Palaeontological Impact Assessment for the proposed rehabilitation of the SA-Swaziland border post at Oshoek, Mpumalanga Province

Desktop Study

For

Delta Built Environment Consultants cc

14 October 2018

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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 Delta Built Environment, Pretoria, 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

There is a proposal to clear land, rehabilitate and extend the Oshoek Border Post between South Africa and Swaziland on the N17, 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.

The proposed site falls on ancient rocks of the Onverwacht and Moodies Groups of the Barberton Sequence. Based on the age of the sediments and occurrence of fossils in the Moodies Group south of Swaziland, although no fossils have been recorded from this area, there is a very small chance that fossils would be identified once excavations begin for the proposed project. Although it is unlikely that any of these fossils would be visible as they are microscopic, a Chance Find Protocol should be included in the EMPr so that the geologist or responsible person in charge of the project can look out for any fossil material, save it and call a professional palaeontologist for advice. As far as the palaeontological heritage is concerned the proposed clearing of land, excavations for foundations and infrastructure can proceed.

Table of Contents

1. Background

This project involves the clearing of land for the future township expansion and the pgrades and rehabilitation at the Oshoek border post on the South African side of the border with Swaziland.

The Department of Public Works is proposing to clear land (19.5 ha) for the future expansion of the township in the Oshoek Border Post on the farms Oshoek 212 IT and Houtbosch 189 IT, in Albert Luthuli Local Municipality of Mpumalanga Province. The department is proposing to also refurbish existing old buildings on site and demolish buildings that are not protected by the National Heritage Resources Act, 25 of 1999. Delta Built Environment Consultants cc is undertaking a Basic Assessment (BAR) process on behalf of Bushbuckridge Local Municipality, in respect of listed activities in the Environmental Impact Assessment (EIA) Regulations 2017, that require an application for Environmental Authorisation in terms of the National Environmental Management Act, 1998 (NEMA). A Public Participation Notice has been submitted to SAHRA in terms of section 38(8) of the National Heritage Resources Act, 25 of 1999 for commenting. SAHRA has requested a palaeontological investigation (Case ID:12874) so this report is the Palaeontological Impact Assessment by a professional palaeontologist.

Figure 1: Detailed Google Earth map of the proposed expansion and rehabilitation of the border post between South Africa and Swaziland at Oshoek, on the N17 highway to Mbabane, on Farms Oshoek 212 IT and Houtbosch 189 IT, Mpumalanga.

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 4 Figure 2
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	Section 8
Any conditions for inclusion in the environmental authorisation	n/a
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8
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 of 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 (*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

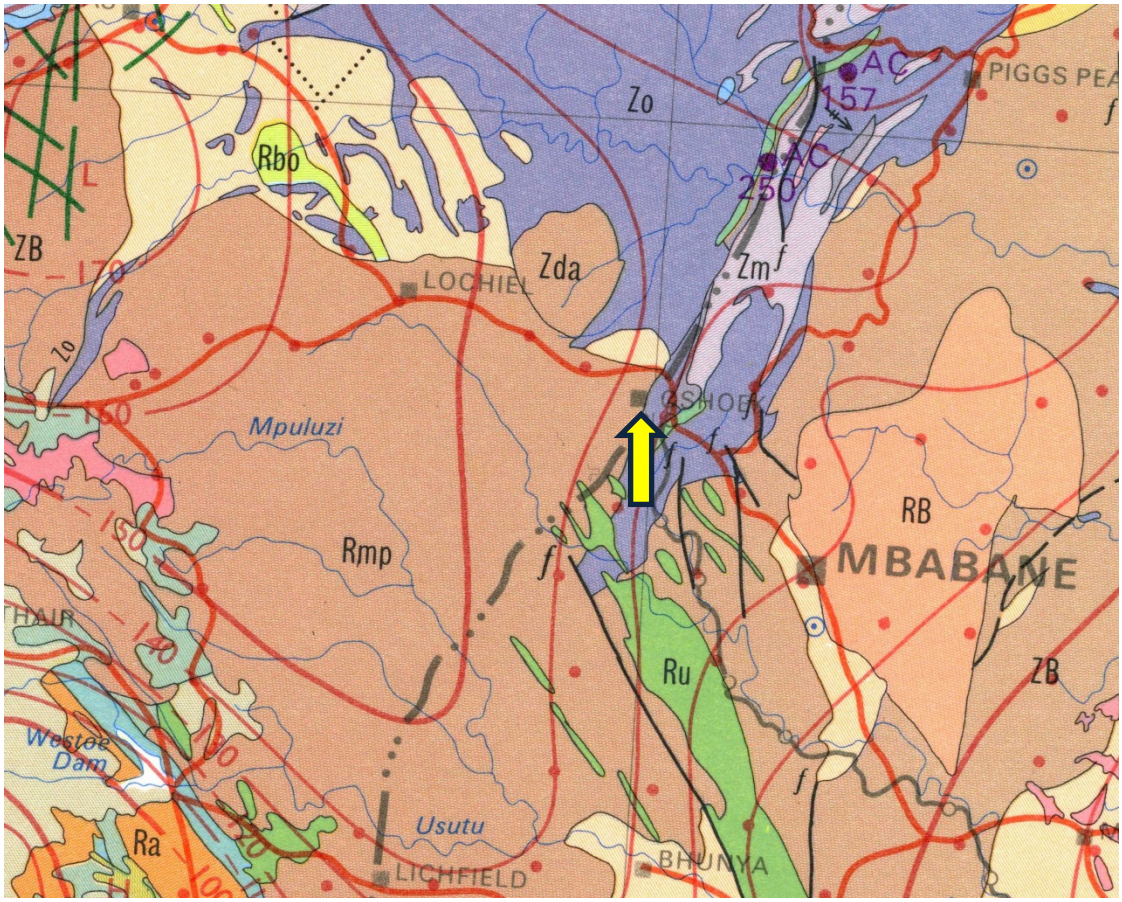

Figure 2: Geological map of the area around Oshoek on the South African and Swaziland Border, Mpumalanga Province. The proposed site is indicated by the yellow arrow. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 1 000 000 map 1984.

Table 2: Explanation of symbols for the geological map and approximate ages (Anhaeusser, 2006; Brandl eta al., 2006; Robb et al., 2006). SG = Supergroup; Fm = Formation.

Symbol	Group/Formation	Lithology	Approximate Age
Ru	Usushwana Complex	Gabbro, ferrogabbro, granite	Ca 2860 Ma
Rmp	Mpuluzi Granite	Quartz monzonite	3105 Ma
ZC	Unnamed	Granite	
ZB	Unnamed basement complex	Potassic granite and granodiorite	
Zm	Moodies Group, Barberton Sequence	Sandstone, shale, conglomerate	>3300 Ma
Zf	Figtree Group, Barberton Sequence	Greywacke, shale, chert, dacitic volcanic rocks	

Symbol	Group/Formation	Lithology	Approximate Age
Zo	Onverwacht Group, Barberton Sequence	Lava, pyroclastic rocks	3600 Ma

The proposed site lies partly on the sandstones, shales and conglomerates of the ancient Moodies Group and partly on the lava and pyroclastic rocks of the Onverwacht Group, both in the Barberton Sequence. Other rocks in the vicinity are basement rocks, ancient volcanic or igneous rocks of the Mpuluzi Granite composed of quartz monzonite, and the gabbro, ferrogabbro and granite of the Usushwana Complex. The Mpuluzi Granite is Archean in age and probably formed from partial melting of tonalitic or trondhjemitic source rocks (Robb et al., 2006). Being a bit younger, the Usushwana Complex is the largest mafic-ultramafic intrusion in the southeast part of the Kaapvaal Craton, and is composed of gabbro and granite.

The Barberton Sequence forms part 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). 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 terranes in the world (Brandl et al., 2006) because of its antiquity. 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).

Most research has been done on the southern part of the BGB and less on the extreme southern part, where Oshoek is situated. Currently the Onverwacht Group is divided into six formations as follows (basal to top): Sandspruit Formation, Theespruit Formation, Komatie Formation, Hooggenoeg Formation, Kromberg Formation, Mendon Formation (Brandl et al., 2006).

ii. Palaeontological context

Although the Onverwacht Group rocks are so old some microfossils have been reported from them, for example the oldest cyanobacteria or blue-green algae from the Kromberg Formation type site along the Komati River (Walsh, 1992; Altermann et al., 2006; Schopf et al., 2016). Recently Kremer and Kazmierczak (2017) have found more microfossils from this general area in the Songimvelo Nature Reserve cherts (some 100km northeast of Oshoek). They interpreted the presumably coccoidal cyanobacteria thriving as benthic and possibly, at least in part, as benthic planktonic communities from the Kromberg Formation. It should

be noted that the microfossils are mostly less than 10 microns in diameter and can only be seen in thin section under a microscope at 1000x magnification.

The Moodies Group, however, is considered to be a foreland basin setting with braided alluvial plains, deltas, shallow water coastal systems and shelf facies (Erikssen et al., 2006) but because of its antiquity predates any organisms that could have occupied such a setting. Theses sediments contain no fossils but trace fossils of microbial mats have been reported (Nofke et al., 2006; Kremer and Kazmierczak, 2017) but from much farther north so not affected by this project.

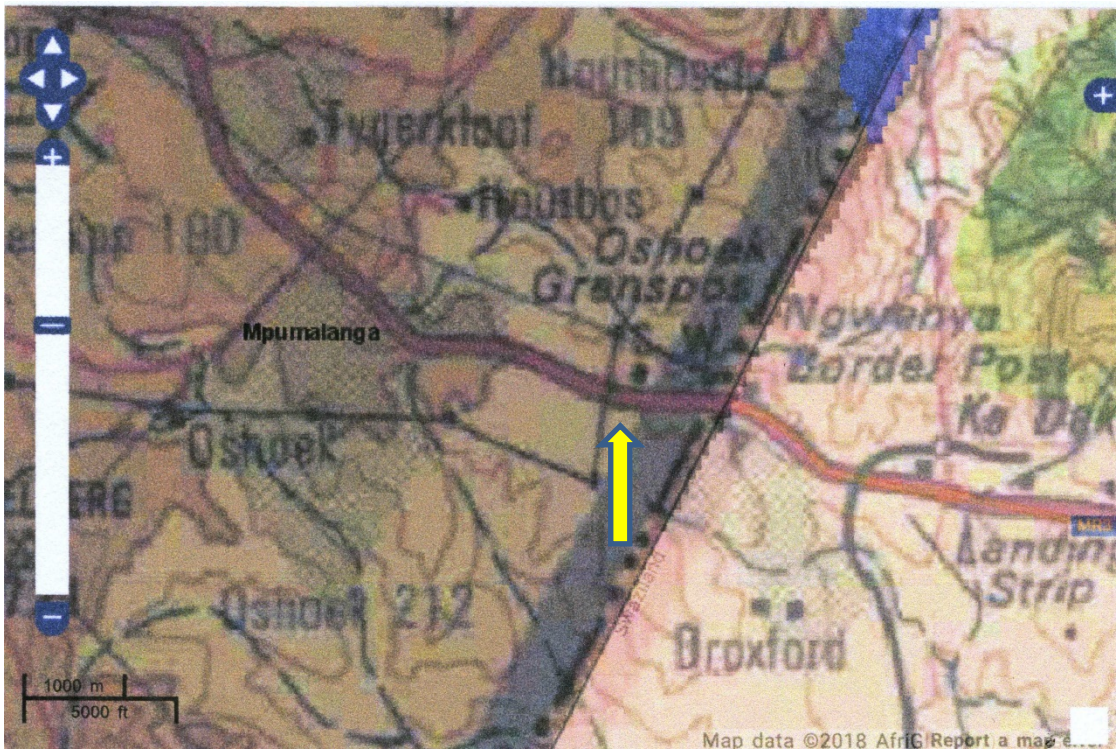

Figure 3: SAHRIS palaeosensitivity map of the region around Oshoek Border post on the farm Houtbosch 189 IT. The site is indicated by the yellow arrow. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

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 a 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 a very small chance of finding microfossils in the shales and sandstones of the Onverwacht Group sediments but none has been recorded in this region.

Based on the nature of the project, the surface soils will be excavated to a depth of several metres for buildings, roads and infrastructure foundations. Since there is only a very small chance of finding microfossils a Chance Find Protocol should be added to the EMPr. 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 and basalts are typical for the country and, except for the sandstones of the Moodies Group, do not contain any fossil plant, insect, invertebrate and vertebrate material. There is a very small chance that the shales and sandstones of the Moodies Group could contain microfossils because they have been found in the same aged sediments south of Swaziland, but not here. No fossils, however, have been reported from this region.

6. Recommendation

Based on the age of the sediments and occurrence of fossils in the Moodies Group south of Swaziland, although no fossils have been recorded from this area, there is a very small chance that fossils would be identified once excavations begin for the proposed project. Although it is unlikely that any of these fossils would be visible a Chance Find Protocol should be included in the EMPr so that the geologist or responsible person in charge of the project can look out for any fossil material, save it and call a professional palaeontologist for advice. As far as the palaeontological heritage is concerned the proposed clearing of land, excavations for foundations and infrastructure 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.

Brandl, G., Cloete, M., Anhauaeusser, C.R., 2006. Archaean Greenstone belts. 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 9-56..

Homann, M., Heubeck, C., Airo, A., Ticec, T.M., 2015. Morphological adaptations of 3.22 Ga-old tufted microbial mats to Archean coastal habitats (Moodies Group, Barberton Greenstone Belt, South Africa). Precambrian Research 266, 47-64.

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? 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.

Westall, F., de Wit, M.J., Dann, J., van der Gaast, S., de Ronde, C.D.J., Gerneke, D., 2001. Early Archean fossil bacteria and biofilms in hydrothermally-influenced sediments from the Barberton greenstone belt, South Africa. Precambrian Research 106, 93-116.

8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations begin.

1. The following procedure is only required if fossils are seen on the surface and when excavations commence.

2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (microfossils, plants, insects, bone, coal) should be put aside in a suitably protected place. This way the construction 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 4, 5). This information will be built into the EMP's training and awareness plan and procedures.

4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.

5. As required and to be agreed upon by the developer and the qualified palaeontologist sub-contracted for this project, the palaeontologist should visit the site to inspect the selected material and check the samples where feasible. The frequency of inspections should be determined by the finding of interesting material. However, if the onsite designated person is diligent and extracts the fossil material then inspections can be less frequent.

6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are

removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.

7. If no good fossil material is recovered then the site inspections by the palaeontologist can be reduced to annual events until construction has ceased. Annual reports by the palaeontologist must be sent to SAHRA.

8. If no fossils are found and the excavations have finished then no further monitoring is required.

Appendix A – Examples of fossils that could occur in the project site

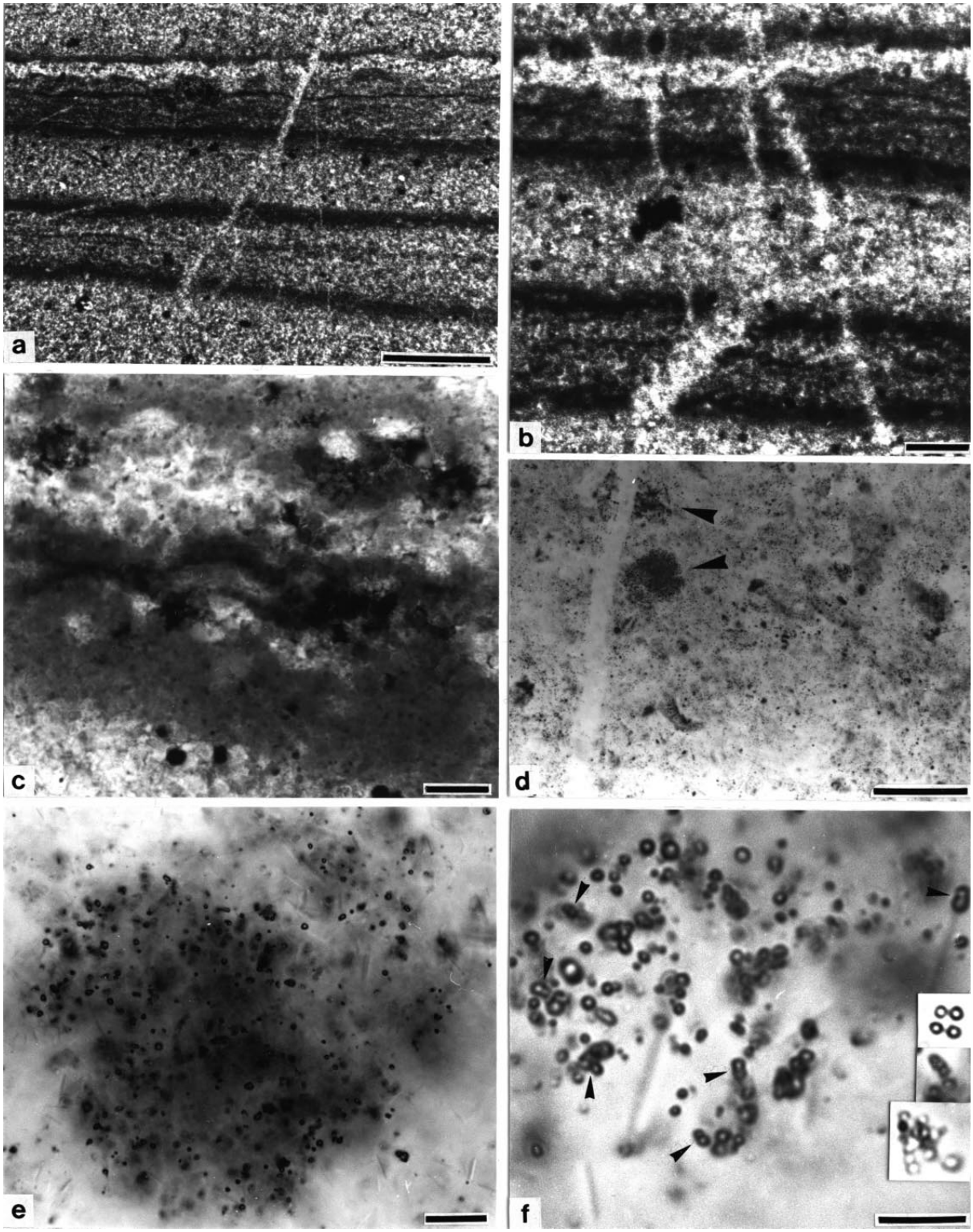

Figure 4: Examples of microfossils (unicellular blue-green algae) in cherts from the Onverwacht Group, Barberton Greenstone Belt taken from Westfall et al., 2001, figure 2). (f) Kromberg Form of spherules. Scale bar = 10µm.

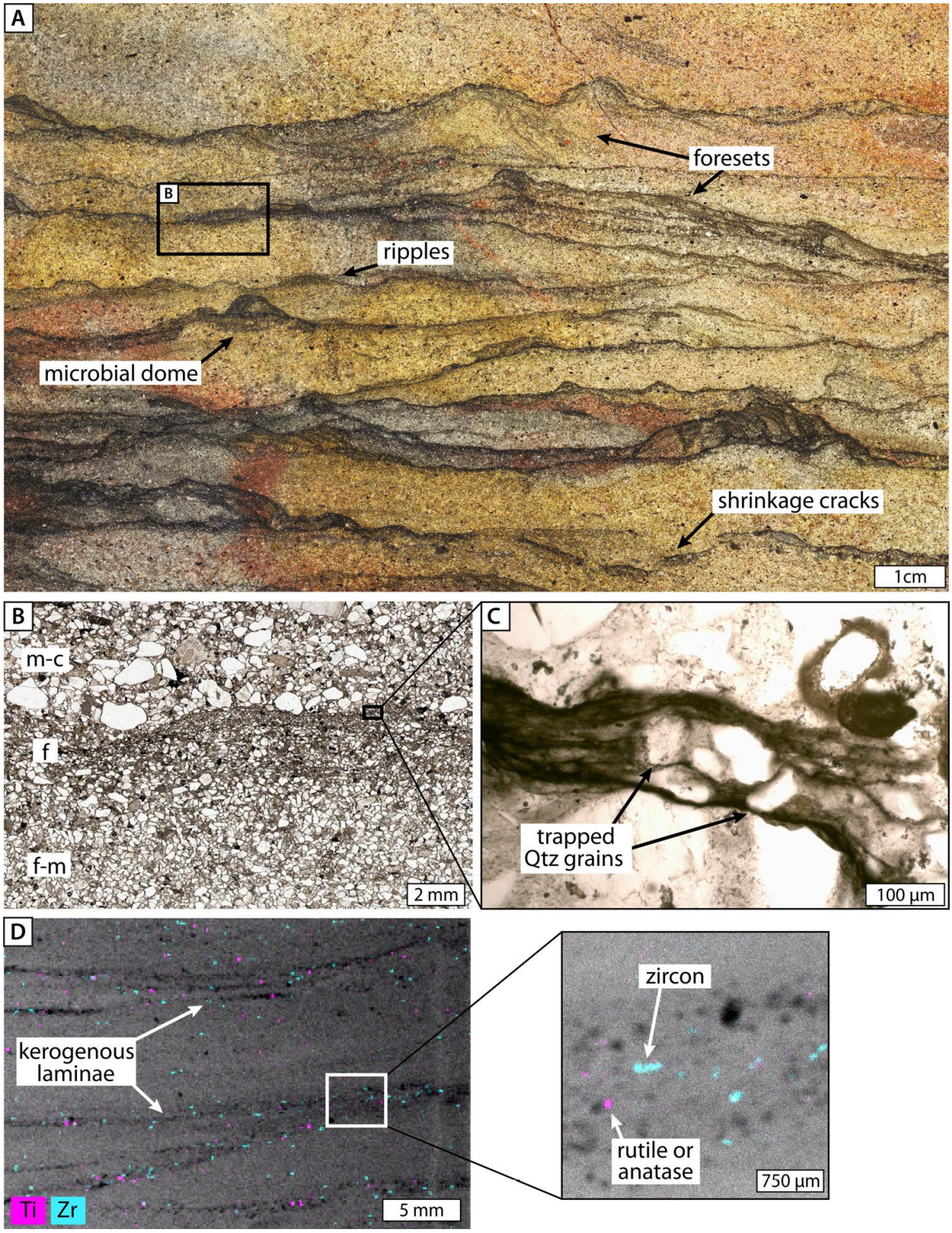

Figure 5: Examples of microfossils from the Moodies Group taken from Homan et al., 2015 Fig. 6. (A) Photograph of polished slab (cross-section view) containing abundant remnants of microbial mats (dark wavy laminae) which coat sand ripples, foresets, form smalldomes and shrinkage cracks. (B) Transmitted light photomicrograph (of boxed area in A) showing that detrital sand particles are commonly fine- to medium-grained (f-m) below a lamina, fine-grained (f) within and medium-to-coarse-grained (m-c) above a lamina. (C) Close-up view of

undulatory kerogenous laminae with fine-grained-sandand silt-sized particles. (D) Trans-X-ray elemental maps of Ti (purple) and Zr (cyan) show the preferential enrichment of zircon and rutile or anatase in the dark microbiallaminae.

Appendix A – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD January 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	6	3
PhD	9	3
Postdoctoral fellows	5	3

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

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

xi) Research Output

Publications by M K Bamford up to January 2018 peer-reviewed journals or scholarly books: over 110 articles published; 5 submitted/in press; 8 book chapters.
Scopus h index = 22; Google scholar h index = 24;
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)