

PALAEONTOLOGICAL HERITAGE IMPACT ASSESSMENT REPORT ON THE ESTABLISHMENT OF THE 65 MW MAJUBA SOLAR PHOTOVOLTAIC FACILITY AND ASSOCIATED INFRASTRUCTURE ON PORTION 1, 2 AND 6 OF THE FARM WITKOPPIES 81 HS, MPUMALANGA PROVINCE

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Prepared for Savannah Environmental (Pty) Ltd

On behalf of:

Eskom Holdings (SOC) Limited

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an agency of the
Department of Arts and Culture

EXECUTIVE SUMMARY

Eskom Holdings (SOC) Ltd proposes the establishment of a 65 MW solar energy facility known as the Majuba Solar Power Facility, which will use photovoltaic (PV) technology. Due to Section 35 of the National Heritage Resources Act, a palaeontological impact assessment is required to detect the presence of fossil material at the proposed development site.

The development area in Majuba is underlain by fossiliferous sedimentary rocks of the Early Permian Volksrust Formation. This Formation is known for the occurrence of fossil plants e.g. glossopterids, cordaitaleans and possibly other seed ferns. During a desktop study a palaeontological sensitive area has been identified. Although the palaeontological sensitivity is rated high, the development area is largely an area which already has been disturbed by human activities (extensive farming and ploughing). A Phase 1 Impact Assessment documented lush grassy vegetation with **no sharp outcrops**. Agricultural activities and the lack of appropriate exposure at the proposed site indicate that the impact on palaeontological material is **negligible and regarded as insignificant**.

It is therefore recommended that no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required for the commencement of this development, pending the discovery or exposure of any fossil remains during the construction phase.

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1 INTRODUCTION

Eskom Holdings (SOC) Ltd proposes the establishment of Majuba, a 65 MW solar energy facility. The proposed location for the solar facility lies within the Majuba coal fired power station boundary, approximately 15 km southwest of Amersfoort and 40 km northwest of Volksrust on Portion 1, 2, and 6 of the farm Witkoppies 81 HS, Gert Sibande Magisterial District, Seme Local Municipality, Mpumalanga Province (Fig.1). A Desktop study was conducted in November 2014 and a potential sensitive area was identified on the Google Earth Image (Fig. 2).

Eskom Holdings (SOC) Ltd has appointed Savannah Environmental (Pty) Ltd to undertake a full Environmental Impact Assessment of the proposed Majuba Solar PV. Savannah Environmental selected the National Museum, Bloemfontein to conduct the Phase 1 Palaeontological Impact Assessment which will form part of the final Heritage Impact Report. The surface area of the proposed project area is approximately 96.6 ha.



Figure 1: Satellite image of the Majuba power station and Solar panel development area. Image modified from Google Earth, 2015.

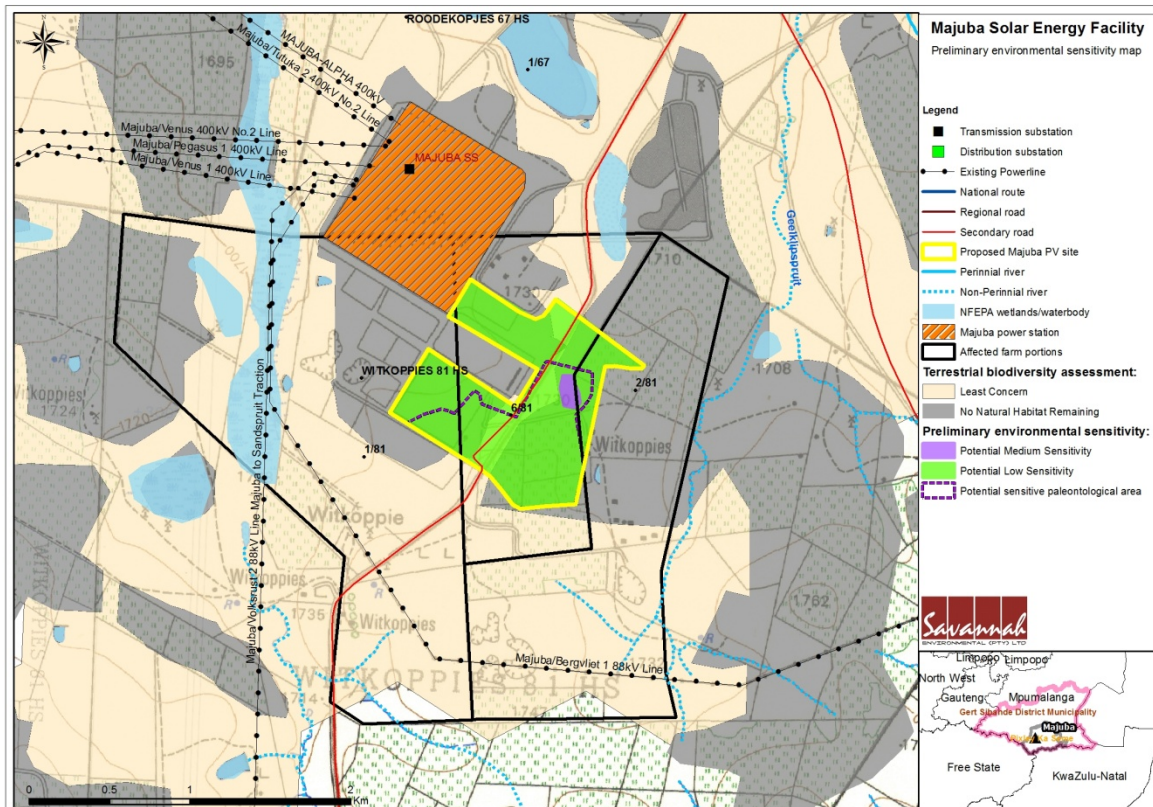


Figure 2: Development site of Majuba Power Facility indicating the potential sensitivity area. Map provided by Savannah Environmental.

2 OBJECTIVE

According to the “SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports” the aims of the palaeontological impact assessment are:

- to identify exposed and subsurface rock formations that are considered to be palaeontologically significant;
- to assess the level of palaeontological significance of these formations;
- to comment on the impact of the development on these exposed and/or potential fossil resources and
- to make recommendations as to how the developer should conserve or mitigate damage to these resources.

When a palaeontological desktop study is conducted, the potentially fossiliferous rocks (i.e. groups, formations, members, etc.) represented within the study area are determined from geological maps. The known fossil heritage within each rock unit is collected from published scientific literature; Fossil sensitivity map; consultations with professional colleagues, previous palaeontological impact studies in the same region and the databases of various institutions may be consulted. This data is then used to assess

the palaeontological sensitivity of each rock unit of the development area. The likely impact of the proposed development on local fossil heritage is subsequently established on the basis of • the palaeontological sensitivity of the rocks concerned and • the nature and scale of the development itself (extent of new bedrock excavated). When rocks of moderate to high palaeontological sensitivity are present within the development area, a field-based assessment by a professional palaeontologist is necessary.

Based on this desktop data as well as a field examination of representative exposures of all major sedimentary rock present, the impact significance of the planned development is considered with recommendations for any further studies or mitigation.

3 LEGISLATION

Cultural Heritage in South Africa is dealt with by the National Heritage Resources Act (Act 25 of 1999). This Palaeontological Assessment forms part of the Heritage Impact Assessment (HIA) and complies with the requirements of the above mentioned Act. In accordance with Section 38, a HIA is required to assess any potential impacts to palaeontological heritage within the development footprint.

3.1 SECTION 25 OF THE NATIONAL HERITAGE RESOURCES ACT 1999.

The various categories of heritage resources are recognised as part of the National Estate in Section 3 of The National Heritage Resources Act. This include among others:

- geological sites of scientific or cultural importance;
- palaeontological sites;
- palaeontological objects and material, meteorites and rare geological specimens.

According to Section 25 of the National Heritage Resources Act 1999, dealing with archaeology, palaeontology and meteorites:

- The protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority.
- All archaeological objects, palaeontological material and meteorites are the property of the State.
- Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to

the nearest local authority offices or museum, which must immediately notify such heritage resources authority.

- No person may, without a permit issued by the responsible heritage resources authority—
 - destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
 - destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
 - trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or
 - bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.
- When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedure in terms of section 38 has been followed, it may—
 - serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;
 - carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary.

4 BACKGROUND TO THE GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

4.1 GEOLOGY

The Main Karoo Basin covers more than 50 % of the surface of South Africa. The Karoo Supergroup strata are between 310 and 182 million years old and span the Upper Carboniferous to Middle Jurassic Periods.

The development area in Majuba is underlain by the Permian Volksrust Formation (Fig. 3). This Formation consists of Middle to Late Permian basinal mudrocks of the Eccca Group. SACS (1980) applied the name Volksrust Shale Formation to the old "Upper Eccca Beds". The general thickness of the unit is between 150 and 250 m and it is dominated by dark grey-green siltstones and mudstones, with phosphatic/carbonate/sideritic concretions (Hankox et al., 2014). The Geology of the area has been described in detail by Dr Millsted who conducted the desktop study.

The Volksrust Formation shows an overall coarsening-upward trend (Cadle, 1974). In some places coals occur interbedded with the mudstones. This Formation is assumed to have formed in shallow to deep water basinal conditions.

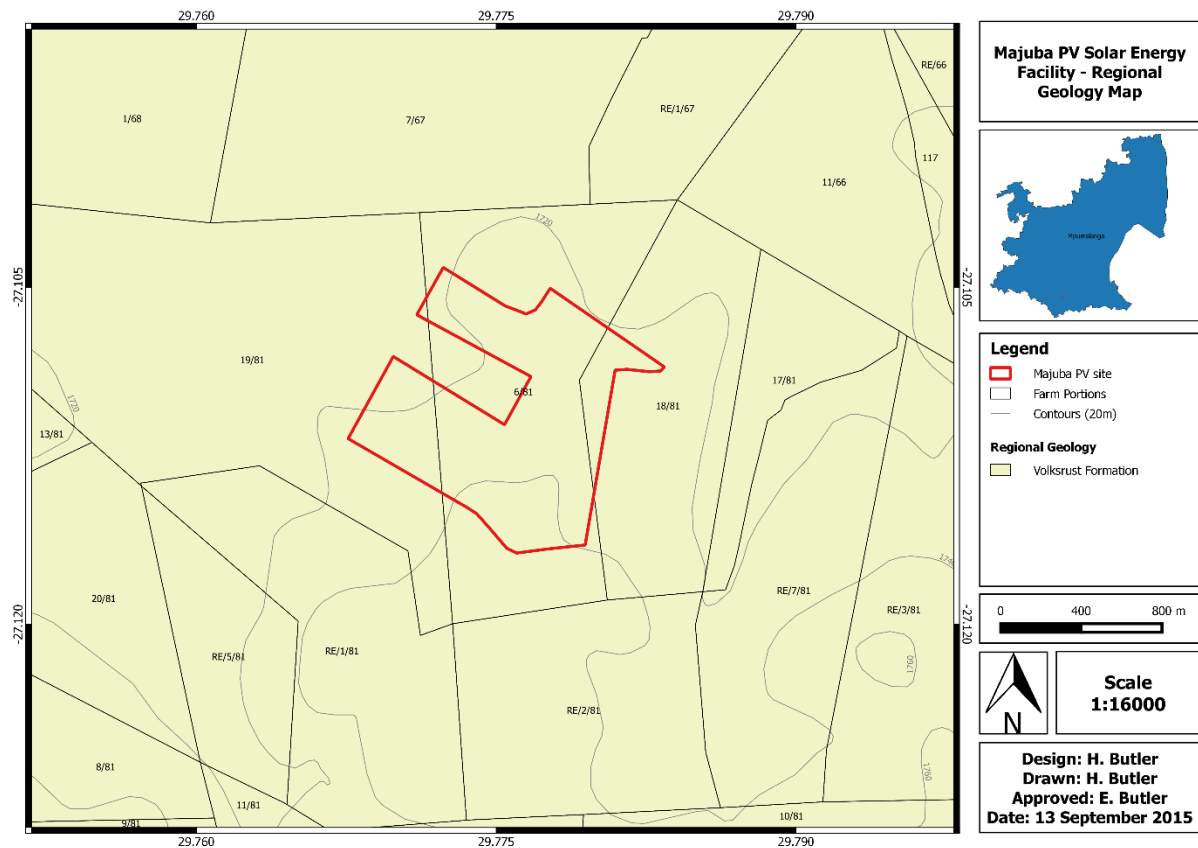


Figure 3. Geology of the development area at Majuba power station Gert Sibande Magisterial District, Seme Local Municipality, Mpumalanga Province (bordered in red). The development area is underlain by the Permian, Volksrust Formation, Ecca Group. (Map modified from Geological Maps: Council for Geosciences, Pretoria).

4.2 PALAEOLOGY

The formation is characterized by the occurrence of plant fossils, eg. *Phyllothea australis*; *Raniganjia kilburnensis*; *Schizoneura africana*; *Glossopteris spp.*, and represents the glossopterids, cordaitaleans and possibly other seed ferns (Bamford 2003; Claassen, 2014). This Formation is also known for its low diversity trace fossil assemblage (Tavener-Smith, et al., 1988) and various organic microfossils. Macrofaunal remains include various insects (Ponomarenko and Mostovski, 2005; Van Dijk, 1981). The first reported discovery of the bivalve, *Megadesmus* in Africa is described from the Late Permian Volksrust Shale Formation, in the north-eastern Karoo Basin (Cairncross, et al, 2005).

5 METHODS

5.1 Assumptions and Limitations

The accuracy and reliability of desktop Palaeontological Impact Assessments as components of heritage impact assessments are normally limited by the following restrictions:

- Old fossil databases that have not been kept up-to-date or are not computerized. These databases do not always include relevant locality or geological information. South Africa has a limited number of professional palaeontologists that carry out fieldwork and most development study areas have never been surveyed by a palaeontologist.
- The accuracy of geological maps where information may be based solely on aerial photographs and small areas of significant geology have been ignored. The sheet explanations for geological maps are inadequate and little to no attention is paid to palaeontological material.
- Impact studies and other reports (*e.g.* of commercial mining companies) is not readily available for desktop studies.

Large areas of South Africa have not been studied palaeontologically. Fossil data collected from different areas but in similar Assemblage Zones might however provide insight on possible occurrence of fossils in an unexplored area. Desktop studies of this nature therefore usually assume the presence of unexposed fossil heritage within study areas of similar geological formations. Where considerable exposures of bedrocks or potentially fossiliferous superficial sediments are present in the study area, the reliability of a palaeontological impact assessment may be significantly improved through field assessment by a professional palaeontologist.

6 SITE VISIT



Figure 4. Lush, grass vegetation at the proposed new development at Majuba power facility station, Gert Sibande Magisterial District, Seme Local Municipality, Mpumalanga Province.



Figure 5. Majuba power facility station, Gert Sibande Magisterial District, Seme Local Municipality, Mpumalanga Province.

7 IMPACT ASSESSMENTS

An assessment of the impact significance of the proposed photovoltaic solar facility development on local fossil heritage on Majuba is presented here:

7.1 NATURE OF THE IMPACT

The PV Solar Facility will include the following infrastructures:

- Arrays of photovoltaic (PV) panels
- PV panels will be supported by mounting structures
- Cabling between project components
- Transformers/inverters enclosures
- A power line to facilitate the connection of the solar facility to the existing substation at the power station
- Internal access roads

8 EXTENT OF IMPACT

The negative impact on the palaeontological heritage will be limited to the footprint of the development area. The extent of the area of potential impact is thus restricted to the project site and therefore categorised as **local**.

9 DURATION OF IMPACT

The expected duration of the impact is assessed as potentially permanent to long term. In the absence of mitigation procedures (should fossil material be present within the affected) the damage or destruction of any palaeontological materials will be permanent.

10 PROBABILITY OF IMPACT

The sediments of the Vryheid Formation are especially known for its plant macrofossils. The occurrence of fossils within the geological record is commonly unpredictable and the chance of impacting a fossil at any particular point within the Vryheid Formation is moderate. The Vryheid Formation strata has been extensively utilised for agricultural production (ploughed) and thus any fossils that may have been occurring at surface or near-surface will have historically been either destroyed, damaged or moved and their value lost.

The possibility of negatively impacting upon fossils that may have been located at the land surface or within the upper few centimetres of the subsurface is negligible.

The infrastructure of this project will generally only affect the upper few meters (1-2 m) of the land surface. Thus, over the majority of the project area the chance of negatively affecting any fossil will be limited to the upper 1-2 m of the land surface. Together with the fact that the land surface has been disrupted over the years by ploughing the total probability of any negative impacts is assessed as low.

11 SIGNIFICANCE OF THE IMPACT

Should the project progress without due care to the possibility of fossils being present within the Vryheid Formation the resultant damage, destruction or inadvertent relocation any affected fossils will be **permanent and irreversible**. Thus, any fossils occurring within the project area are potentially scientifically and culturally significant and any negative impact on them would be of **high significance**.

12 SEVERITY / BENEFIT SCALE

The proposed project is potentially beneficial because the project will provide a long term benefit to the community in terms of the provision of electricity to a progressively stressed national power grid.

The likelihood of fossils being affected by the planned project is low. Many fossil taxa are known from only a single fossil and, thus, any fossil material is potentially highly significant. Thus, although the possibility of any disturbance of palaeontological materials is moderate, the severity of any impact is potentially high. The possibility of a negative impact on the palaeontological heritage of the area can, however, be reduced by the implementation of adequate damage mitigation procedures. If damage mitigation is properly undertaken the benefit/severity scale for the project will lie within the beneficial category.

A potential secondary advantage of the project would be that the excavations may uncover fossils that were hidden beneath the surface exposures and, as such, would have remained unknown to science.

13 STATUS

It is thus expected that as long as acceptable mitigation processes are emplaced preceding commencement of the construction phase, little to no negative effect on the palaeontological heritage is predicted. As the proposed project would supply electricity to the South African national power grid the project is determined as having a positive status herein.

14 DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSABLE LOSS

14.1 Mitigation

Should fossil material exist within the project area any negative impact upon it could be mitigated by its excavation (permit from SAHRA is required) by a palaeontologist and the material being housed with a permitted institution. In the event that an excavation is impossible or inappropriate the fossil or fossil locality could be protected and the site of any planned construction moved.

14.2 Degree of irreversible loss

Once a fossil is damaged, destroyed or moved from its original position without its geographical position and stratigraphic location being recorded the damage is irreversible.

15 FINDINGS AND RECOMMENDATIONS

The proposed development area at Majuba power facility consists of areas disturbed by agriculture. The palaeontological sensitive area identified in the desktop study were recognised through the study of images on Google Earth. Vegetation on the images provided by Google Earth for the desktop study is absent from this area and the presence of fossils could not be ruled out. During the site visit the area was scrutinized and lush grass vegetation were identified in the area. It thus appears that the Google Images were photographed during a previous season and that the area is presently overgrown with grassy vegetation.

In these areas the **absence of potentially fossiliferous gulleys** and **appropriate exposures** suggest that fossils are absent from this site. The impact on paleontological material is **negligible and regarded as insignificant**. It is therefore recommended that no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required for the commencement of this development, **pending the discovery or exposure of any fossil remains during the construction phase**.

Should fossil remains be discovered during any phase of construction, either on the surface or exposed by fresh excavations, the ECO responsible for these developments should be alerted. Such discoveries ought to be protected (preferably *in situ*) and the ECO should alert SAHRA (South African Heritage Research Agency) so that appropriate mitigation (*e.g.* recording, sampling or collection) can be taken by a professional paleontologist.

The specialist involved would require a collection permit from SAHRA. Fossil material must be curated in an approved collection (*e.g.* museum or university collection) and all fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA.

16 IMPACT TABLE

NATURE: Prevent Possible loss of valuable Palaeontological Heritage on proposed development of Majuba solar facility		
	With Mitigation	Without Mitigation
Extent	Low (2)	Low (2)
Duration	Long term to permanent (4-5)	Long term to permanent (4-5)
Magnitude	Small (1)	Small (2)
Probability	Improbable (2)	Improbable (2)
Significance	Low	Low
Status (positive or negative or neutral)	Neutral	Negative
Reversibility	Reversible	Irreversible
Irreplaceable loss of resources?	Yes	Yes
Mitigation : Mitigation measures: Through monitoring of the site while construction is in progress, immediate notification if Heritage is found and mitigation can be initiated		
Cumulative impacts: Low impact on development area		
Residual impacts on development area: Beneficial to community because of the electricity shortage, low impact on Fossil Heritage because of low occurrence of fossils in the development area and absence of fossiliferous outcrops		

17 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

Elize Butler has an MSc in Palaeontology from the University of the Free State, Bloemfontein, South Africa. She has been working at the National Museum for the past 22 years and currently holds the position of Collection Manager of the Karoo Vertebrate Collection of the Palaeontology Department at the National Museum in Bloemfontein. Her current research interests comprise of Permo-Triassic vertebrate palaeobiology, with a special focus on gorgonopsians at the End-Permian Mass Extinction.

18 DECLARATION OF INDEPENDENCE

I, Elize Butler, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed project, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise my objectivity in this work.

Sincerely

A handwritten signature in black ink that reads "Butler." The signature is written in a cursive style with a large, stylized initial 'B'.

Mrs. Elize Butler

19 REFERENCES

ANDERSON, A.M., MCLACHLAN, I.R., 1976. *The plant record in the Dwyka and Ecca Series (Permian) of the southwestern half of the Great Karoo Basin, South Africa.* Palaeontologia africana 19: 31- 42.

ANDERSON, J.M., ANDERSON, H.M., 1985. *Palaeoflora of Southern Africa. Prodrum of South African megafloras, Devonian to Lower Cretaceous.* A.A. Balkema, Cape Town.

ADENDORFF, R., BAMFORD, M.K., and MCLOUGHLIN, S. 2003. *Liknopetalon: a review of a rare Gondwanan Permian pteridophyte.* Review of Palaeobotany and Palynology. 126: 83-101.

ADENDORFF, R., MCLOUGHLIN, S., and BAMFORD, M. K. 2002. *A new genus of ovuliferous glossopterid fructification from South Africa.* Palaeontologia africana. 38: 1- 17.

BAMFORD, M. 2003. *Diversity of the Woody Vegetation of Gondwanan Southern Africa.* Gondwana Research 7(1): 153 – 164

CADLE, A.B., 1974. *A Subsurface Sedimentological Investigation of Parts of the Ecca and Beaufort Groups in the North-eastern Karoo Basin.* Unpublished MSc Thesis, University of Natal, Pietermaritzburg, 144 pp.

CAIRNCROSS, B., BEUKES, N.J., COETZEE, L. L. and REHFELD, U. 2005. *The Bivalve Megadesmus from the Permian Volksrust Shale Formation (Karoo Supergroup), north-eastern Karoo Basin, South Africa: implications for late Permian Basin development.* South African Journal of Geology 108: 547-556.

JOHNSON, M.R., *et. al.* 2006. Sedimentary Rocks of the Karoo Supergroup. **In:** M.R. Johnson, *et. al.* (eds). *The Geology of South Africa.* Geological Society of South Africa.

CLAASSEN, M., 2008. *A note on the biostratigraphic application of Permian plant fossils of the Normandien Formation (Beaufort Group, North-eastern Main Karoo Basin), South Africa.* South African Journal of Geology. 111: 263–280.

HANCOX, P.J., and GÖTZ, A.E., 2014. *South Africa's coalfields-A 2014 perspective.* International Journal of Coal Geology 132:170–254.

JOHNSON, M.R., VAN VUUREN, C.J., VISSER, J.N.J., COLE, D.I., WICKENS, H.de V., CHRISTIE, A.D.M., ROBERTS, D.L., BRANDT, G. 2006. *Sedimentary rocks of the Karoo*

Palaeontological Impact Assessment Report-Eskom Holdings (SOC) Limited's proposed Majuba Solar Energy Facility near Amersfoort, Mpumalanga Province

Supergroup. In: Johnson, M.R., Anhaeusser, C.R., Thomas, R.J., (eds). *The Geology of South Africa*. Council for Geosciences and Geological Society of South Africa, pp 461-499.

HOBDAV, D. K. and TAVERNER-SMITH, R. 1975. *Trace fossils in the Ecca of northern Natal and their palaeo-environmental significance*. *Palaeontologia africana* 18:47-52.

PONOMARENKO, A.G., and MOSTOVSKI, M.B. 2005. *New beetles (Insecta: Coleoptera) from the Late Permian of South Africa*. *African Invertebrates* 46. The Council of Natal Museum.

PREVEC, R, LABANDEIRA, C.C., NEVELING, J., GASTALDO, R.A., LOOY, C., BAMFORD, M., 2009. *Portrait of a Gondwanan ecosystem: A new Late Permian locality from KwaZulu-Natal, South Africa*. *Review of Palaeobotany and Palynology* 156: 454-493.

PREVEC, R., MCLOUGHLIN, S., BAMFORD, M.K., 2008. *Novel double wing morphology revealed in a South African ovuliferous glossopterid fructification*. *Review of Palaeobotany and Palynology* 150, 22-36.

RUBIDGE, B.S. (ed) 1995. *Biostratigraphy of the Beaufort Group (Karoo Supergroup)*. South African Committee for Stratigraphy, Geological Survey of South Africa Biostratigraphic Series No. 1. 46 pp.

Republic of South Africa (1999). *National Heritage Resources Act (No 25 of 1999)*. Pretoria: The Government Printer.