

**Palaeontological Impact Assessment for the proposed
demarcation of 350 sites on Farm Keerweder 169MT,
Dolidoli Village, Makhado Local Municipality
Limpopo Province**

Desktop Study (Phase 1)

For

Ngoti Development Consultants

29 May 2021

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Expertise of Specialist

The Palaeontologist Consultant: 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 Ngoti Development Consultants, 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:

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 demarcation of 350 sites on a portion of Farm Keerweder 169 MT for Dolidoli Village, Makhado Local Municipality, Limpopo Province.

To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development.

The proposed site lies on the non-fossiliferous rocks of the intrusive diabase, Sibasa Basalt and the arenaceous Wyllies Poort Formation (Soutpansberg Group). The latter is incorrectly indicated as moderately sensitive for palaeontology on the SAHRIS map. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no palaeontological site visit is required unless trace fossils are found once excavations commence.

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1. Background

Ngoti Development Consultants have been appointed by the Makhado Local Municipality to assist with professional services through the demarcation of 350 sites, situated on a portion of the Farm Keerweder 169 MT (Figures 1, 2). The subject property is owned by the Makhado Local Municipality and they hold the title deed number: T30117/1951VNPTA.

A Palaeontological Impact Assessment was requested for the demarcation project. 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 desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development and is reported herein.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (amended 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 B
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
b	A declaration that the person is independent in a form as may be specified by the competent authority	Page 1
c	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
ci	An indication of the quality and age of the base data used for the specialist report: SAHRIS palaeosensitivity map accessed – date of this report	Yes
cii	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
d	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
e	A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 4
g	An identification of any areas to be avoided, including buffers	N/A
h	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5

j	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 4
k	Any mitigation measures for inclusion in the EMPr	Section 8, Appendix A
l	Any conditions for inclusion in the environmental authorisation	N/A
m	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8, Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	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 demarcation of 350 sites on Farm Keerweder 169 MT, in Dolidoli Village, Makhado Local Municipality, with the section shown by the red outline. Map supplied by Ngoti Development Consultants.

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 (*not applicable to this assessment*);
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*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 (*not applicable to this assessment*).

3. Geology and Palaeontology

i. Project location and geological context

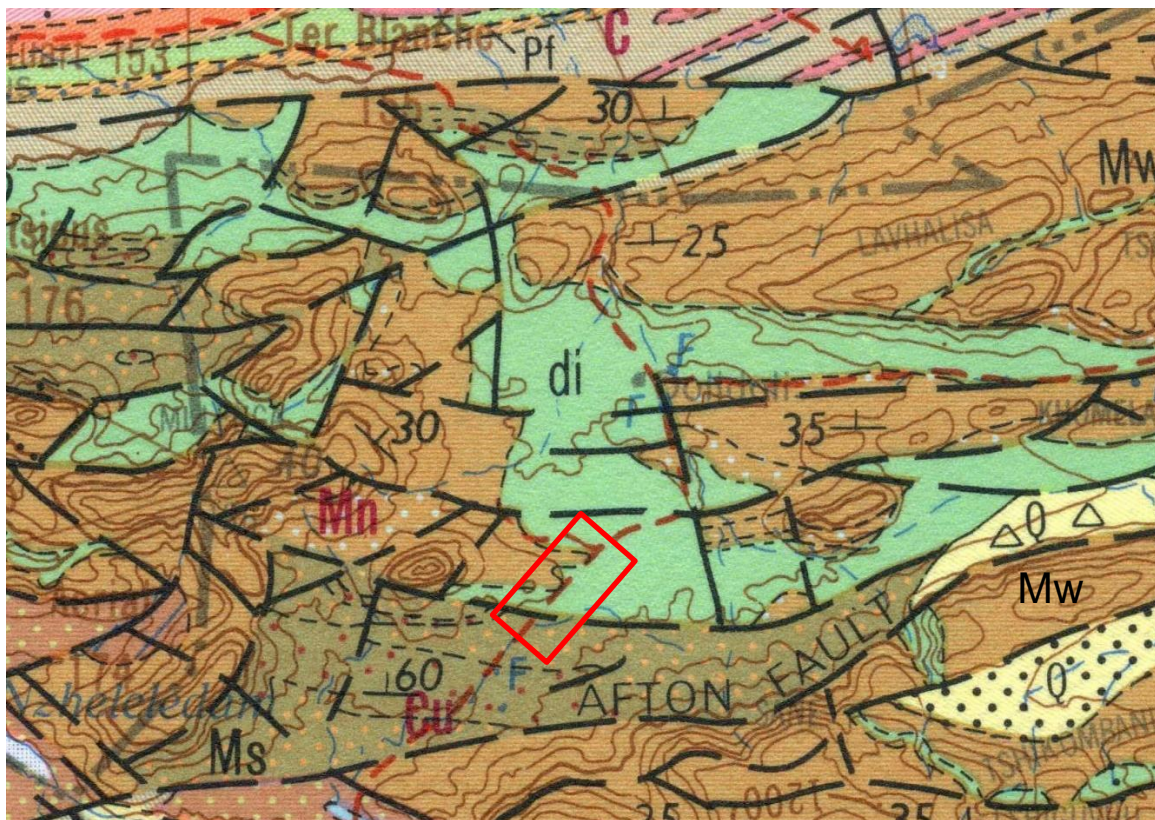


Figure 2: Geological map of the area around the Farm Keerweder 169 MT, Dolidoli, with the site shown within the red outline. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2230 Messina.

Table 2: Explanation of symbols for the geological map and approximate ages (Barker et al., 2006. Johnson et al., 2006). 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 rocks	Post Soutpansberg Group
Mw	Wyllies Poort Fm, Soutpansberg Group	Pink quartzite, sandstone, minor conglomerate, red shaley sandstone	2000 – 1700 Ma
Ms	Sibasa Basalt, Soutpansberg Group	Basalt, minor tuff	2000 – 1700 Ma

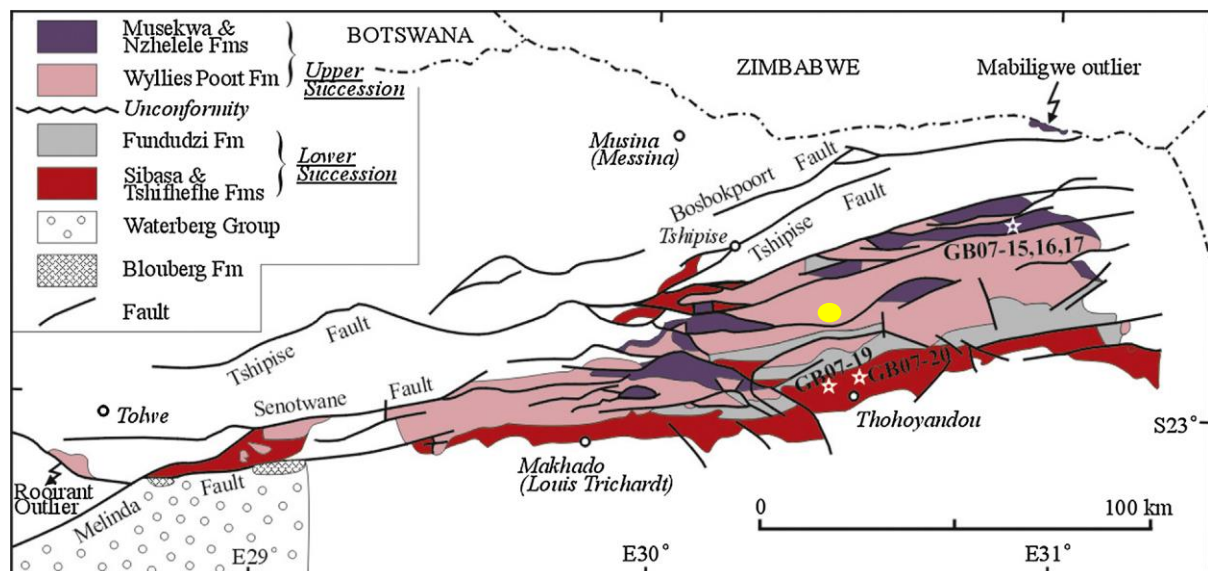


Figure 3: Overview of the distribution of the Soutpansberg Group rocks (Fig 3 in Geng et al., 2014 that they based on Barker et al., 2006). Dolidoli indicated by the yellow dot.

The Palaeoproterozoic rocks of southern Africa occur in Limpopo, Mpumalanga and Gauteng Provinces and extend westwards into Botswana, and occur in three basins. Three main strata are recognised, the Soutpansberg Group, the Waterberg Group and the Blouberg Formation. A number of attempts have been made to correlate the strata in the different basins, the Waterberg Basin, the Soutpansberg Basin and the Middelburg Basin. The Soutpansberg Group, in the Soutpansberg Basin, rests unconformably on Archaean granulite-grade gneisses as well as on the Blouberg Formation and Mogalakwena Formation of the Waterberg Group (Barker et al., 2006) and is unconformably overlain by the much younger Karoo Supergroup Rocks.

Six Formations are recognised in the Soutpansberg Group, and from the base upwards they are the Tshifhefhe, Sibasa, Fundudzi, Wyllie's Poort, Musekwa and Nzhelele Formations.

The Waterberg Group occurs in the Waterberg and Nylstroom Basins (Barker et al., 2006) and rests unconformably on rocks of the Transvaal Supergroup and the Bushveld Complex. It is overlain by Karoo Supergroup rocks. Three subgroups are recognised throughout the main Waterberg Basin but only the oldest subgroup occurs in the Nylstroom Basin. Different formations are noted in the south, southwest and central areas compared to the North, northeast and central areas according to SACS (1980).

The region is highly faulted and also intruded by dolerite or diabase dykes that are younger than the host rocks (Figures 2 and 3).

ii. Palaeontological context

The palaeontological sensitivity, the SARIS map, of the area under consideration is presented in Figure 3. The site for development is in the Soutpansberg Basin and on non-fossiliferous diabase and Sibasa Basalt (grey). Part of the site lies on moderately fossiliferous Wyllies Poort Formation quartzites and sandstones (green). This is a contradiction to the sensitivity as noted in the Palaeotechnical Report for Limpopo (Groenewald et al., 2014) who indicate that the Soutpansberg Group palaeosensitivity is insignificant (blue).

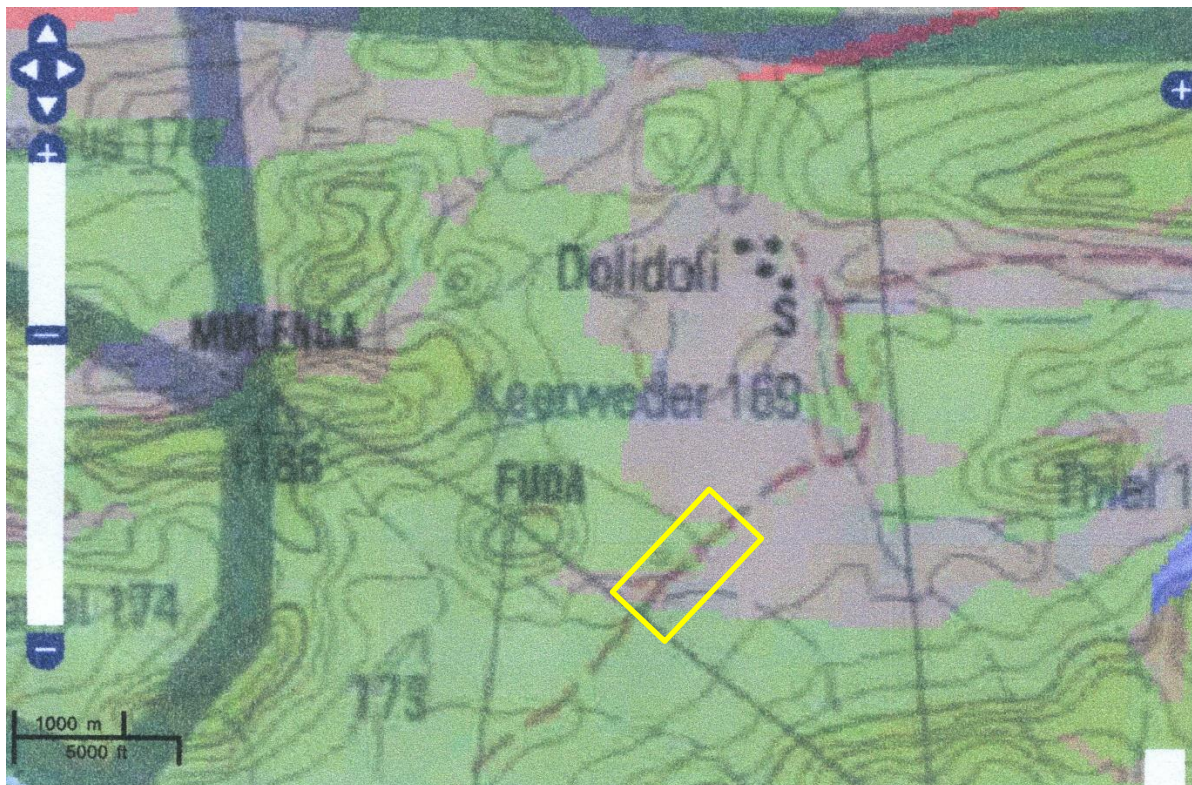


Figure 4: SAHRIS palaeosensitivity map for the site for the proposed demarcation of 350 sites on Farm Keerweder 169 MT shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

More recent research on the Wyllies Poort Formation (Geng et al., 2014) confirms that the sediments are almost entirely arenaceous with very rare local inter-beds of argillaceous and volcanic rocks (Fig. 3; reproduced as Figure 3 in this report), and extends over the entire length and width of Soutpansberg Mountain. They interpret the depositional environment of these super mature quartzites was most probably a deltaic to shallow marine shelf setting. While such a setting might be conducive to the formation of microbially-induced sedimentary structures (MISS), as have been recorded from the low energy playa lake deposits of the Makgabeng Formation (Matlabas Subgroup, Waterberg Group) by Simpson et al. (2013), the Wyllies Poort Formation was probably a higher energy setting. It is unlikely therefore, to form or preserve the microbial trace fossils (see Noffke, 2009, for conditions required for MISS formation).

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	Coarse (high energy system) sands do not preserve fossils or trace fossils; so far there are no records from the Soutpansberg Group of any fossils so it is very unlikely that fossils occur on the site. The impact would be very unlikely.

PART B: ASSESSMENT		
	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 MISS, 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 mature and coarse-grained sands of the Soutpansberg Group. Since the SAHRIS palaeosensitivity map shows moderate 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 much too old to contain body fossils and not even trace fossils have been recorded from the Wyllies Poort Formation (Soutpansberg Group. Since the Formation is indicated as moderately sensitive in the SAHRIS map, a Fossil Chance Find Protocol has been added to this report. Based on equivalent aged strata, the MISS trace fossils of the Makgabeng Formation (Matlabas Subgroup, Waterberg Group) are included here. 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 trace fossils or fossil plant, insect, invertebrate and vertebrate material. The uncertainty is the interpretation by SAHRIS.

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area or from this Group, it is extremely unlikely that any fossils would be preserved in the arenites of the Wyllie's Poort Formation. Based only on the interpretation of the palaeosensitivity for this region by SAHRIS, a Fossil Chance Find Protocol should be added to the EMPr: if trace fossils such as microbially induced sedimentary structures (MISS) are found once the fences and amenities are constructed for the site, then they should be rescued, photographed and a palaeontologist called to assess and collect a representative sample.

7. References

- Anderson, J.M., Anderson, H.M., 1985. Palaeoflora of Southern Africa: Prodrum of South African megafloras, Devonian to Lower Cretaceous. A.A. Balkema, Rotterdam. 423 pp.
- Barker, O B., Brandl, G., Callaghan, C.C., Erikssen, P.G., van der Neut, M., 2006. The Soutpansberg and Waterberg Groups and the Blouberg Formation. 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 301-318.
- Geng, H., Brandl, G., Sun, M., Wong, G., Kröner, A., 2014. Precambrian Research Zircon ages defining deposition of the Palaeoproterozoic Soutpansberg Group and further evidence for Eoarchean crust in South Africa. *Precambrian Research* 249, 247–262.
- Groenewald, G., Groenewald, D., Groenewald, S., 2014. SAHRA Palaeotechnical Report. Palaeontological Heritage of Limpopo. 22 pages.
- 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.
- Noffke, N., 2009. The criteria for the biogenicity of microbially induced sedimentary structures (MISS) in Archean and younger, sandy deposits. *Earth Science Reviews* 96, 173–180.
- 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.
- SACS: South African Commission for Stratigraphy (1980). Stratigraphy of South Africa, Part 1. (Compiled: L E Kent). Lithostratigraphy of the Republic of South Africa, South west Africa/Namibia and the republics of Bophuthatswana, Transkei and Venda. Handbook of the Geological Survey, South Africa, 8, (690pp.)
- Simpson, E.L., Heness, E., Bumby, A., Eriksson, P.G., Eriksson, K.A, Hilbert-Wolf, H.L., Linnevelt, S., Malenda, H.F., Modungwa, T., Okaforba, O.J., 2013. Evidence for 2.0 Ga continental microbial mats in a paleodesert setting. *Precambrian Research* 327, 36-50.

8. Chance Find Protocol

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

1. The following procedure is only required if fossils are seen on the surface and when drilling/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 (trace fossils, fossil plants, insects, bone, coal) should be put aside in a suitably protected place. This way the project activities will not be interrupted.
3. Photographs of similar fossils must be provided to the developer to assist in recognizing the fossil plants, vertebrates, invertebrates or trace fossils in the shales and mudstones (for example see Figure 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. 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 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 from the Makgabeng Formation.

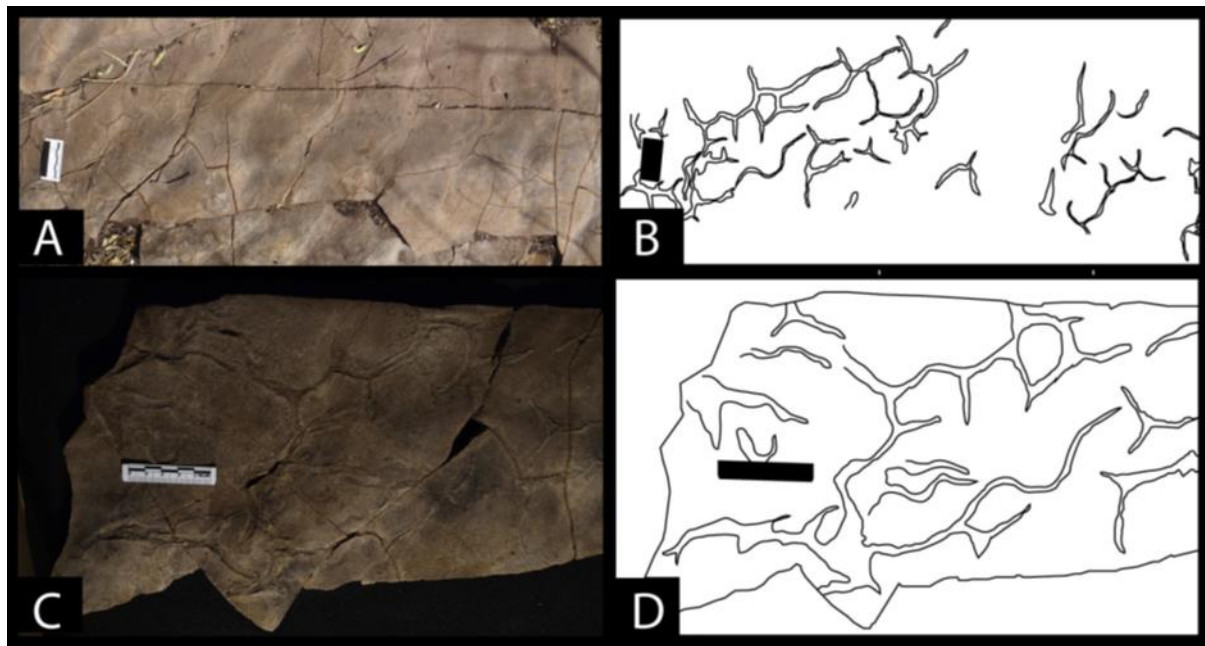


Figure 5: (From Simpson et al., 2013). Photographs of sand cracks. (A) Photomosaic of sand cracks in interdune deposit. Asymmetrical ripples cover the bedding plane. Scale card is 6 cm in length. Outlined block is slab in C. (B) Line drawing of crack system in A. (C) Slab photograph of sand cracks. Note the curving nature of the cracks and elevated crack rims. (D) Line drawing of crack system in C.

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	0
Masters	10	4
PhD	11	4
Postdoctoral fellows	10	5

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 –

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
- Klippoortjie 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; 10 book chapters.

Scopus h-index = 29; Google scholar h-index = 35; -i10-index = 92

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)