

**PALAEONTOLOGICAL ASSESSMENT OF
THE PROPOSED DEVELOPMENT OF A
75MW PHOTOVOLTAIC SOLAR FARM, ON
THE FARM UITKYK 509, WELKOM, FREE
STATE PROVINCE.**

FOR

Enviroworks

DATE: 14 October 2013

By

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EXECUTIVE SUMMARY

Gideon Groenewald was appointed by Enviroworks to undertake a desktop survey, assessing the potential palaeontological impact of the proposed development of a 75MW Photovoltaic Solar Farm, on the Farm Uitkyk 509, Welkom, Free State Province. Some development will take place on the farms Helderwater 494 and Portion 1 of Doornepan 426.

This Palaeontological Assessment forms part of the Heritage Impact Assessment (HIA) and complies with the requirements of the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 (Heritage Resources Management), a HIA is required to assess any potential impacts to palaeontological heritage within the development footprint.

Most of Uitkyk 509 and Portion 1, Doornepan 426 is underlain by Quaternary aged aeolian sand deposits. The south-eastern corner of Portion 1, Doornepan 426 is underlain by Permian aged sedimentary rocks of the Adelaide Subgroup, Beaufort Group, Karoo Supergroup, as is a small section near the centre of Uitkyk 509. The Northern half of Uitkyk 509 is underlain by the Permian aged rocks of the Volksrust Formation, Eccca Group, Karoo Supergroup. Helderwater 494 is mostly underlain by Quaternary aged limestone and tufa deposits, with the south-eastern corner underlain by Quaternary aged aeolian sand deposits. A small section near the centre of Uitkyk 509 is underlain by Jurassic aged dolerite.

Most of the study area is underlain by Quaternary aeolian sand deposits that are sparsely fossiliferous, and have thus been allocated a Low palaeontological sensitivity. Due to the fact that numerous fossils have been described from similar deposits, areas underlain by Quaternary surface limestone and tufa have been allocated a Moderate palaeontological sensitivity. The Adelaide Subgroup is known to contain a rich assemblage of fossil remains of plants and vertebrates and areas underlain by these sediments have thus been allocated a Moderate sensitivity rating. Due to a general lack of good outcrop of the Volksrust Formation, it is allocated a Low palaeontological sensitivity rating.

It is recommended that:

- The EAP of the project team should be made aware of the possible occurrence of fossils. If any fossils are recorded during initial field visits, a trained palaeontologist must be notified to assess the finds.
- Where construction is envisaged on areas with a Moderate sensitivity rating, a palaeontological site inspection by a qualified palaeontologist needs to be done to assess the presence of fossils.

INTRODUCTION

Gideon Groenewald was appointed by Enviroworks to undertake a desktop survey, assessing the potential palaeontological impact of the proposed development of a 75MW Photovoltaic Solar Farm, on the Farm Uitkyk 509, Welkom, Free State Province.

Thabong Solar Farm (Pty) Ltd intends to construct a 75MW Photovoltaic facility on the Farm Uitkyk 509. The development area will constitute a total laydown footprint of approximately 194 ha which will include associated infrastructure such as an onsite substation, wiring between the PV mirror and the substation, internal access roads, security infrastructure and a storage area. Some development will take place on Helderwater 494 and Portion 1 of Doornepan 426. The locality for the development is shown in Figure 1 below.



Figure 1 Google image showing the locality of the Thabong Solar project

SOUTH AFRICAN NATIONAL HERITAGE RESOURCE ACT NO 25/1999

This Palaeontological Assessment forms part of the Heritage Impact Assessment (HIA) and complies with the requirements of the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 (Heritage Resources Management), a HIA is required to assess any potential impacts to palaeontological heritage within the development footprint.

Categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act, and which therefore fall under its protection, include:

- geological sites of scientific or cultural importance;
- objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens;
- objects with the potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage.

METHODOLOGY

Following the "SAHRA APM Guidelines: Minimum Standards for the Archaeological & 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.

In preparing a palaeontological desktop study the potential fossiliferous rock units (groups, formations etc.) represented within the study area are determined from the relevant geological maps (1:250 000 2726 Welkom) and Google Earth imagery. The known fossil heritage within each rock unit is inventoried from the published scientific literature, previous palaeontological impact studies in the same region and the author's field experience.

The likely impact of the proposed development on local fossil heritage is determined on the basis of the palaeontological sensitivity of the rock units concerned and the nature and scale of the development itself, most notably the extent of fresh bedrock excavation envisaged. The different sensitivity classes used are explained in Table 1 below.

Table 1 Palaeontological sensitivity analysis outcome classification

Sensitivity	Description
Low Sensitivity	Areas where there is likely to be a negligible impact on the fossil heritage. This category is reserved largely for areas underlain by igneous rocks. However, development in fossil bearing strata with shallow excavations or with deep soils or weathered bedrock can also form part of this category.
Moderate Sensitivity	Areas where fossil bearing rock units are present but fossil finds are localised or within thin or scattered sub-units. Pending the nature and scale of the proposed development the chances of finding fossils are moderate. A field-based assessment by a professional palaeontologist is usually warranted.
High Sensitivity	Areas where fossil bearing rock units are present with a very high possibility of finding fossils of a specific assemblage zone. Fossils will most probably be present in all outcrops and the chances of finding fossils during a field-based assessment by a professional palaeontologist are very high. Palaeontological mitigation measures need to be incorporated into the Environmental Management Plan

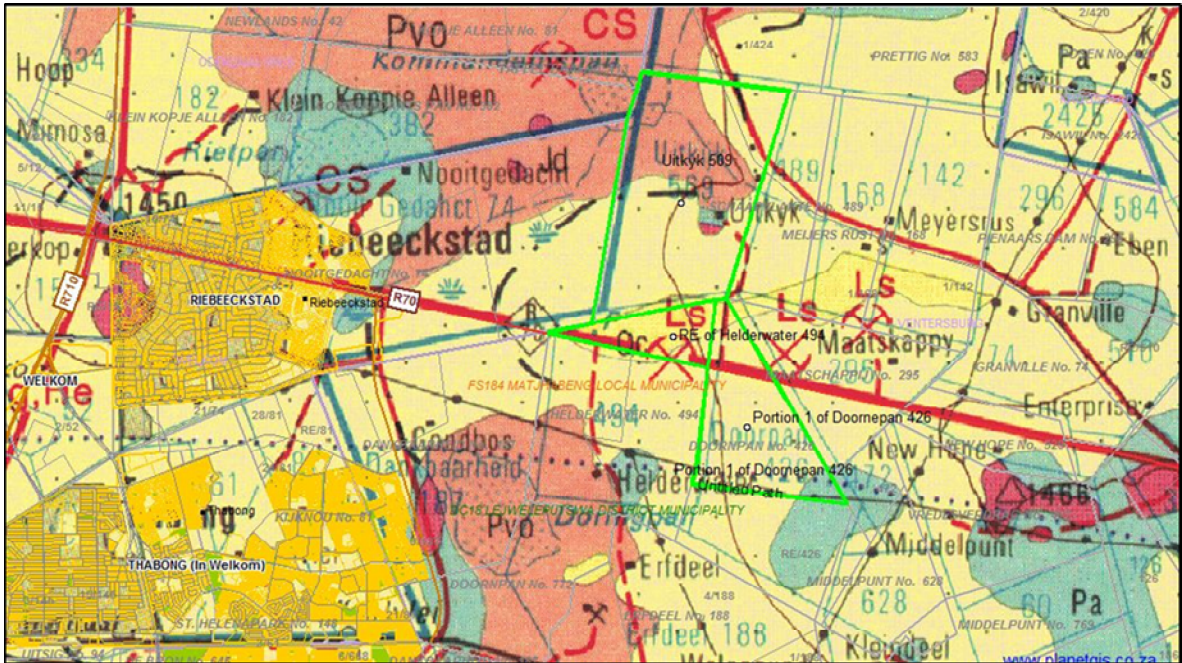
When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a field-based assessment by a professional palaeontologist is usually warranted.

The key assumption for this desktop study is that the existing geological maps and datasets used to assess site sensitivity are correct and reliable. However, the geological maps used were not intended for fine scale planning work and are largely based on aerial photographs alone, without ground-truthing. There are also inadequate database for fossil heritage for much of South Africa, due to the small number of professional palaeontologists carrying out fieldwork in South Africa. Many proposed development study areas have thus never been studied before by a professional palaeontologist.

These factors may have a major influence on the assessment of the fossil heritage significance of a given development, and without supporting field assessments, this may lead to either:

- an underestimation of the palaeontological significance of a given study area due to ignorance of significant recorded or unrecorded fossils preserved there, or
- an overestimation of the palaeontological sensitivity of a study area, for example when originally rich fossil assemblages inferred from geological maps have in fact been destroyed by weathering, or are buried beneath a thick mantle of unfossiliferous “drift” (soil, alluvium etc).

GEOLOGY



GEOLOGIESE LEGENDE / GEOLOGICAL LEGEND

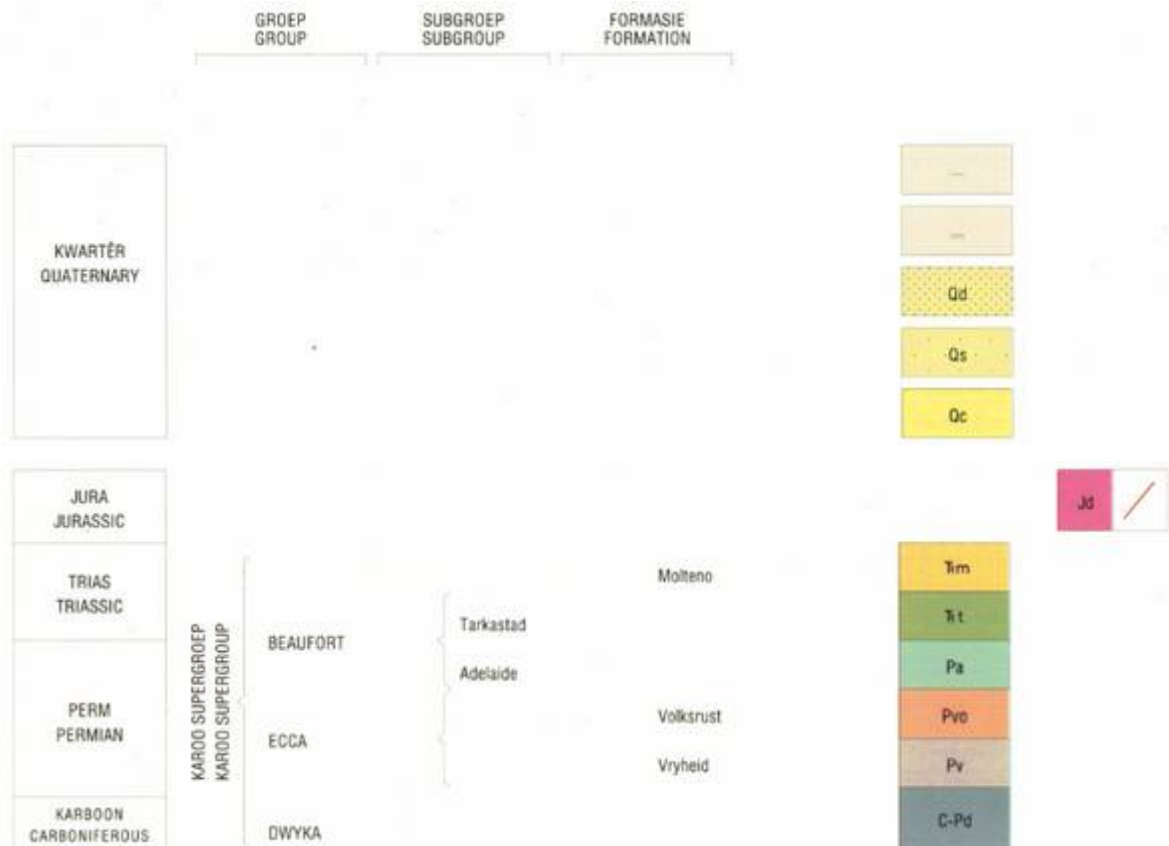


Figure 2 Geological map of the Thabong study area

Most of Uitkyk 509 and Portion 1, Doornepan 426 is underlain by Quaternary aged aeolian sand deposits. The south-eastern corner of Portion 1, Doornepan 426 is underlain by Permian aged sedimentary rocks of the Adelaide Subgroup, Beaufort Group, Karoo Supergroup, as is a small section near the centre of Uitkyk 509. The Northern half of Uitkyk 509 is underlain by the Permian aged rocks of the Volksrust Formation, Eccca Group, Karoo Supergroup. Helderwater 494 is mostly underlain by Quaternary aged limestone and tufa deposits, with the south-eastern corner underlain by Quaternary aged aeolian sand deposits. A small section near the centre of Uitkyk 509 is underlain by Jurassic aged dolerite.

Quaternary sand deposits (Qs)

This deposit is characterised by red to grey aeolian dune sand deposits (Council for Geoscience 1998).

Quaternary limestone and tufa deposits (Qc)

This deposit consists of surface limestone and tufa that was deposited during the Quaternary period (Council for Geoscience 2000). These freshwater calcites were deposited by springs associated with high groundwater table levels in the past (Johnson et al 2006).

Dolerite (Jd)

Dolerite is a very hard igneous rock that intruded the sedimentary layers during the Jurassic Period and occurs either as sills or as dykes. Sills can be from a few meters to tens of meters thick.

Adelaide Subgroup (Pa)

The Adelaide Subgroup consists mainly of blue-grey mudstone and shale with very fine to coarse grained buff-white to white sandstone and subordinate conglomerate (Council for Geoscience 1998). It is interpreted as a mixed fluvial and lacustrine deposit with major meandering river systems (Johnson et al 2006).

Volksrust Formation (Pvo)

The Volksrust Formation consists of mudstone, siltstone and shale (Council for Geoscience 2000). This unit of dark greenish-grey siltstone or shale, weathering into a light yellow to khaki colour is interpreted as a deep-water deposit that accumulated in an off-shore marine environment (Botha and Botha, 2002)

PALAEONTOLOGY

Quaternary aeolian sand deposits (Qs)

No fossils have been described from the quaternary aeolian deposits in the study area, although fossil finds have been recorded from similar aged sediments, for example: the Cornelia Formation in the north-eastern Free State (Johnson et al, 2006).

Quaternary limestone and tufa deposits (Qc)

No fossils have been described from these deposits in the study area. Examples of fossils from similar units do, however, include examples of early hominid remains, e.g. The Florisbad Formation to the south of the study area. Tufa deposits are known to contain the fossilized remains of numerous vertebrates and plants (Johnson et al, 2006)

Dolerite (Jd)

Dolerite is an igneous rock type and will not contain any fossils.

Adelaide Subgroup (Pa)

The Permian Adelaide Subgroup is interpreted as a meandering river deposit grading upwards into a lacustrine environment and is well known for containing fossils (Johnson et al, 2006). Although difficult to correlate the units in the study area directly with more well-known outcrops of the lower part of the Adelaide Subgroup to the east, the subgroup is known to contain very good examples of *Glossopteris* flora as well as numerous remains of vertebrate fossils associated with the *Dicynodon* Assemblage Zone in the north-eastern part of the Karoo Basin (Groenewald, 1989 and 1996).

Volksrust Formation (Pvo)

The Volksrust Formation contains very little recorded evidence of vertebrate life, but trace fossils have been described from the upper layers of the formation. The bivalve *Megadesmus* is described from the Late Permian Volksrust Shale Formation in the north-eastern Karoo Basin, South Africa; this is the first reported discovery of this genus in Africa. The fossil is large, 9 cm dorsally and 8.4 cm laterally, and both valves are articulated indicating minimum transport after death. The bivalve was encased in interbedded siltstone-shale that constitutes the distal sediments of a prograding delta at the Beaufort –Ecca Group boundary. *Megadesmus* is known from other continents (Australia, India, Siberia, South America and Tasmania) where its presence indicates exclusively marine conditions. The implication for the northeastern Karoo Basin during the Late

Permian is that a marine enclave still existed in this geographic area and that terrestrial conditions did not yet prevail as in the southern basin region (Cairncross et al, 2005).

DISCUSSION

The predicted palaeontological impact of the development is based on the initial mapping assessment and literature reviews. The palaeontological significance is summarised in Table 2.

Table 2 Palaeontological significance of geological units on site

Geological Unit	Rock Type and Age	Fossil Heritage	Vertebrate Biozone	Palaeontological Sensitivity
Quaternary aeolian sand deposits	Aeolian sand, dune sand, QUATERNARY	Sparse mammal teeth, bones, shell fragments etc.	None	Low sensitivity
Quaternary Surface limestone and tufa deposits	Surface limestone and tufa QUATERNARY	Early hominid remains, numerous vertebrate and plant macrofossils	None	Moderate sensitivity
Dolerite	Dolerite sills and Dykes JURASSIC	None	None	Low sensitivity
Adelaide Subgroup	Blue-grey Mudstone and White Sandstone PERMIAN	Vertebrate fossils of the <i>Therapsid</i> Group e.g. <i>Gorgonopsian</i> and <i>Dicynodonts</i> . Plant fossils e.g. <i>Glossopteris</i> trees and leaves.	<i>Dicynodon</i> Assemblage Zone	Moderate sensitivity
Volskrust Formation	Mudstone, siltstone and shale PERMIAN	Little evidence for vertebrate life, but trace fossils are known from the upper layers. The bivalve <i>Megadesmus</i> .	None	Low Sensitivity

There is a possibility that fossils will be encountered during excavation into the Quaternary deposits as well as the Permian Adelaide Subgroup and Volskrust Formation within the development footprint. The study area has been extensively modified through agricultural development and fossils are only expected to be exposed in these developed areas during deep excavation. These fossils would be of international significance. The damage and/or loss of these fossils due to inadequate mitigation would have a highly negative palaeontological impact. The exposure and subsequent reporting of fossils (that would otherwise have remained undiscovered) to a qualified palaeontologist for excavation will be a beneficial palaeontological impact.

MANAGEMENT PLAN

The likely impact of the proposed development on local fossil heritage is determined on the basis of the palaeontological sensitivity of the rock units concerned and the nature and scale of the development itself, most notably the extent of fresh bedrock excavation envisaged. The different sensitivity classes used are explained in Table 1 above. Sections of the study area that are underlain by sediments of the Quaternary surface limestone and tufa deposits as well as rocks of the Adelaide Subgroup have been allocated a Moderate sensitivity rating (Figure 3). Areas underlain by Quaternary aeolian sand deposits and dolerite have been allocated a Low sensitivity rating. Due to a general lack of good outcrop of the Volksrust Formation, it is allocated a Low palaeontological sensitivity rating.

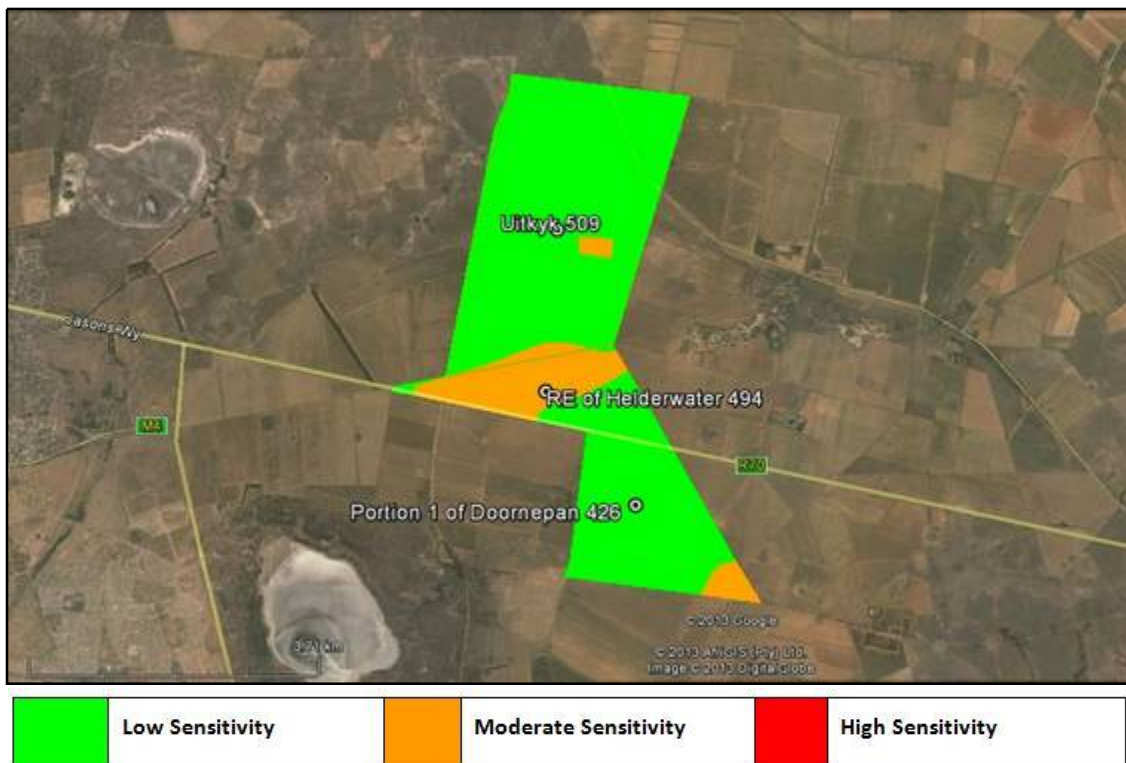


Figure 3 Palaeontological sensitivity of the Thabong Solar Farm study area

CONCLUSION

Most of the study area is underlain by Quaternary aeolian sand deposits that are sparsely fossiliferous, and have thus been allocated a Low palaeontological sensitivity. Due to the fact that numerous fossils have been described from similar deposits, areas underlain by Quaternary surface limestone and tufa have been allocated a Moderate palaeontological sensitivity. The Adelaide Subgroup is

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QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

Dr Gideon Groenewald has a PhD in Geology from the University of Port Elizabeth (Nelson Mandela Metropolitan University) (1996) and the National Diploma in Nature Conservation from Technicon RSA (the University of South Africa) (1989). He specialises in research on South African Permian and Triassic sedimentology and macrofossils with an interest in biostratigraphy, and palaeoecological aspects. He has extensive experience in the locating of fossil material in the Karoo Supergroup and has more than 20 years of experience in locating, collecting and curating fossils, including exploration field trips in search of new localities in the southern, western, eastern and north-eastern parts of the country. His publication record includes multiple articles in internationally recognized journals. Dr Groenewald is accredited by the Palaeontological Society of Southern Africa (society member for 25 years).

DECLARATION OF INDEPENDENCE

I, Gideon Groenewald, declare that I am an independent specialist consultant and have no financial, personal or other interest in the proposed development, nor the developers or any of their subsidiaries, apart from fair remuneration for work performed in the delivery of palaeontological heritage assessment services. There are no circumstances that compromise the objectivity of my performing such work.

A handwritten signature in dark ink, appearing to read 'Gideon Groenewald', with a stylized flourish at the end.

Dr Gideon Groenewald
Geologist