Development of a 22kV line at Lockshoek, Griekwastad, Northern Cape

PALAEONTOLOGICAL IMPACT ASSESSMENT

Compiled by: Dr JF Durand (Sci.Nat.)

For:

Vhubvo Consultancy
546 16th Road, Constantia Park, Building 2 Upstairs, Midrand, 1685
Cell: +27 82 535 6855 |
Tel: +27 11 312 2878 |
Email: munyadziwa@vhubvo.co.za

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1. Executive Summary

The study site is situated in an area that is considered to be of Very High Palaeontological Sensitivity.

The purpose of this document is to detail the probability of finding fossils in the study area and how, if indeed there are fossils, the development at the study site will impact on the fossils and fossil sites.

Southern Africa is world renowned for its rich and scientifically important fossil heritage. The Heritage Act of South Africa stipulates that fossils and fossil sites may not be altered or destroyed.

An overview of the literature on the palaeontology and associated geology of the area is given. Although no publications exist of palaeontological studies that were done in the study area, several palaeontological studies were done in the areas to the north, east and west of the study area. The results of these studies enable us to predict that these fossiliferous strata exist within the study area due to the association of certain fossils with certain geological strata.

No fossils, including stromatolites, were found during the site visit in spite of good exposures of the underlying geology. If fossils do occur in the Banded Iron Formation (BIF) of the Daniëlskuil Formation, they would probably be microscopic, based on evidence from the underlying Kuruman Formation that outcrops to the east of the study site.

Due to the improbability of finding any macroscopic fossils at the study site, no further palaeontological studies are advised.

2. Introduction

This is a Palaeontological Impact Assessment that was prepared in line with Regulation 28 of the National Environmental Management Act (No. 107 of 1998) Regulations on Environmental Impact Assessment. This involved an overview of the literature on the palaeontology and associated geology of the area and a site visit.

The Heritage Act of South Africa stipulates that fossils and fossil sites may not be altered or destroyed. The purpose of this document is to detail the probability of finding fossils in the study area that may be impacted by the proposed development.

The palaeontological heritage of South Africa is unsurpassed and can only be described in superlatives. The South African palaeontological record gives us insight in inter alia the origin of dinosaurs, mammals and humans. Fossils are also used to identify rock strata and determine the geological context of the subregion with other continents and played a crucial role in the discovery of Gondwanaland and the formulation of the theory of plate tectonics. Fossils are also used to study evolutionary relationships, sedimentary processes and palaeoenvironments.

South Africa has the longest record of palaeontological endeavour in Africa. South Africa was even one of the first countries in the world in which museums displayed fossils and palaeontologists studied earth history. South African palaeontological institutions and their vast fossil collections are world-renowned and befittingly the South African Heritage Act is one of the most sophisticated and best considered in the world.

3. Terms of reference for the report

According to the South African Heritage Resources Act (Act 25 of 1999) (Republic of South Africa, 1999), certain clauses are relevant to palaeontological aspects for a terrain suitability assessment.

- **Subsection 35(4)** No person may, without a permit issued by the responsible heritage resources authority-
- (a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
- (b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
- (c) 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
- (d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist with the detection or recovery of metals or archaeological material or objects, or use such equipment for the recovery of meteorites.
- **Subsection 35(5)** 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 procedures in terms of section 38 has been followed, it may-
- (a) 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;
- (b) 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;
- (c) if mitigation is deemed by the heritage resources authority to be necessary, assist the person on whom the order has been served under paragraph (a) to apply for a permit as required in subsection (4); and
- (d) recover the costs of such investigation form the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

South Africa's unique and non-renewable palaeontological heritage is protected in terms of the NHRA. According to this act, heritage resources may not be excavated, damaged, destroyed or otherwise impacted by any development without prior assessment and without a permit from the relevant heritage resources authority.

As areas are developed and landscapes are modified, heritage resources, including palaeontological resources, are threatened. As such, both the environmental and heritage legislation require that development activities must be preceded by an assessment of the impact undertaken by qualified professionals. Palaeontological Impact Assessments (PIAs) are specialist reports that form part of the wider heritage component of:

- Heritage Impact Assessments (HIAs) called for in terms of Section 38 of the National Heritage Resources Act, Act No. 25, 1999 by a heritage resources authority.
- Environmental Impact Assessment process as required in terms of other legislation listed in s. 38(8) of NHRA;
- Environmental Management Plans (EMPs) required by the Department of Mineral Resources.

HIAs are intended to ensure that all heritage resources are protected, and where it is not possible to preserve them in situ, appropriate mitigation measures are applied. An HIA is a comprehensive study that comprises a palaeontological, archaeological, built environment, living heritage, etc specialist studies. Palaeontologists must acknowledge this and ensure that they collaborate with other heritage practitioners. Where palaeontologists are engaged for the entire HIA, they must refer heritage components for which they do not have expertise on to appropriate specialists. Where they are engaged specifically for the palaeontology, they must draw the attention of environmental consultants and developers to the need for assessment of other aspects of heritage. In this sense, Palaeontological Impact Assessments that are part of Heritage Impact Assessments are similar to specialist reports that form part of the EIA reports. The standards and procedures discussed here are therefore meant to guide the conduct of PIAs and specialists undertaking such studies must adhere to them. The process of assessment for the palaeontological (PIA) specialist components of heritage impact assessments, involves:

Scoping stage in line with regulation 28 of the National Environmental Management Act (No. 107 of 1998) Regulations on Environmental Impact Assessment. This involves an **initial assessment** where the specialist evaluates the scope of the project (based, for example, on NID/BIDs) and advises on the form and extent of the assessment process. At this stage the palaeontologist may also decide to compile a **Letter of Recommendation for Exemption from further Palaeontological Studies**. This letter will state that there is little or no likelihood that any significant fossil resources will be impacted by the development. This letter should present a reasoned case for exemption, supported by consultation of the relevant geological maps and key literature.

A **Palaeontological Desktop Study** – the palaeontologist will investigate available resources (geological maps, scientific literature, previous impact assessment reports, institutional fossil collections, satellite images or aerial

photos , etc) to inform an assessment of fossil heritage and/or exposure of potentially fossiliferous rocks within the study area. A Desktop studies will conclude whether a further field assessment is warranted or not. Where further studies are required, the desktop study would normally be an integral part of a field assessment of relevant palaeontological resources.

A **Phase 1 Palaeontological Impact Assessment** is generally warranted where rock units of high palaeontological sensitivity are concerned, levels of bedrock exposure within the study area are adequate; large-scale projects with high potential heritage impact are planned; and where the distribution and nature of fossil remains in the proposed project area is unknown. In the recommendations of Phase 1, the specialist will inform whether further monitoring and mitigation are necessary. The Phase 1 should identify the rock units and significant fossil heritage resources present, or by inference likely to be present, within the study area, assess the palaeontological significance of these rock units, fossil sites or other fossil heritage, comment on the impact of the development on palaeontological heritage resources and make recommendations for their mitigation or conservation, or for any further specialist studies that are required in order to adequately assess the nature, distribution and conservation value of palaeontological resources within the study area.

A **Phase 2 Palaeontological Mitigation** involves planning the protection of significant fossil sites, rock units or other palaeontological resources and/or the recording and sampling of fossil heritage that might be lost during development, together with pertinent geological data. The mitigation may take place before and / or during the construction phase of development. The specialist will require a Phase 2 mitigation permit from the relevant Heritage Resources Authority before Phase 2 may be implemented.

A **'Phase 3' Palaeontological Site Conservation and Management Plan** may be required in cases where the site is so important that development will not be allowed, or where development is to co-exist with the resource. Developers may be required to enhance the value of the sites retained on their properties with appropriate interpretive material or displays as a way of promoting access of such resources to the public.

The assessment reports will be assessed by the relevant heritage resources authority, and depending on which piece of legislation triggered the study, a response will be given in the form of a Review Comment or Record of Decision (ROD). In the case of PIAs that are part of EIAs or EMPs, the heritage resources authority will issue a comment or a record of decision that may be forwarded to the consultant or developer, relevant government department or heritage practitioner and where feasible to all three.

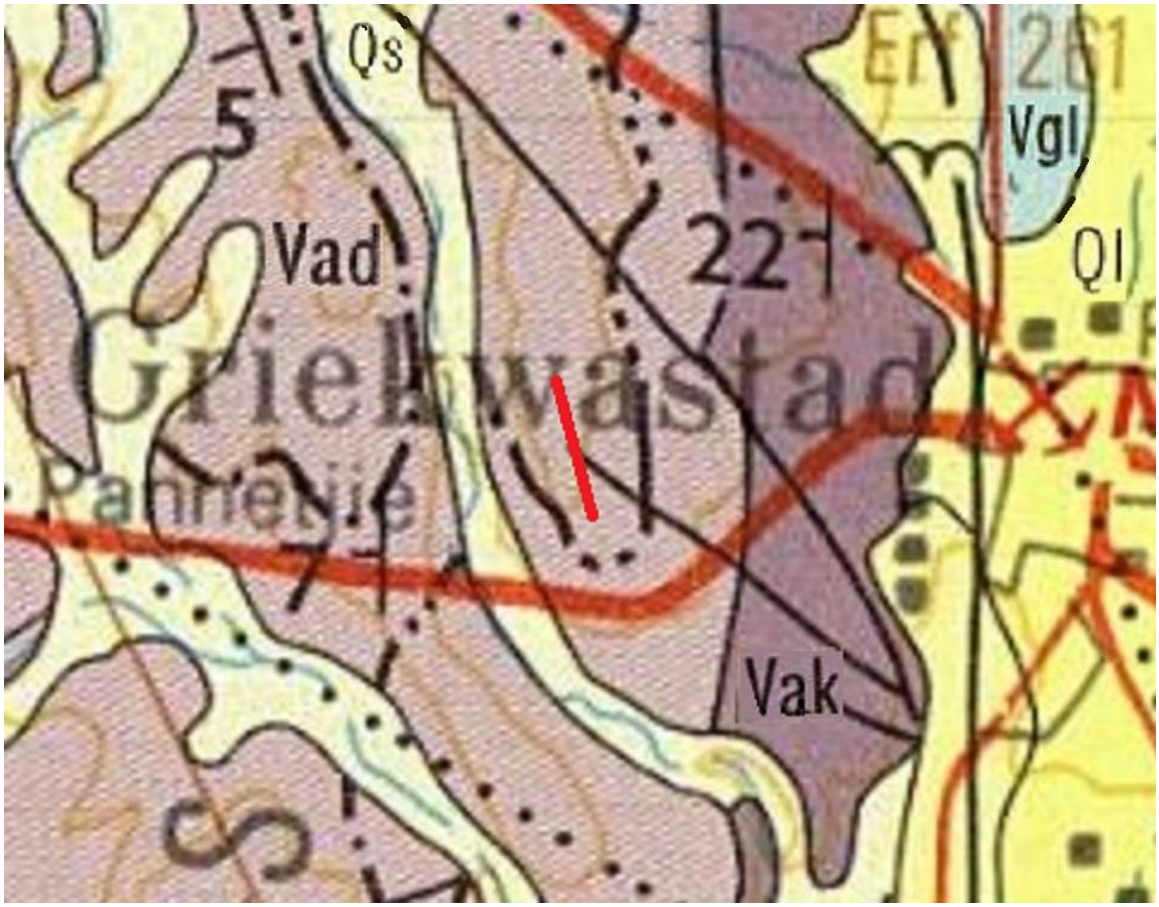
4. Details of study area and type of assessment:

Figure 1: Google Earth photo indicating study site (white line)

The relevant literature and geological maps have been studied and the site was visited on 26 May 2019 for a Palaeontological Impact Assessment.

The study site lies on the crest of the ridge situated west of Griekwastad. The study site lies in an NNW/SSE line between two cell phone towers (Fig. 1). The bedrock is covered in places with shallow soil and shrubs.

5. Geological setting



The study area is indicated by the red line

Figure 2: Geology map of the study area and surroundings. Adapted from the 2822 Postmasburg 1:250 000 geology map (Geological Survey, 1977)

GEOLOGICAL MAP LEGEND

	Lithology	Stratigraphy			Age
Qs	Red to flesh-coloured wind-blown sand				Quarter-nary
Ql	Surface limestone				
Vad	Yellow-brown jaspilite and crocidolite with alternating layers of shale and mudstone near top	Danielskuil / Griquatown Formation	Asbestos Hills Subgroup of the Ghaap Group	Transvaal / Griqualand West Supergroup	Vaalian (±2.50–2.05 Ga)
Vak	Banded ironstone with bands of amphibolite and lenses of conglomerate, crodidolite, tuff	Kuruman Formation			
Vgl	Dolomitic limestone with subordinate coarsely crystalline dolomite, chert and lenses of limestone	Lime Acres Member of the Ghaap Plateau Dolomite of the Cambellrand Subgroup			

The study site is underlain by the Daniëlskuil (Griquatown) Formation of the Asbestos Hills Subgroup of the Ghaap Group of the Griekwaland West / Transvaal Supergroup (Trendall *et al*., 1990). The Daniëlskuil Formation of the Asbestos Hill Subgroup overlies the Kuruman Formation that outcrops to the east of the study site.

The Asbestos Hills Subgroup comprises mostly of Banded Ironstone Formation (BIF) that is subdivided into a lower orthochemical, rhythmically banded Kuruman Formation and an upper allochemical, clastic-textured Daniëlskuil (Griquatown) Formation (Beukes, 1983). This transition represents drowning of the platform (Klein and Beukes, 1989; Sumner and Grotzinger, 2004). Deeper-water banded chert and iron formation of the Kuruman Formation form the base; they pass up section to the shallow-water granular iron formation of the Griquatown Formation (Beukes, 1984).

The sediments comprising the Daniëlskuil Formation are considered to be a reworked Kuruman-type BIF. The sediments have been reworked by currents or waves of a shallow-water, storm-dominated epeiric sea and are granular and not as finely laminated as the underlying Kuruman Formation sediments that were set down deeper in the basin (Beukes, 1983; Eriksson et al., 2009).

The Asbestos Hills Subgroup consists of a succession of thin alternating layers of light coloured chert and jasper and dark ferruginous (magnetite, haematite and limonite) jaspilite. Thin layers of riebeckite-amphibolite and shale occur in places (Eriksson *et al*., 2009).

The Asbestos Hills Subgroup conformably overlie the dolomitic limestone of the Cambellrand Subgroup that outcrops northeast of the study site.

6. Site visit

The study site was visited on 26 May 2019.

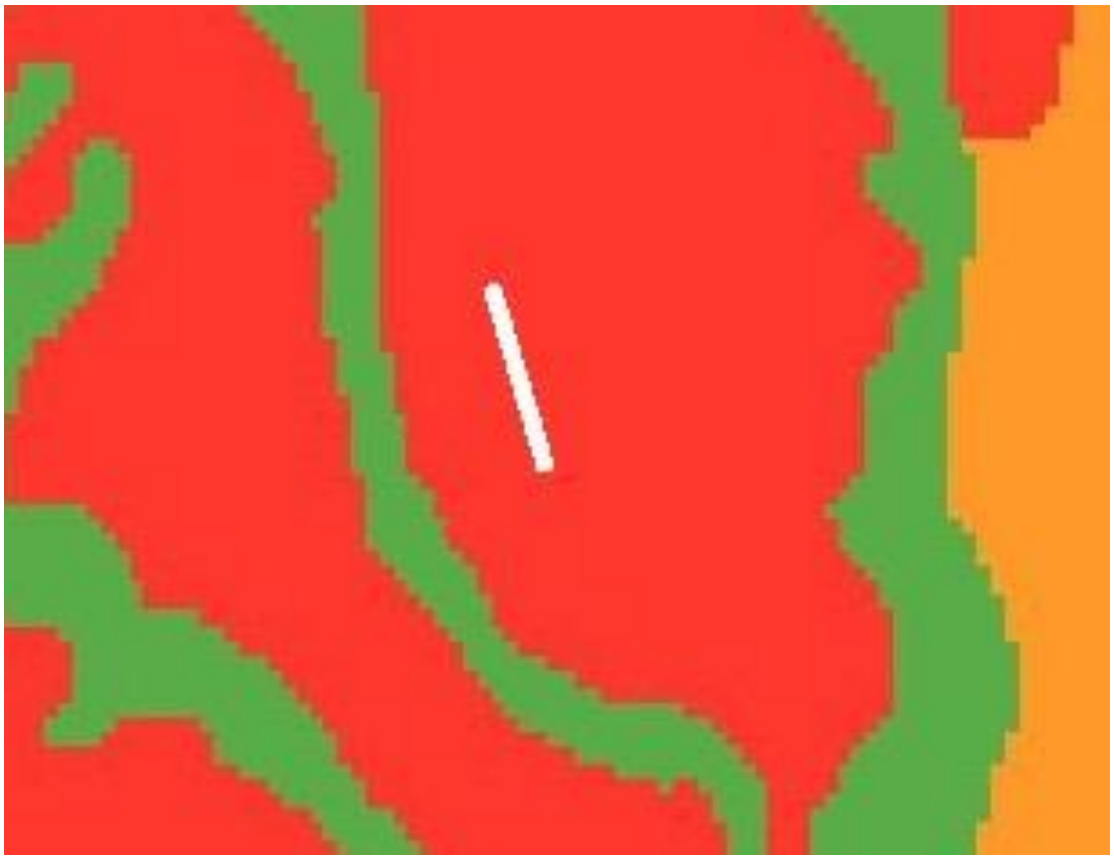
Figure 3: Outcrop of BIF at 28º51′04.49″S 23º13′45.00″E

Figure 4: Outcrop of BIF at 28º50′53.33″S 23º13′41.61″E

Figure 5: Rocks at 28º50′46.88″S 23º13′38.96″E showing alternating BIF layers

No fossils or stromatolitic structures were found during the site visit.

7. Palaeontological assessment of the study site



(The study site is indicated with the white line)

Figure 6: Palaeontological sensitivity of the region (SAHRA, 2019)

Colour	Palaeontological Significance	Action
RED	VERY HIGH	Field assessment and protocol for finds are required.
ORANGE	HIGH	Desktop study is required and based on the outcome of the desktop study, a field assessment is likely.
GREEN	MODERATE	Desktop study is required.

The origin of Banded Iron Formation (BIF) is still a matter of contention because there are no modern equivalents to compare it with (Beukes, 1983). Rare earth and isotope geochemistry would suggest a marine hydrothermal source for the iron in BIF (Beukes & Klein, 1990) but the precipitation of iron and associated manganese also points towards photochemical oxidation, which suggests the presence of cyanobacteria (Beukes and Klein, 1992; Konhauser *et al*., 2002). The temporal and spatial relationship between carbonate deposition and the origin of BIF is still unclear (Schröder, 2006).

No macroscopic fossils, including stromatolites, have been reported from the Asbestos Hills Subgroup.

Microfossils have been reported from the chert layers in the Kuruman Formation that underlies the Daniëlskuil Formation however (Tankard *et al*., 1982; MacRae, 1999). It is therefore possible that further research on the cherts from the Daniëlskuil Formation may still yield similar microfossils (Almond & Pether, 2008)

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8. Conclusion and recommendations:

No macroscopic fossils or stromatolitic structures were found during the site visit. Although the Banded Iron Formations represent a very important part of the history of life on earth, there are no macroscopic palaeontological features to be preserved.

It is predicted that evidence of bacteria will be found in the chert layers in the BIF of the Daniëlskuil Formation, similar to those that have been found in the cherts of the underlying Kuruman Formation.

Our oxygen rich atmosphere originated when cyanobacteria proliferated during the Vaalian (± 2.50 – 2.05 Ga). Cyanobacteria enriched the oceans with oxygen from where it escaped into the air and converted it from a reducing to an oxidising atmosphere. The oxygen in the atmosphere was crucial to the origin of eukaryotic life on earth.

9. Declaration of Independence:

I, Jacobus Francois Durand declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed development, 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 the objectivity of my performing such work.

Palaeontological specialist:
Dr JF Durand (Sci. Nat.)
BSc Botany & Zoology (RAU), BSc Zoology (WITS), Museology Dipl. (UP), Higher Education Diploma (RAU), PhD Palaeontology (WITS)