Palaeontological Impact Assessment for the proposed clearing for agriculture on Farm Spago 460 JU south of Malelane, Mpumalanga Province

Desktop Study

For

Henwood Environmental Solutions (Pty) Ltd

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Expertise of Specialist

The Palaeontologist Consultant is: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 30 years research; 22 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Henwood, Environmental Solutions (Pty) Ltd, Nelspruit, 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

Henwood Environmental Solutions (Pty) Ltd has been contracted to carry out an EMPr for the proposed clearing of land for agricultural development on the Farm Spago 460 JU, south of Malelane, Mpumalanga province. The site lies on ancient rocks of the Figtree and Moodies Groups (ca 3461 – 3227 Ma). Microfossils (bluegreen algae, less than 10 microns in diameter) have been reported from the same sediments about 100 km to the southwest, so there is a very small chance that microfossils could occur in chert bands, if chert occurs on the site. It is recommended, therefore, that if chert occurs on the site then hand samples of the chert should be sent to the University of Johannesburg, Geology Department, for further analysis. Microfossils are not visible to the naked eye so could not be identified in the field, only in a laboratory. Because the land clearance and agriculture will be done on soils and nor rocks, the fossil heritage would not be affected. As far as the palaeontological heritage is concerned the project can continue and no further assessment is required.

Table of Contents

1. Background

Henwood Environmental Solutions has been appointed to carry out the EIA and WULA for a proposed clearing of vegetation and development of land for agricultural purposes on the Farm Spago 460 JU south of Malelane, Mpumalanga Province. The National Heritage Resources Act (Act 25 of 1999) and the National Environmental Management Act (Act 107 of 1998) requires that the proposed development must be preceded by the relevant impact assessment, in this case for palaeontology.

Figure 1: Detailed map from Google Earth of the proposed area for clearing, Spago 460 JU. Area to be cleared in shown in yellow.

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This report is the palaeontological impact assessment for the project.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (2014)

A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain:	Relevant section in report
Details of the specialist who prepared the report	Appendix A
The expertise of that person to compile a specialist report including a curriculum vitae	Appendix A

A declaration that the person is independent in a form as may be specified by the competent authority	Page 1
An indication of the scope of, and the purpose for which, the report was prepared	Section 1
The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section ii **Error! Reference source not found.**
An identification of any areas to be avoided, including buffers	N/A
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
A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
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
Any mitigation measures for inclusion in the EMPr	n/a
Any conditions for inclusion in the environmental authorisation	n/a
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	n/a
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	N/A
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
A description of any consultation process that was undertaken during the course of carrying out the study	N/A
A summary and copies if any comments that were received during any consultation process	N/A
Any other information requested by the competent authority.	N/A

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;
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*not applicable to this assessment*); and
4. Determination of fossils representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected.

3. Geology and Palaeontology

i. Project location and geological context

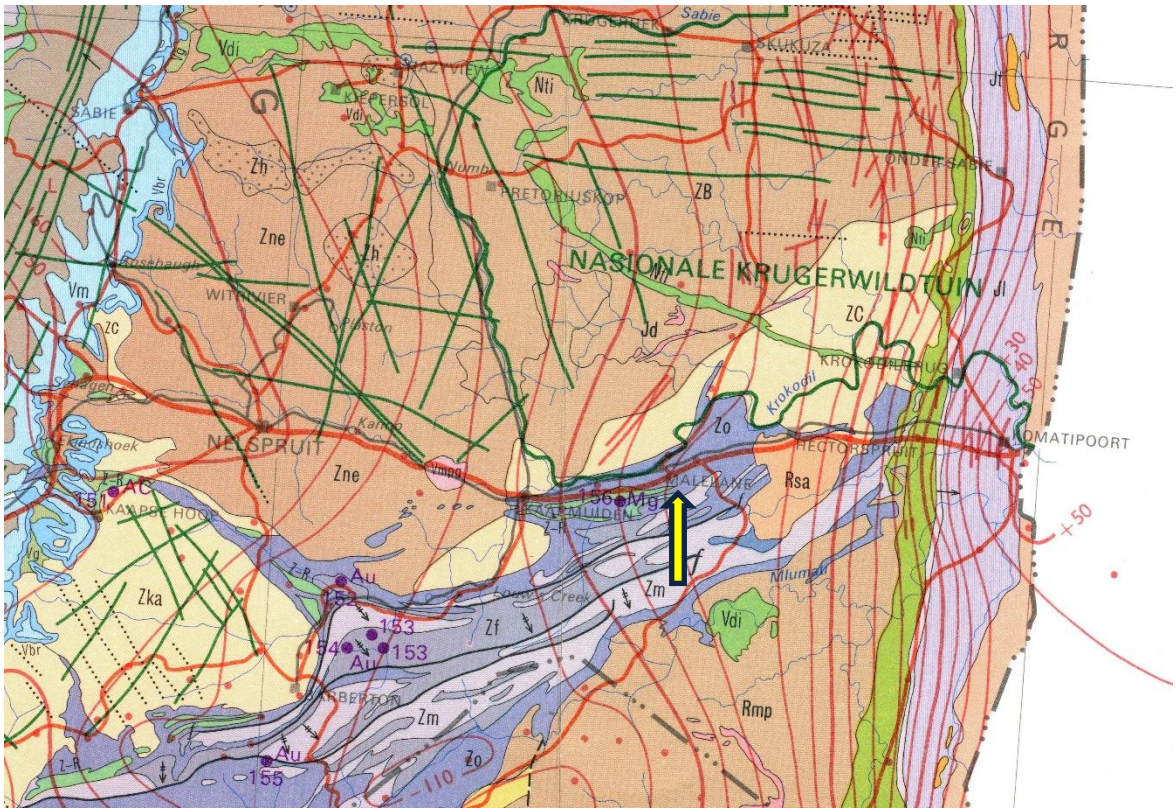

Figure 2: Geological map of the area around Malelane, Mpumalanga Province where the project will occur. The proposed site is indicated by the yellow arrow. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 1 000 000 map 1984.

Table 2: Explanation of symbols for the geological map and approximate ages (Cornell et al., 2006; Duncan and Marsh, 2006; Erikssen et al., 2006. Johnson et al., 2006; Partridge et al., 2006). SG = Supergroup; Fm = Formation.

Symbol	Group/Formation	Lithology	Approximate Age
P-Tr	Permo-Triassic	Undifferentiated Karoo sediments, shale, coal, sandstone, mudstone	Ca 300 – 180 Ma
Jm	Movene Fm, Lebombo Group	Basalt	Ca 195 – 160 Ma
Jj	Jozini Fm, Lebombo Group	Rhyodactite	Ca 178 Ma
Jl	Letaba Fm, Lebombo Group	Picritic basalt	Ca 183 Ma
Jt	Tshokwane granophyre	Granophyre	Ca 140 Ma
Rmp	Mpuluzi Granite	Quartz monzonite	
ZC	Unnamed	Granite	
ZB	Unnamed	Potassic granite and granodiorite	
Zm	Moodies Group, Barberton SG	Sandstone, shale, conglomerate	>3300 Ma
Zf	Figtree Group, Barberton SG	Greywacke, shale, chert, dacitic volcanic rocks	
Zo	Onverwacht Group, Barberton SG	Lava, pyroclastic rocks	

The proposed site lies on several outcrops of the oldest rocks in South Africa, those of the Barberton Greenstone Belt (BGB), which is mid Archean in age (3600- 3100 Ma; Brandl et al., 2006) and in particular on the Figtree and Moodies Groups. There are also a number of plutons and batholiths in the area that range in age from 3509 to 3104 Ma. The Barberton Greenstone Belt is one of the best studied granite-greenstone terrane in the world (Brandl et al., 2006) because it is one of the oldest known, it is composed of a unique sequence of the best-preserved, first-formed lithologies on the planet, and geologists have used it as a model to interpret other greenstone belts (ibid).

The Barberton Supergroup comprises three major lithostratigraphic units (Fig 3) with the Onverwacht group at the base, the Figtree Group in the middle and the Moodies Group at the top. It is thought that these sediments formed in an oceanic setting, followed by island arc development as a consequence of some primitive form of Archaean plate tectonic processes (ibid).

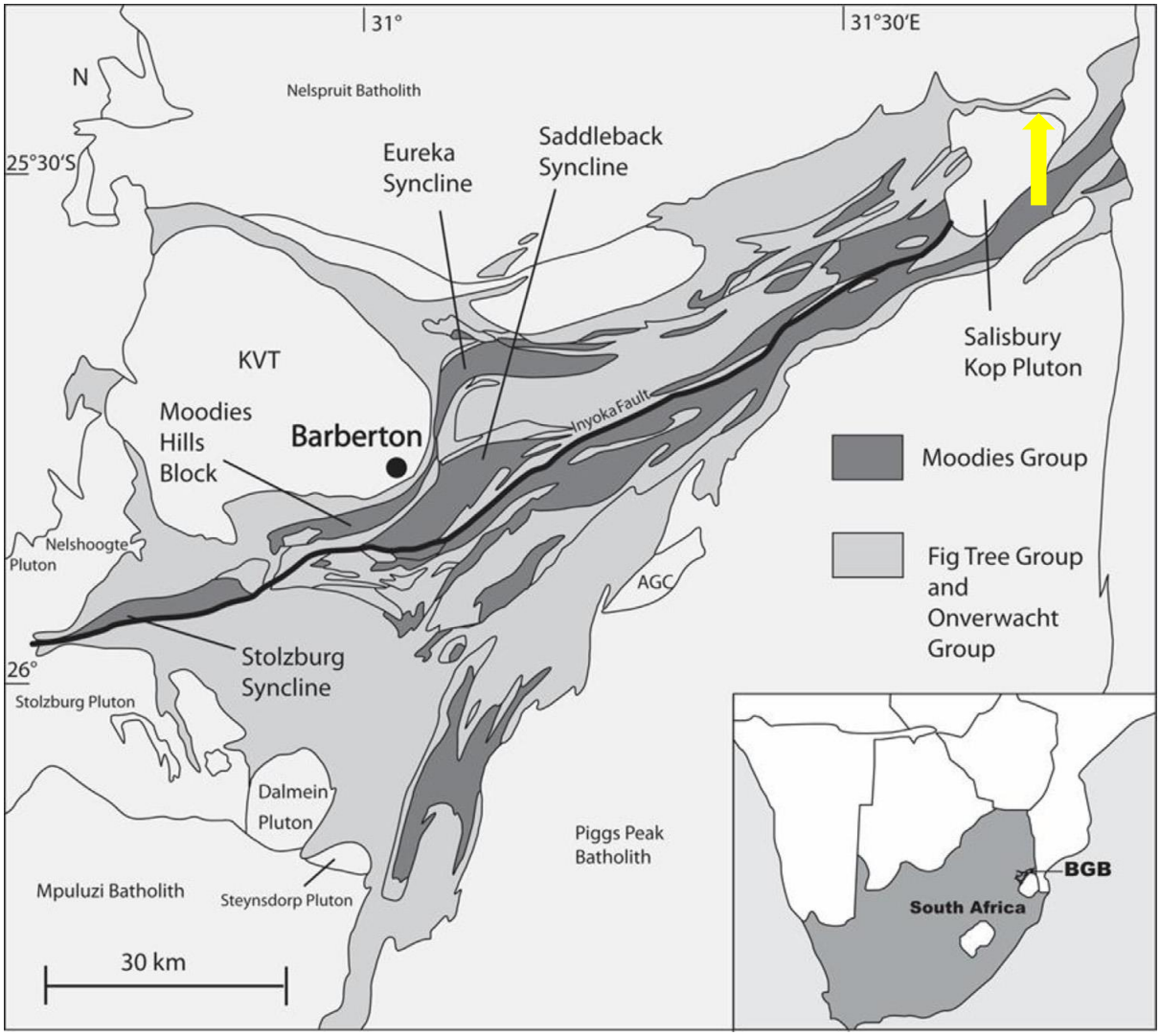

Figure 3: Map showing the updated geological groups in the Barberton Greenstone Belt (from Noffke et al., 2006, Brandl et al., 2006, figure 1, page 120) with a focus on the three main stratigraphic divisions and the volcanic rock types. Malelane, arrow, is in the northeast part.

Most research has been done on the southern part of the BGB and little on the northern part, where Malelane is situated. Currently the Figtree Group is divided into five formations in the northern part as follows (basal to top): Sheba Formation, Belvue Road Formation and Schoongezicht Formation. They comprise various combinations of deepwater facies such as turbiditic lithic greywacke, shale, turbiditic siltstone and locally coarse volcaniclastic rocks (Brandl et al., 2006). The overlying Moodies Group is divided into three formations, from the base upwards, the Clutha Formation, Joe's Luck Formation and the Baviaanskop Formation. These formations each represents an upward-fining cycle comprising a coarse basal unit of conglomeratic quartzose sandstone, siltstone and shale (Brandl et al., 2006).

The Lebombo Mountains to the east of South Africa are igneous in origin and comprise easily distinguishable formations of different types of basalt and rhyolite (Duncan and Marsh, 2006). Running parallel to these mountains is a north-south exposure of Karoo sequence deposits that has not been well studied. The parallel Karoo rocks are far to the east of the proposed dam site and will not be discussed further,

ii. Palaeontological context

The Figtree Group depositional environment was a deep-water one and about 3461-3225 million years ago (Brandl et al., 2006). The Moodies Group is slightly younger at about 3225 to 3126 Ma and represents a foreland basin with braided alluvial plains, deltas, shallow water coastal systems and shelf facies (Jackson et al., 1987 in Brandl et al., 2006). The oldest forms of life are from around this age but they are microscopic algae and mostly formed stromatolites in warm shallow, low energy environments (Knoll et al., 2016). These are trace fossils and very seldom contain direct evidence of the life forms. Stromatolites have been reported from the southern exposures of the underlying Onverwacht Group but not from the Figtree or Moodies Groups. Microbially induced sedimentary structures, another form of trace fossils, have been reported from the Dycedale and Saddleback Synclines, Moodies Group, close to Barberton (Noffke et al., 2006). They are preserved in hard rocks, not soils. No fossils or trace fossils have been reported from the Figtree Group (Altermann et al., 2006; Nabham et al., 2016; Kremer et al., 2017).

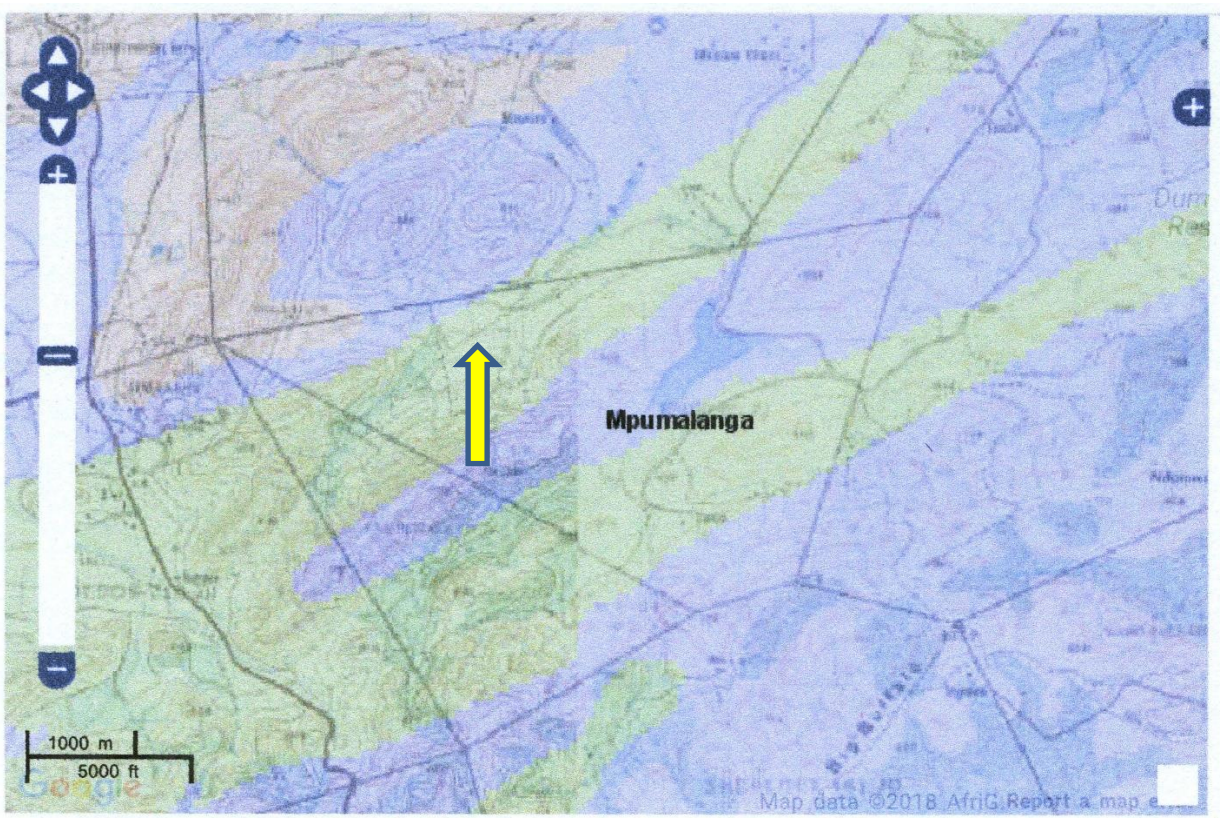

Figure 3: SAHRIS palaeosensitivity map of the region south of Malelane. The site in the blue/grey area (arrow). Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

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	There is no to a very small chance of fossils being found here
	L+	-
	M+	
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	**L**	The spatial scale is extremely small.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	
	L	There is no chance to a very small chance of finding fossils in the cherts in the rocks but they are microscopic and would NOT be visible to the naked eye.

Based on the nature of the project, the surface soils will be excavated to a depth of 1-2 m and will be used for planting. Only if chert bands are visible in the rocks and only if these are going to be disturbed, should they be sampled (GPS coordinates and hand specimens of rock taken) and posted to a research facility (university or museum – for example the University of Johannesburg geologists work on rocks of this age). Since there is no chance of finding fossils in the soils and granites there would be no impact on the fossil heritage. There is no chance of finding fossils BEFORE excavations commence so a phase 2 or site visit is NOT recommended at this stage. Taking account of the defined criteria, the potential impact to fossil heritage resources is very 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 gneisses, schists, granites, greywackes and basalts are typical for the country and, except for the cherts, do not contain any fossil plant, insect, invertebrate and vertebrate material. There is a very small chance that the chert bands within the Moodies Group may contain microfossils of early unicellular bluegreen algae but these are not visible to the naked eye. No fossils, however, have been reported from this region. It is assumed that the clearing for agriculture will be on soils and not on rocky outcrops. Soils would not contain fossils.

6. Recommendation

Based on the age of the sediments and extremely rare occurrence of fossils in this formation, and the fact that no fossils have been recorded from this area, there is no chance that fossils would be preserved in the soils. No further palaeontological assessment is required. It is recommended that if chert is excavated then a hand sample should be sent to the University of Johannesburg, Department of Geology, for their records and possible further research. As far as the palaeontological heritage is concerned the proposed clearing of vegetation where there is soil of sufficient depth for agriculture can proceed.

7. References

Altermann, W. Kazmierczak, J. Oren, A., Wright, D.T., 2006. Cyanobacterial calcification and its rock-building potential during 3.5 billion years of earth history. Geobiology 4, 147-166.

Duncan, A.R., Marsh, J.S., 2006. The Karoo Igneous Province. 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 501-520.

Johnson, M.R., van Vuuren, C.J., Visser, J.N.J., Cole, D.I., Wickens, H.deV., Christie, A.D.M., Roberts, D.L., Brandl, G., 2006. Sedimentary rocks of the Karoo Supergroup. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 461 – 499.

Knoll, A.H., Bergmann, K.D., Strauss, J.V., 2016. Life: the first two billion years. Philosophical Transactions of the Royal Society B 371, 20150493.

Kremer, B., Kazmierczak, J., 2017. Cellularly preserved microbial fossils from ca 3.4 Ga deposits of South Africa: A testimony of early appearance of oxygenic life? Geology 34(4), 253–256.

Nabhan, S., Luber T., Scheffler, F., Heubeck, C., 2016. Climatic and geochemical implications of Archean pedogenic gypsum in the Moodies Group (~3.2 Ga), Barberton Greenstone Belt, South Africa. Precambrian Research 285, 117-129.

Noffke, N., Erikssen, K.A., Hazen, R.M., Simpson, E.L. 2006. A new window into Early Archean life: Microbial mats in Earth's oldest siliciclastic tidal deposits (3.2 Ga Moodies Group, South Africa). Geology 34, 253–256.

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.

Walsh, M.M., 1992. Microfossils and possible microfossils from the Early Archean Onverwacht Group, Barberton Mountain Land, South Africa. Precambrian Research, 54, 271-293.

Appendix A – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
May 2018

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	5	2
Masters	8	1
PhD	10	2
Postdoctoral fellows	7	3

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

ix) Editing and reviewing
Editor: Palaeontologia africana: 2003 to 2013; 2014 – onwards, 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
- Isondlo and Kwasobabili 2018 for GCS
- Kanakies Gypsum 2018 for Cabanga
- Nababeep Copper mine 2018
- Glencore-Mbali pipeline 2018 for Digby Wells

xi) Research Output

Publications by M K Bamford up to January 2018 peer-reviewed journals or scholarly books: over 120 articles published; 5 submitted/in press; 8 book chapters.
Scopus h index = 24; Google scholar h index = 26;
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)