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Environmental Authorisation for the Proposed Imvula Coal Mine

Palaeontological Impact Assessment addendum to the Heritage Impact Assessment

Project Number:

IXI3002

Prepared for:

Ixia Coal (Pty) Ltd

April 2016

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Project Name:	**Environmental Authorisation for the Proposed Imvula Coal Mine**
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Name	Responsibility	Signature	Date
Prof. Marion Bamford	Palaeontological Assessment		9 April 2016
Justin du Piesanie Heritage Management Consultant ASAPA Member No 270	First review		April 2016
Johan Nel HRM Unit Manager ASAPA Member No 095	Second review		April 2016

DECLARATION OF INDEPENDENCE

Digby Wells and Associates (South Africa) (Pty) Ltd

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I, Marion Bamford as duly authorised representative of Digby Wells and Associates (Pty) Ltd., hereby confirm my independence (as well as that of Digby Wells and Associates (Pty) Ltd.) and declare that neither I nor Digby Wells and Associates (Pty) Ltd. have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of Ixia Coal (Pty) Ltd, other than fair remuneration for work performed, specifically in connection with the Palaeontological Impact Assessment (PIA) for the proposed Imvula Mining Project.

Full Name:	Prof Marion Bamford
Title:	Palaeobotanist
Qualification (s):	PhD
Experience (Years):	20 years
Registration (s)	Palaeontological Society of Southern Africa; International Quaternary Association (INQUA); International Organisation of Palaeobotanists (African representative)

DECLARATION OF INDEPENDENCE

Digby Wells and Associates (South Africa) (Pty) Ltd

Contact person: Justin du Piesanie

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I, Justin du Piesanie as duly authorised representative of Digby Wells and Associates (Pty) Ltd., hereby confirm my independence (as well as that of Digby Wells and Associates (Pty) Ltd.) and declare that neither I nor Digby Wells and Associates (Pty) Ltd. have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of Ixia Coal (Pty) Ltd, other than fair remuneration for work performed, specifically in connection with the Heritage Resources Management (HRM) Process for the proposed Imvula Mining Project.

Full Name:	Justin du Piesanie
Title/ Position:	Heritage Management Consultant: Archaeologist
Qualification (s):	MSc
Experience (Years):	9 years
Registration (s)	Association of Southern African Professional Archaeologists International Council on Monuments and Sites (ICOMOS) South Africa

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1 Introduction

1.1 Project Background[1]

Digby Wells Environmental (hereafter Digby Wells) completed an Environmental Impact Assessment (EIA) and Environmental Management Programme (EMPr) for Ixia Coal (Pty) Ltd (hereafter Ixia Coal) in support of the latter's Mining Right Application (MRA) for the proposed Imvula Open Pit Coal Mine (Imvula Project) near Secunda, Mpumalanga Province.

The MRA was submitted to the Department of Mineral Resources (DMR) in accordance with the Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA). The supporting EIA and EMPr are currently out for public review in accordance with the EIA Regulations, 2014. The EIA included a Heritage Resources Management (HRM) process during which the following documents were completed and submitted to the South African Heritage Resources Agency (SAHRA) and Mpumalanga Provincial Heritage Resources Authority (MPHRA) in accordance with Section 38 of National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA):

- A Notification of Intent to Develop (NID);
- Heritage Scoping Report (HSR); and
- Heritage Impact Assessment (HIA).

These reports were submitted online via the South African Heritage Resources Information System (SAHRIS) and allocated the case ID number 8831.

SAHRA issued Interim Comment on the HSR on 16 March 2016 require the completion of a specialist Palaeontological Impact Assessment (PIA) for the proposed Project. This document constitutes the PIA as an addendum to the submitted HIA report to inform the Environmental Management Plan (EMP) Report for the proposed Imvula Project.

1.2 Terms of reference

The Terms of Reference for the PIA were based on the requirements contained in the SAHRA Interim comment. The PIA needed to include:

- Consultation of geological maps, palaeontological databases, published and unpublished records, and peer-reviewed literature;
- Assessment of palaeontological sensitivity of the proposed project area; and
- Recommendations for palaeontological monitoring programme.

[1] Detailed project descriptions, including consideration of alternatives, definitions, legal frameworks and baseline cultural landscape descriptions were reported on in the HSR and not repeated in this report for the sake of brevity.

2 Methodology

The following activities were completed to compile the PIA report:

- Desktop survey of geological maps and palaeontological databases; and
- A review of relevant published and unpublished literature, including a review of the unpublished HSR submitted to SAHRA and MPHRA;

3 Potential fossil plants in the Karoo-aged deposit of the Imvula Project[2]

The *Vryheid Formation*[3] is the main potential fossiliferous rock underlying the site-specific study are of the Project. It is inherently associated with coal and fossil plants.

Fossil plants in general resemble modern plants – leaves of various shapes and sizes, twigs with leaf scars long the surface, chunks of wood, seeds, cones, ferns, etc. These fossils are more likely to be recognised in the shales between the coal seams or in fine grained mudstones and shales. They may be found in sandstone, but are not as well preserved. The colour of the matrix can be black, red, grey, white and the fossil plant may be an impression (no colour difference) or be stained with some mineral and so easy to see.

Brief descriptions of the typical fossil plants that may be expected in the *Vryheid Formation* are provided below.

3.1 Glossopteris

Glossopteris leaves resemble feathers with a midrib and veins, stained orange by iron chelate on a white kaolin matrix. Figure 1a depicts a mat of leaves of several types. In coal deposits they would be black on a grey matrix. The specimen was a seed fern and the leaves grew in spirals at the ends of stems of bushes or trees. Figure 1d represents a well-preserved example of a fern, black on grey, and Figure 1g another example of *Glossopteris* leaves stained black or red on a grey matrix.

The *Dicroidium* species is depicted in Figure 1e. This is a seed fern with the stem dividing in two. *Dicroidium* sp. Is extinct and usually found in Triassic sediments and associated with slightly younger coal.

[2] The detailed geological and palaeontological baseline contained in the HSR was reviewed by Prof. Bamford and not repeated in this PIA report.

[3] **Note**: In the HSR, the the *Vryheid Formation* was incorrectly identified as the *Madzaringwe Formation*. This was due to the use of outdated geological plans and information. The *Madzaringwe Formation* is exclusively associated with the Tshipise Basin of the Limpopo Belt (Johanson, et al., 2006) and does not occur in the regional study area.

A root impression of *Glossopteris*, called *Vertebraria* is depicted in Figure 1f. Note the central longitudinal hard section and the alternating hollows or depressions along the sides. These roots were adapted for growing in swamps so have sections of soft tissue or *aerenchyma* (now depressions) for gas exchange.

This is the most common plant group of the coal deposits and is now extinct. Size range of leaves 5-80cm long but more commonly 10-20cm long. Figure 1b depicts another fern stained slightly and not flat on the surface as is more common.

Many ferns still live today. Size range 5-80cm but usually fragmented.

3.2 Calamites

Figure 1c depicts a *Calamites* stem with notable longitudinal striations along the stem and occasional horizontal lines that are the nodes where long, narrow leaves or roots would have been attached.

Calamites was a reed-like plant and the large forms are extinct. Today we have small versions only – *Equisetum* spp.

3.3 Animal fossils

Fossil mammal-like reptiles and mammals are known to be associated with coal deposits. The bone fragments depicted in Figure 1h are partially buried in the hard grey rock. This would be part of a mammal-like reptile skeleton.

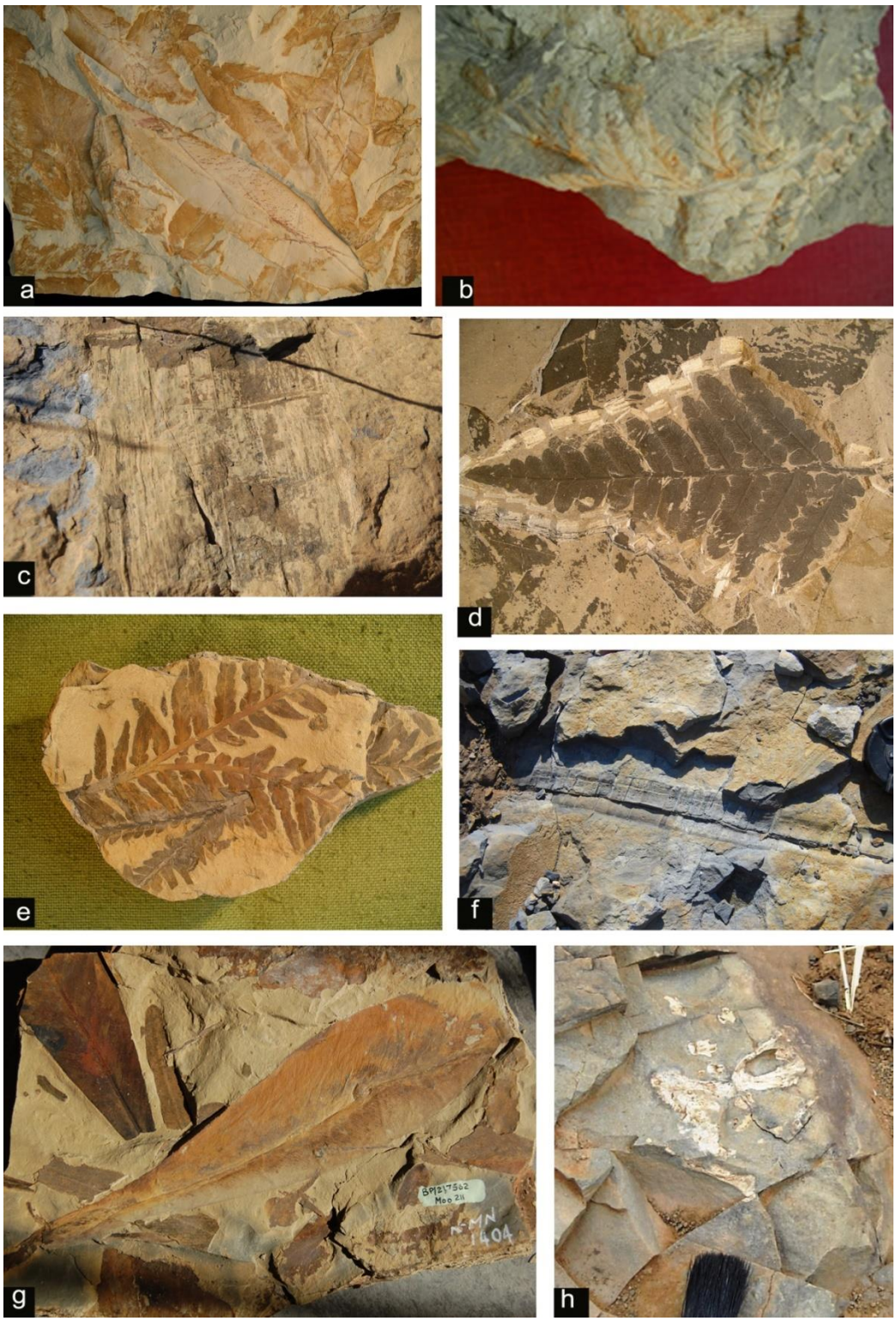

Figure 1: Composite of possible Karoo-aged fossil plants that may be identified within the Project Area

4 Summary discussion and recommendations

On the basis of the previous reports submitted but Digby Wells, as well as the geological and palaeontological context summarised in the HSR report, it is strongly recommended that a Fossil Monitoring Programme be adopted for **operational** activities.

If fossil plant material is discovered during development of the infrastructure, then it is strongly recommended that a professional palaeontologist, preferably a palaeobotanist, be called to assess the importance and rescue them if necessary (*with the relevant SAHRA permit*). Where deemed to be of scientific interest then further visits by a professional palaeontologist would be required to collect more material. Given the shortage of such qualified people in South Africa and the stringent safely laws for underground access by the mining companies, any long term monitoring of the fossils is impractical. Nonetheless a monitoring programme is outlined below.

4.1 Proposed Palaeontological Monitoring Programme

The following procedure is only required if and when mining commences. The surface activities would not impact on the fossil heritage as the coals and any associated fossil plants are below ground.

1. When mining **operations commence** the shales and mudstones (*of no economic value*) must be given a cursory inspection by the mine geologist or designated person before being added to the dumps used by the mine. Any fossiliferous material should be put aside in a suitably protected place. This way the mining activities will not be interrupted.
2. Photographs of similar fossil plants must be provided to the mine to assist in recognizing the fossil plants in the shales and mudstones (Figure 1).
3. On a regular basis, to be agreed upon by the mine management and the qualified palaeobotanist sub-contracted for this project, the palaeobotanist should visit the mine to inspect the selected material and check the dumps where feasible. The frequency of inspections should be monthly. If the geologist/deputy is diligent and extracts the fossil material then inspections can be less frequent.
4. Fossil plants considered to be of good quality or scientific interest by the palaeobotanist 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 mine a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA.
5. If any underground inspection is deemed necessary then the normal safety procedures that the mine management endorses, must be followed by the palaeobotanist and associated mine employees.
6. If no good fossil material is recovered then the site inspections by the palaeobotanist can be reduced to annual events until mining operations cease. Annual reports by the palaeobotanist must be sent to SAHRA.

Appendix A: Specialist CV

Curriculum vitae (short) - Marion Bamford PhD
February 2016

I) Personal details

Surname	:	**Bamford**
First names	:	**Marion Kathleen**
Identity Number	:	6110250256188
Present employment	:	Personal Professor, and Member Executive Committee of the Evolutionary Studies Institute and NRF/DST Centre of Excellence for Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa; July 2013 -
Telephone	:	+27 11 717 6690
Fax	:	+27 11 717 6694
Cell	:	082 555 6937
E-mail	:	marion.bamford@wits.ac.za

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
First enrolled: June 1984
Honorary Secretary: Sept 1998 - Sept 2000

Vice President: Sept 2000- Sept 2002.
President: Oct 2002 - Sept 2004.
Immediate Past President: Sept 2004 - Sept 2006
Vice President: Sept 2012-Sept 2014.
President: Sept 2014-Sept 2016

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
First enrolled: May 1993
African representative of the International Task Force on Mesozoic Coniferous Woods, 1996.
Regional Representative for Africa and the Arabian Peninsula: 2002 - present

Botanical Society of South Africa
First enrolled: January 1996

South African Committee on Stratigraphy - Biostratigraphy.
Committee member 1997 - present

SASQUA (South African Society for Quaternary Research)
First enrolled: mid 1997
1999 - 2005: Committee member
2000 - 2006: Committee member for ICSU for INQUA
2002: chairman of 2003 Conference Organising Committee
2005-2012 – Secretary
2012-2014 – Vice President
2015-2017 - President

PAGES
2008 –onwards: South African representative

ROCEEH / WAVE
2008 onwards – member

INQUA – PALCOMM
2011 onwards

v) Academic distinctions/fellowships/awards

Member of the Academy of Sciences, South Africa, October 2014 onwards.
Deputy Director of BPI Palaeontology, University of the Witwatersrand, 2007 to July 2013 when BPI and the IHE merged to become the ESI.
Honorary Reader in the School of Geosciences, University of the Witwatersrand, 01 Sept 2013 – 31 August 2016
Co-Director: Olduvai Landscape Palaeontology Project in Tanzania (2011 onwards)
Chief Coordinator of the PAST (Palaeontological Scientific Trust) Scientific Advisory Committee, 2011 onwards.
PAST-Standard Bank Award for Research Excellence – Senior Researcher 2008
Elected a Fellow of the Royal Society of South Africa – 2007 onwards
Mellon Foundation Mentoring Award 2008; 2009; 2011-2012 with student Natasha Barbolini
NRF Rating: B-3 (2005-2009) (2010-2014)
NRF Rating: C-2 (1999-2004)
MSc awarded with distinction, Wits University 1986.

vi) Academic and professional experience

2014 April – Personal Professor and Member of the Executive Committee of the ESI, and Centre of Excellence for Palaeosciences, Wits University
2013 – March 2014: Associate Professor and Member of the Executive Committee of the ESI, and Centre of Excellence for Palaeosciences, Wits University.
2007 – June 2013: Associate Professor and Deputy Director, BPI Palaeontology, Wits University.
2001- 2006: Senior Research Officer and Deputy Director, BPI Palaeontology, Wits University
1997-2000: Research Officer, BPI Palaeontology, Wits University.
1992-1996: Research Fellow, BPI Palaeontology, Wits University.
1990-1991: Research Associate, BPI Palaeontology, Wits University
1989-1990: Research Officer in Palaeobotany, Council for Geosciences, Pretoria

Visiting Professorships (one month each)
1999: Professor Invitée, School of Biology, University of Claude Bernard, Lyon, France.
2000: Professor Invitée, School of Biology, University of Claude Bernard, Lyon, France.
2009: Visiting professorship, AGAUR, Department of History, Prehistory and Archaeology, University of Barcelona, Spain.

vii) Supervision of Higher Degrees

All at Wits University

Degree	Graduated	Current
Honours	4	2

Masters	4	0
PhD	5	6
Post doctoral fellows	3	5

Publications – editorships:
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 the following ISI-listed journals:
Acta Palaeontologia Polonica
Alcheringa
Ameghiniana
American Journal of Physical Anthropology
Archaeometry
Bulletin de la Société géologique de France
Cretaceous Research
Geoarchaeology
Geobios
Geological Journal
Gondwana Research
IAWA Journal
Journal of African Earth Sciences
Journal of Arid Environments
Journal of Human Evolution
Palaeogeography, Palaeoclimatology, Palaeoecology
Palaeontographica Abt B
Quaternary International
Quaternary Science Reviews
Review of Palaeobotany and Palynology
South African Journal of Botany
South African Journal of Science

Review of project proposals/funding applications:
Leakey Foundation
NRF funding and rating
PAST funding
Rustaveli Foundation, Georgia
Darwin Institute, The Netherlands
Marsden foundation, New Zealand

4.4 Departmental and other duties:

A. Research and publication of research

B. Supervision of Honours and Postgraduate students and projects; Post Graduate coordinator; Chairman of institute's Post Graduate supervisory committee.

C. Teaching:

1. Geology II palaeobotany component of Palaeontology course (GEOL2008);
2. Animal, Plant and Environmental Sciences III: Palaeontology; course co-ordinator (APES3029)
3. Archaeology II: Palynology and Quaternary Palaeoclimate; 2003-4
4. Honours topics: Palaeobotany, Palaeobiogeography, Taphonomy, Origin of Life, Palynology.

D. Curation of Palaeobotany Herbarium and Collections.

E. Administration

- Post graduate co-ordinator
- Graduate Studies Committee Representative for Geosciences and Deputy Chairman of committee
- Member of the ESI Executive Committee and Centre of Excellence Management Committee (2013 --) decision-making, coordination of post graduate students.

4.5 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

4.6 Research Output

Publications by M K Bamford up to February 2016 in peer-reviewed journals: 97 articles published; 5 submitted/in press; 4 book chapters in press .
Scopus h index = 20; Google scholar h index = 22;

Publications for the last five years only:

97. De Franceschi, D., Bamford, M.K., Pickford, M., Senut, B. 2016. Fossil wood from the upper Miocene Mpesida Beds at Cheparain (Baringo District, Kenya): botanical affinities and palaeoenvironmental implications. Journal of African Earth Sciences 115, 271-280.

96. Habermann, H.M., Stanistreet, I.G., Stollhofen, H., Albert, R.M., Bamford, M.K., Pante, M.C., Njau, J.K., Masao, F.T., 2016. In situ ~2.0 Ma trees discovered as fossil rooted stumps, lowermost Bed I, Olduvai Gorge, Tanzania. Journal of Human Evolution 90, 74-87.

95. Bamford, M.K., 2015. Macrobotanical remains from Wonderwerk Cave (Excavation 1), Oldowan to Late Pleistocene (2Ma to 14ka BP), South Africa. African Archaeological Review 32, 813-838. Wonderwerk Special Issue. DOI 10.1007/s10437-015-9200-0

94. Bamford, M.K. 2015. Charcoal from pre-Holocene Stratum 5, Wonderwerk Cave, South Africa. Palaeoecology of Africa 33, 153-174.

93. Neumann, F.H., Bamford, M.K., 2015. Shaping of the modern southern African biomes-Neogene vegetation and climate changes. Transactions of the Royal Society of South Africa 70, No. 3, 195–212, http://dx.doi.org/10.1080/0035919X.2015.1072859

92. Gastaldo, R.A., Kamo, S., Neveling, J., Geissman, J., Bamford, M., Looy, C. 2015. Is the vertebrate-defined Permian-Triassic Boundary in the Karoo Basin, South Africa, the terrestrial expression of the End Permian marine event? Geology 43(10), 939-942.

91. Andreoli, M.A.G., Przybylowicz, W.J., Kramers, J., Belyanin, G., Westraadt, J., Bamford, M., Mesjasz-Przybylowicz, J., Venter, A., 2015. PIXE micro-mapping of minor elements in Hypatia, a diamond bearing carbonaceous stone from the Libyan Desert Glass area, Egypt: Inheritance from a cold molecular cloud? Nuclear Instruments and Methods in Physics Research B, 363, 79-85.

90. Lennox S, Wadley, L., Bamford, MK. 2015. Charcoal analysis from 49 000-year-old hearths at Sibudu: implications for wood uses and the KwaZulu-Natal environment. South African Archaeological Bulletin 70 (201), 36–52.

89. Albert, R.M., Bamford, M.K., Esteban, I. 2015. Reconstruction of ancient palm vegetation landscapes using a phytolith approach. Quaternary International 369, 51-66. http://dx.doi.org/10.1016/j.quaint.2014.06.067.

88. Albert, R.M., Bamford, M.K., Stanistreet, I., Stollhofen, H., Rivera-Rondón, C., Rodríguez-Cintas, A. 2015. Vegetation landscape at DK locality, Olduvai Gorge, Tanzania Palaeogeography, Palaeoclimatology, Palaeoecology 426, 34-45. http://dx.doi.org/10.1016/j.palaeo.2015.02.022

87. Lennox, S.J., Bamford, M.K., 2015. Use of wood anatomy to identify poisonous plants: Charcoal of Spirostachys africana. South African Journal of Science.111 (3/4), Art. #2014-0143, 9 pages. http://dx.doi.org/10.17159/sajs/20140143

86. Norström, E., Neumann, F.H., Scott, L., Smittenberg, R.H., Holmstrand, H., Lundqvist, S., Snowball, I., Sundqvist, H.S., Risberg, J., Bamford, M., 2014. Late Quaternary vegetation dynamics and hydro-climate in the Drakensberg, South Africa. Quaternary Science Reviews 105, 48-65.

85. Barbolini, N., Bamford, M.K., 2014. Palynology of an Early Permian coal seam from the Karoo Supergroup of Botswana. Journal of African Earth Sciences 100, 136-144.

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82. Rößler, R., Philippe, M., van Konijnenburg-van Cittert, J.H.A., McLoughlin, S., Sakala, J., Zijlstra, G., et al. (35 coordinating authors including Bamford, M.K.,). (2014). Which name(s) should be used for Araucaria-like fossil wood? – Results of a poll. Taxon 63(1), 177-184.

81. Sciscio, L., Neumann, F.H., Roberts, D.L., Tsikos, H., Scott, L., Bamford, M.K., 2013. Fluctuations in Miocene climate and sea levels along the south-western South African coast: Inferences from biogeochemistry, palynology and sedimentology. Palaeontologia africana 48, 2-18.

80. Maxbauer, D.P., Peppe, D.J., Bamford, M.K., McNulty, K., Harcourt-Smith, W.E.H., Davis, L.E., 2013. A morphotype catalog and paleoenvironmental interpretations of Early Miocene fossil leaves from the Hiwegi Formation, Rusinga Island, Lake Victoria, Kenya. Palaeontologia Electronica 16 (3) 28A; 19pp.

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77. Cantrill, D.J., Bamford, M.K., Wagstaff, B., Sauquet. H. 2013. Early Eocene fossil plants from the Mwadui Kimberlite Pipe, Tanzania. Review of Palaeobotany and Palynology 196, 19-35.

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75. Chazan, M., Avery, DM, Bamford, MK., Berna, F., Brink, J., Holt, S., Fernandez-Jalvo, Y., Goldberg, P., Matmon, A., Porat, N., Ron, H., Rossouw, L., Scott, L., Horwitz, L.K., 2012. The Oldowan horizon in Wonderwerk Cave (South Africa): Archaeological, geological, paleontological and paleoclimatic evidence. Journal of Human Evolution 63, 859-866.

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4.7 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)