; Eriksson et al., 2006). The Chuniespoort Group is divided into the basal **Malmani Subgroup** that comprises dolomites and limestones and is divided into five formations based on chert content, stromatolitic morphology, intercalated shales and erosion surfaces. The top of the Chuniespoort Group has the Penge Formation and the Duitschland Formation.

Making up the lower Pretoria Group are the **Timeball Hill Formation** and the Boshoek Formation. The Hekpoort, Dwaalheuwel, Strubenkop and Daspoort Formations form a sequence as the middle part of the Pretoria Group, Transvaal Supergroup, and represent rocks that are over 2060 million years old. The Hekpoort Formation is a massive lava deposit and is overlain by the Dwaalheuwel conglomerates, siltstone and sandstone (not present here). A hiatus separates the Strubenkop Formation slates and shales from the overlying quartzites of the Daspoort Formation. Upper Pretoria Group formations are the Silverton, Magaliesberg, Vermont, Lakenvalei, Nederhorst, Steenkampsberg and Houtenbek Formations

The Transvaal sequence has been interpreted as three major cycles of basin infil and tectonic activity with the first deep basin sediments forming the Chuniespoort Group, the second cycle deposited the lower Pretoria Group, and the sediments in this area are from the interim lowstand that preceded the third cycle. These sediments were deposited in shallow lacustrine, alluvial fan and braided stream environments (Eriksson et al., 2012).

Transvaal Supergroup rocks in the Transvaal Basin were intruded by the Bushveld Complex at around 2060 million year ago (Eriksson et al. 2006; 2055 Ma in Zeh et al., 2020), with the Magaliesberg Formation of the Pretoria Group forming the floor rocks in most areas (Eriksson et al., 2006). In other areas of the basin the lavas and other subordinate sedimentary rocks of the Rooiberg Group form the floor instead (ibid).

The Transvaal Supergroup rocks represent on a very large scale, a sequence of sediments filling the three 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 photosysnthesis, 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).

Overlying the Rooihoogte Formation is the Timeball Hill Formation which is composed of thick shales and subordinate sandstones that were deposited in a fluvio-deltaic basin-filling sequence (Eriksson et al., 2006). A number of facies are included in this formation. At the base is black shale facies associated with subsurface lavas and pyroclastic rocks of the Bushy Bend Lava Member. Above these are rhythmically interbedded mudstones/siltstones and fine-grained sandstones that have been interpreted as turbidite deposits (Eriksson et al., 2006). These fine-grained sediments grade up into the medial Klapperkop Quartzite Member that has been interpreted as fluvio-deltaic sandstones which fed the more distal turbidites (ibid). Above this is an upper shale member and rhythmite facies. In the east of the Transvaal Basin the Upper Timeball Hill shales have undergone extensive soft-sediment deformation caused by the onset of tectonic instability that led to the eventual fan deposits of the Boshoek Formation and the flood basalts of the Hekpoort Formation (ibid).

After the deposition of the Transvaal Supergroup sediments, volcanic activity resulted in the intrusion of dykes through the sediments thus leaving bands of diabase. Since these are non-fossiliferous they not be considered any further.

Erosion over time has led to the deposition of alluvium, sands and scree along the river beds. They are Quaternary in age and may have been sourced from a number of older strata at some distance from their present site of deposition.

ii. Palaeontological context

The Malmani Subgroup comprises dolomites, limestones, cherts and stromatolitic dolomites. The latter were formed in warm shallow sea and are the accumulation of layer upon layer of minerals deposited by blue-green algae (also known as cyanobacteria) and rarely some filamentous algae. Minerals deposited by the algae include calcium carbonate, calcium sulphate and magnesium carbonate. Very rarely are the algal cells preserved in the stromatolites and these are microscopic. Stomatolites are essentially trace fossils and these ones are 2750 to 2650 million years old and very abundant.

According to Schroder et al. (2016), the Timeball Hill Formation consists of two coarsening-upward sequences (each about 200 m thick), separated by a marine flooding surface. In each sequence, carbonaceous black mudstones at the base gradually pass up section to even and wavy laminated siltstone with graded lamination and wave ripple cross lamination. The lower sequence is capped by a 6275 m thick quartzite with iron oolitic beds, fining- and coarsening-upward quartzite units, the Klapperkop Quartzite Member. Palaeocurrent measurements that were taken in cross-bedded quartzites indicate source areas towards the north, north-east and west.

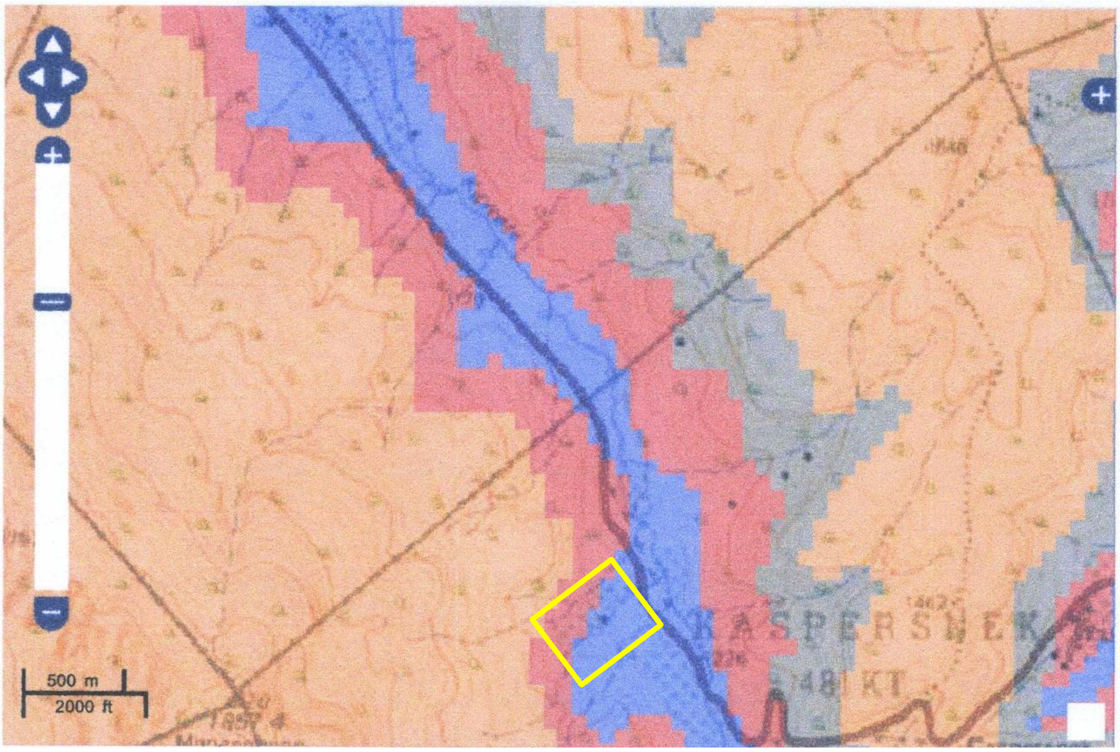

Figure 4: SAHRIS palaeosensitivity map for the site for the proposed clearing of vegetation on Farm Kaspersnek 481 KT shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

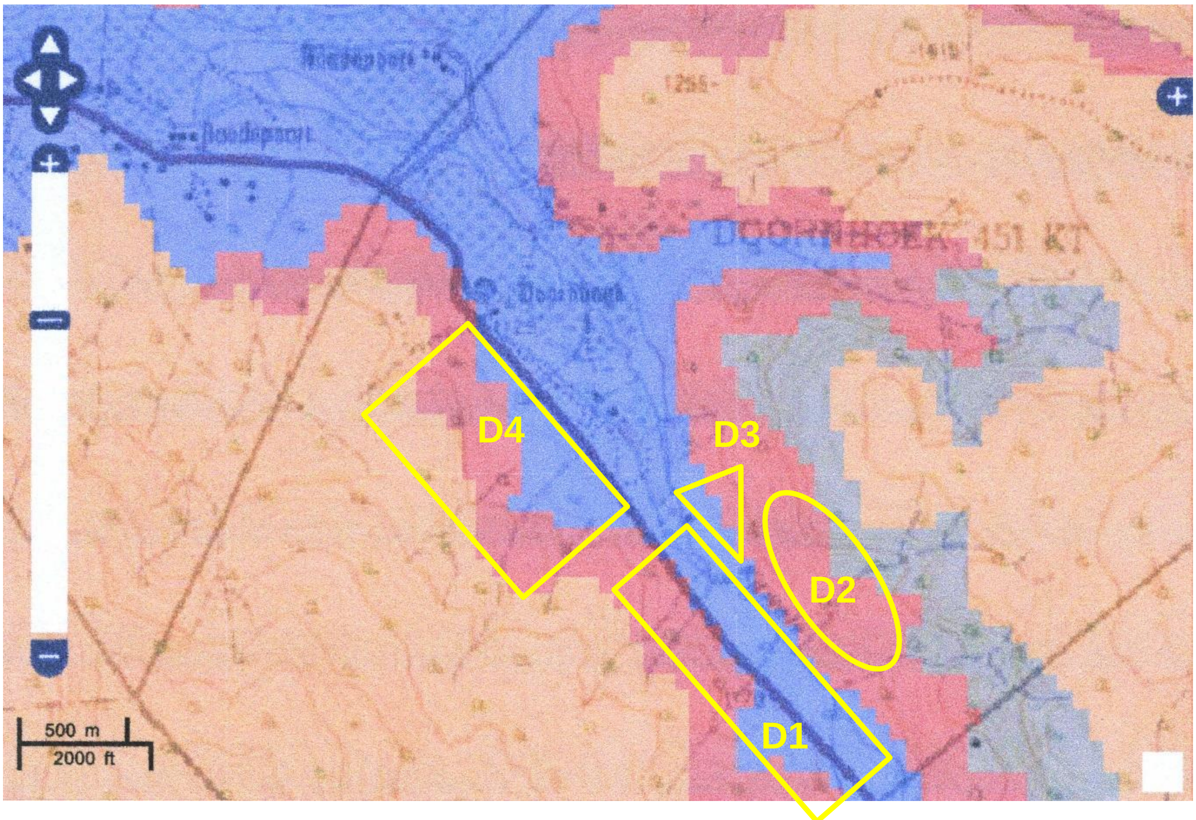

Figure 5: SAHRIS palaeosensitivity map for the Farm Doornfontein with the sections marked in yellow outlines and numbered the same as in Figure 1. See Figure 4 for background colours.

From the SAHRIS map above part of the area is indicated as very highly sensitive (red) so a site visit was undertaken on 09 March 2021.

Iii Site visit observations

Based on the geology and the chance of finding fossils, a site visit was conducted by Prof Bamford and Dr House on 09 March 2021 in search of dolomite with stromatolites in the Malmani Subgroup and the Timeball Hill Formation. Any fossils found would be photographed and their location recorded with GPS coordinates from a handheld Garmin etrex-20.

Table 3: Site visit stops, co-ordinates and observations. Figures refer to photographs taken by Bamford and appearing below the table.

GPS coordinates	Observations	Figure
Stop 1 24° 43,927" S 30° 42,684" E	Farm Kaspersnek, central part for recci to find typical dolomite for the region. Roadside stop on the bend of the road. Only exposure of dolomite seen at all. Above and below are weathered mudstones. No stromatolites seen in the dolomite and the gradient is much too steep for planting and irrigating orchards	6

Stop 2 24° 44.621"S 30° 42,301" E	Part of recci in open land to see the exposed soils and slope that is preferred for cultivation. Southernmost extent of new orchard on Kaspersnek. Beyond the orchard the land is very steep and densely vegetated with typical Bushveld trees shrubs and rare grasses.	7, 8
Stop 3 24° 43, 663" S 30° 43,667" E (K on maps)	Farm Kaspersnek, fenced-in field that used to have cattle and now has only impala, nyala and waterbuck. Bushveld vegetation more open with grassy patches. Water trough and feeding trough. Shallow sandy soil and slate, small quartzite boulders and rare conglomerate. No dolomite and no stromatolites	
	Walked through the grid-like pattern of roads but could find no more outcrops of dolomite.	
Stop 4 24° 43,795" S 30° 42,028" E	Fence line at the higher elevation of this section. Same vegetation and soils as at previous point but a few more pieces of fractured quartzite. No dolomite and no fossils	
Stop 5 24° 43,468" S 30° 42,228"E	Northern border of the field and close to the gravel road. Disturbed Bushveld vegetation, deeper soils here and fewer pieces of slate and mudstone. No dolomite and no fossils.	9
Stop 6 24° 43.066" S 30° 41,708" E	Farm Doornhoek section 1. Dense vegetation surrounding the more open drainage. Rocky soils and alluvium and no outcrops. No fossils	10, 11
Stop 7 24° 42,931" S 30° 41,988" E	Doornhoek section 2, area near the building. Dense vegetation beyond but topography slightly sloping and not steep enough for the dolomite outcrops to be exposed.	12
Stop 8 24° 42,627" S 30° 41,627" E	Doornhoek section 3, end of road because vegetation is too dense. Beyond the topography is slightly sloping and not steep enough for the dolomite outcrops to be exposed. No fossils	13
Stop 9 24° 42,261" S 30° 41,258" E	Doornhoek 4. Roadside stop because no accessibility. Again the topography is a slight slope and not steep enough for the dolomite exposures, Soil and slatey mudrocks only	No photos

Figure 6: Photograph of the only exposure of dolomite found on the two farms. Note the steep slope of the outcrop. This dolomite does not have any stromatolites.

Figure 7: View across the central part of Farm Kaspersnek to get an impression of the gentle slopes required for the orchards.

Figure 8: Newly planted citrus orchard on central Kaspersnek. Note the pieces of slate and mudstone that have been exhumed, and the orchards extending in the background as far as the abrupt change in slope.

Figure 9: Farm Kaspersnek, section to be developed, fence on the far side from the road. This section is indicated as fossiliferous on the SAHRIS map (Figure 4) but there are no outcrops of dolomite to be seen (Stop 4).

Figure 9: Farm Kaspersnek showing the stones and soils that occur commonly in this section.

Figure 10: Doornhoek section 1 with gentle topography, stony soil and no rocky outcrops or dolomite.

Figure 11: (Stop 6) Farm Doornhoek section 1. Soils and alluvium but no dolomite and no fossils.

Figure 12: (Stop 7) Farm Doornhoek section 2. Low topography and dense Bushveld vegetation.

Figure 13: (Stop 8) Farm Doornhoek section 3. Sandy alluvium and no rocky outcrops.

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	**L**	Quickly reversible. Less than the project life. Short term

DURATION of impacts	**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	-
	L	Sands and soils do not preserve fossils; dolomites of the Malmani Subgroup might preserve trace fossils or stromatolites. So far there are no records from the Timeball Hill Fm of any trace fossils in this region so it is very unlikely that fossils occur on the site. The impact would be very unlikely.
	L+	-
	M+	-
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	**L**	Since only the possible fossils within the area would be trace fossils such as stromatolites in the dolomites, 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 sand that will be cultivated; the dolomites are hard rocks and often form steep faces so would not be cultivated. 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 but there might be trace fossils such as stromatolites in the Malmani subgroup dolomites. However, rocky faces or surfaces will not be cultivated because there are no soils on them. Since there is an extremely small chance that trace fossil such as stromatolites of the Malmani 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 do not contain fossil plant, insect, invertebrate and vertebrate material. Malmani Subgroup dolomites could contain stromatolites BUT only one exposure was found, farther up the slope and on ground that is too steep and impractical for the establishment of an orchards. The soils and sands of the Quaternary period would not preserve fossils. NO fossils were found in the project footprint.

6. Recommendation

Based on the site visit survey and observations, there are n stromatolites or any other fossils in the project footprint. It is extremely unlikely that any fossils would be preserved in the rocks below the soils because the dolomites occurred much higher up the valley slope than the flatter lands that are the target of the project. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr: if fossils are found once clearing of the vegetation and ploughing of the land for planting have commenced then they should be rescued, photographs sent to a palaeontologist to assess and decide whether to collect a representative sample.

7. References

Anderson, J.M., Anderson, H.M., 1985. Palaeoflora of Southern Africa: Prodromus of South African megafloras, Devonian to Lower Cretaceous. A.A. Balkema, Rotterdam. 423 pp.

Beukes, N.J., 1987. Facies relations, depositional environments, and diagenesis in a major early Proterozoic stromatolitic carbonate platform to basinal sequence, Campbell Rand Subgroup, Transvaal Supergroup, southern Africa. Sedimentary Geology 54, 1-46.

Eriksson, P.G., Altermann, W., Hartzer, F.J., 2006. The Transvaal Supergroup and its pre-cursors. 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 237-260.

Eriksson, P.G., Bartman, R., Catuneanu, O., Mazumder, R., Lenhardt, N., 2012. A case study of microbial mats-related features in coastal epeiric sandstones from the Palaeoproterozoic Pretoria Group, Transvaal Supergroup, Kaapvaal craton, South Africa; the effect of preservation (reflecting sequence stratigraphic models) on the relationship between mat features and inferred palaeoenvironment. Sedimentary Geology 263, 67-75.

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.

Schröder, S., Beukes, N.J., Armstrong, R.A., 2016. Detrital zircon constraints on the tectonostratigraphy of the Paleoproterozoic Pretoria Group, South Africa. Precambrian Research 278, 362 – 393.

Zeh, A., Wilson, A.H., Gerdes, A., 2020. Zircon U-Pb-Hf isotope systematics of Transvaal Supergroup – Constraints for the geodynamic evolution of the Kaapvaal Craton and its hinterland between 2.65 and 2.06 Ga. Precambrian Research 345, 105760. https://doi.org/10.1016/j.precamres.2020.105760

8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the clearing of vegetation and ploughing activities begin.

1. The following procedure is only required if fossils are seen on the surface and when clearing and ploughing commence.
2. When the activities begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (dolomite with stromatolites) should be put aside in a suitably protected place. This way the mining activities will not be interrupted.
3. Photographs of similar fossils must be provided to the developer to assist in recognizing the trace fossils in the dolomites (for example see Figure 14, 15). 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 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. 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.

Appendix A – examples of stromatolites from the Malmani Subgroup

Figure14: Examples of stromatolites, a - in the field in side view; b – surface view in the field; c – side view in section. (Photographs from MacRae, 1999. Life etched in Stone).

Figure 15: Surface view of stromatolites (notice the concentric rings). 15cm scale.

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
January 2021

I) Personal details

Surname	:	**Bamford**
First names	:	**Marion Kathleen**
Present employment	:	Professor; Director of the Evolutionary Studies Institute. Member Management Committee of the NRF/DST Centre of Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa-
Telephone	:	+27 11 717 6690
Fax	:	+27 11 717 6694
Cell	:	082 555 6937
E-mail	:	marion.bamford@wits.ac.za ; marionbamford12@gmail.com

ii) Academic qualifications

Tertiary Education: All at the University of the Witwatersrand:
1980-1982: BSc, majors in Botany and Microbiology. Graduated April 1983.
1983: BSc Honours, Botany and Palaeobotany. Graduated April 1984.
1984-1986: MSc in Palaeobotany. Graduated with Distinction, November 1986.
1986-1989: PhD in Palaeobotany. Graduated in June 1990.

iii) Professional qualifications

Wood Anatomy Training (overseas as nothing was available in South Africa):
1994 - Service d'Anatomie des Bois, Musée Royal de l'Afrique Centrale, Tervuren, Belgium, by Roger Dechamps
1997 - Université Pierre et Marie Curie, Paris, France, by Dr Jean-Claude Koeniguer
1997 - Université Claude Bernard, Lyon, France by Prof Georges Barale, Dr Jean-Pierre Gros, and Dr Marc Philippe

iv) Membership of professional bodies/associations

Palaeontological Society of Southern Africa
Royal Society of Southern Africa - Fellow: 2006 onwards
Academy of Sciences of South Africa - Member: Oct 2014 onwards
International Association of Wood Anatomists - First enrolled: January 1991
International Organization of Palaeobotany – 1993+
Botanical Society of South Africa
South African Committee on Stratigraphy – Biostratigraphy - 1997 - 2016
SASQUA (South African Society for Quaternary Research) – 1997+

PAGES - 2008 –onwards: South African representative
ROCEEH / WAVE – 2008+
INQUA – PALCOMM – 2011+onwards

vii) Supervision of Higher Degrees

All at Wits University

Degree	Graduated/completed	Current
Honours	11	2
Masters	10	5
PhD	11	4
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 –
Journal of African Earth Sciences: 2020 –

Review of manuscripts for ISI-listed journals: 25 local and international journals

x) Palaeontological Impact Assessments

Selected – list not complete:

- Thukela Biosphere Conservancy 1996; 2002 for DWAF
- Vioolsdrift 2007 for Xibula Exploration
- Rietfontein 2009 for Zitholele Consulting
- Bloeddrift-Baken 2010 for TransHex
- New Kleinfontein Gold Mine 2012 for Prime Resources (Pty) Ltd.
- Thabazimbi Iron Cave 2012 for Professional Grave Solutions (Pty) Ltd
- Delmas 2013 for Jones and Wagener
- Klipfontein 2013 for Jones and Wagener
- Platinum mine 2013 for Lonmin
- Syferfontein 2014 for Digby Wells
- Canyon Springs 2014 for Prime Resources
- Kimberley Eskom 2014 for Landscape Dynamics
- Yzermyne 2014 for Digby Wells
- Matimba 2015 for Royal HaskoningDV

- Commissiekraal 2015 for SLR
- Harmony PV 2015 for Savannah Environmental
- Glencore-Tweefontein 2015 for Digby Wells
- Umkomazi 2015 for JLB Consulting
- Ixia coal 2016 for Digby Wells
- Lambda Eskom for Digby Wells
- Alexander Scoping for SLR
- Perseus-Kronos-Aries Eskom 2016 for NGT
- Mala Mala 2017 for Henwood
- Modimolle 2017 for Green Vision
- Klipoortjie and Finaalspan 2017 for Delta BEC
- Ledjadja borrow pits 2018 for Digby Wells
- Lungile poultry farm 2018 for CTS
- Olienhout Dam 2018 for JP Celliers
- Isondlo and Kwasobabili 2018 for GCS
- Kanakies Gypsum 2018 for Cabanga
- Nababeep Copper mine 2018
- Glencore-Mbali pipeline 2018 for Digby Wells
- Remhoogte PR 2019 for A&HAS
- Bospoort Agriculture 2019 for Kudzala
- Overlooked Quarry 2019 for Cabanga
- Richards Bay Powerline 2019 for NGT
- Eilandia dam 2019 for ACO
- Eastlands Residential 2019 for HCAC
- Fairview MR 2019 for Cabanga
- Graspan project 2019 for HCAC
- Lieliefontein N&D 2019 for Enviropro
- Skeerpoort Farm Mast 2020 for HCAC
- Vulindlela Eco village 2020 for 1World
- KwaZamakhule Township 2020 for Kudzala
- Sunset Copper 2020 for Digby Wells
- McCarthy-Salene 2020 for Prescali
- VLNR Lodge 2020 for HCAC
- Madadeni mixed use 2020 for Enviropro

xi) Research Output

Publications by M K Bamford up to December 2019 peer-reviewed journals or scholarly books: over 150 articles published; 5 submitted/in press; 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 *January 2021*

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.
October 2020 – Salene-McCarthy Manganese mine for Prescali

November 2020 – Universal Coal Ubuntu Colliery for HCAC