

Proposed rebuilding of the existing
Tahiti Fontein (TF) powerline route in
the farming area east of the N1 Vaal
tollgate, Free State

PALAEONTOLOGICAL IMPACT ASSESSMENT

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3 October 2021

Table of Contents:

1. Executive Summary.....	3
2. Introduction.....	4
3. Terms of reference for the report.....	5
4. Details of study site and the type of assessment.....	8
5. Geological setting of the study site.....	9
6. Site visit.....	11
7. Palaeontology of the study area.....	17
8. Conclusion and Recommendations.....	20
9. Declaration of independence.....	22

List of Figures:

Figure 1: Google Earth photo of the study site.....	8
Figure 2: Geology Map of the study area (adapted from the 2626 WEST RAND 1:250 000 Geology Map, Geological Survey, 1986).....	9
Figure 3: Facing north-northwest from 26°54'01.8"S 27°37'48.6"E.....	11
Figure 4: Facing southeast from 26°53'30.4"S 27°37'40.8"E.....	11
Figure 5: Facing east from 26°53'24.1"S 27°37'44.1"E.....	12
Figure 6: Facing east from 26°53'12.5"S 27°37'47.8"E.....	12
Figure 7: Facing north from 26°53'26.7"S 27°38'04.5"E.....	13
Figure 8: Facing west from 26°53'28.8"S 27°38'16.8"E.....	13
Figure 9: Facing west from 26°53'41.7"S 27°38'27.2"E.....	14
Figure 10: Facing west from 26°54'13.1"S 27°38'41.8"E.....	14
Figure 11: Facing east from 26°54'33.4"S 27°38'51.0"E.....	15
Figure 12: Facing west from 26°54'33.4"S 27°38'51.0"E.....	15
Figure 13: Facing northwest from 26°54'43.5"S 27°38'11.6"E.....	16
Figure 14: Facing east from 26°54'44.7"S 27°37'59.7"E.....	16
Figure 15: Palaeosensitivity map of the study site (SAHRA, 2021).....	17
Figure 16: <i>Glossopteris</i> leaf imprints found at Ryedale.....	18

1. Executive summary

The study site is underlain by rocks of the Archaean Basement, the Hospital Hill Subgroup of the Transvaal Supergroup and the Vryheid Formation of the Eccca Group of the Karoo Supergroup. The Archaean Basement rocks and diabase intrusion are non-fossiliferous. No fossils have been reported from the rocks of the Hospital Hill Subgroup in the Free State so far and it is improbable that any will be found in the study area.

Shale and sandstone of the Vryheid Formation of the Eccca Group of the Karoo Supergroup are however highly fossiliferous in places. The fossils that occur in the Vryheid Formation are mostly that of leaf and stem imprints of plants such as *Glossopteris*, lycopods, ferns, horsetails, conifers, cordaitaleans and ginkgoaleans. Rare fossils of silicified and coalified wood, insects, bivalves, conchostrachans and fish scales have also been reported from this formation.

No fossils were found during the site assessment. The geology in the study area is mostly obscured by soil and vegetation, but there is a high probability that fossils will be found if the bedrock is exposed in the southeastern part of the study area during development. If a particularly fossiliferous area is discovered during development, the ECO should follow the guidelines as stipulated under the Chance Find Procedure on p. 20-21.

2. Introduction

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 life, dinosaurs and humans.

Fossils are also used to identify rock strata and determine the geological context of the subregion with other continents and to study evolutionary relationships, sedimentary processes and palaeoenvironments. The Ecca Group of the Karoo Supergroup contains a vast amount of fossil leaf imprints of plants that occurred in Southern Gondwana during the Permian. These lacustrine deposits contained plant matter that turned into coal in certain parts of the Ecca Group. The resulting coal fields form a very important mineral resource for the country.

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.

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 from 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 the type of assessment:

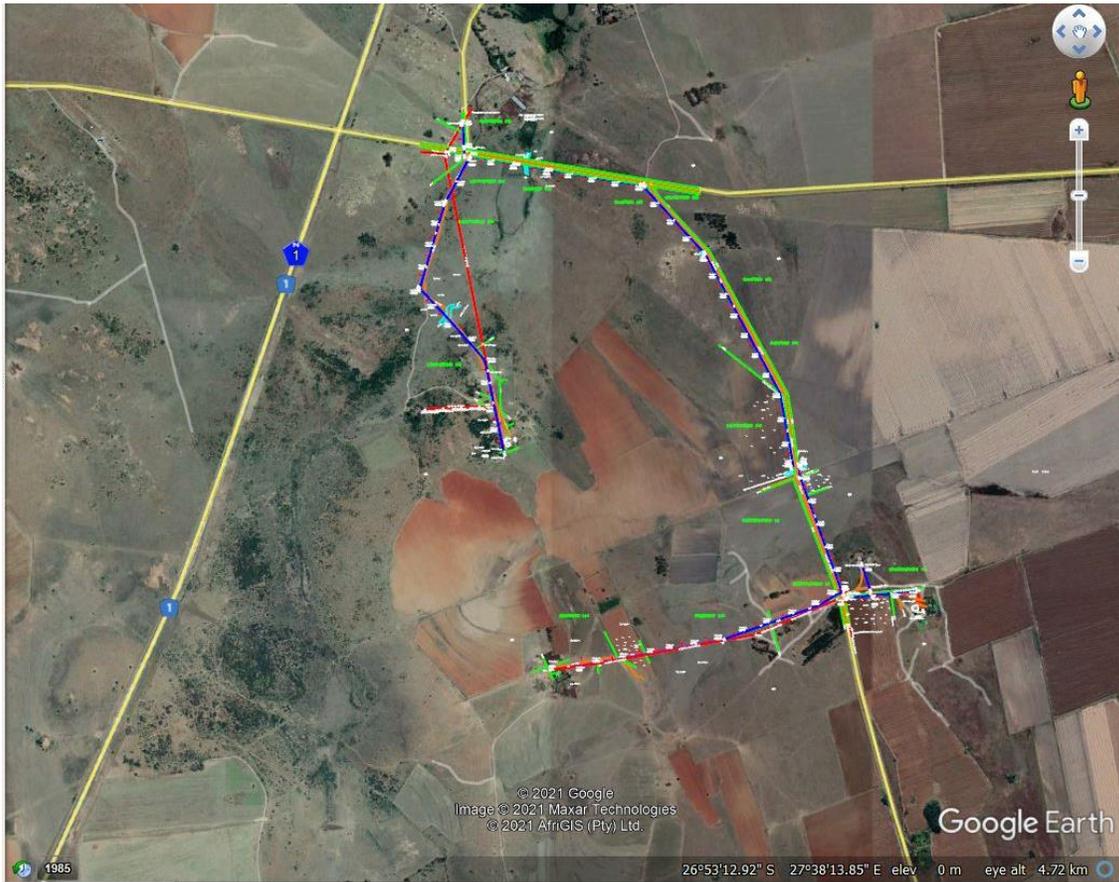


Figure 1: Google Earth photo of the study site

The study area (indicated by the annotated lines in Fig. 1) is situated east of the N1 and south of the Wolwehoek/Parys Road, some 27km southwest of Vanderbijlpark, in the Free State.

Geomorphologically, large parts of the study area is characterised by a gently undulating landscape consistent with the erosion of the almost horizontally orientated underlying sandstone and mudstone layers of the Ecca Group with some sandstone ridges in the northern and western part of the study area. The area is used mainly for farming.

The southeastern part of the study site is considered to be of VERY HIGH PALAEOLOGICAL SENSITIVITY (SAHRA, 2021) (see Fig. 3). The relevant literature and geological maps for the region in which the development is proposed to take place, have been studied and the site was visited for a Palaeontological Impact Assessment.

5. Geological setting



The study area is indicated by the white lines.

GEOLOGICAL LEGEND

Legend				
	Lithology	Stratigraphy		Age
Pv	Shale, subordinate sandstone, coal	Vryheid Formation of the Eccca Group	Karoo Supergroup	Permian
Vdi	Diabase intrusion			Vaalian
Rh	Ferruginous shale, quartzite, banded ironstone, hornfels	Hospital Hill Subgroup	Westrand Group of the Witwatersrand Supergroup	Randian
Ro	Quartzite and shale	Orange Grove Formation		
Zg	Undifferentiated granite and gneiss			Swazian

Figure 2: Geology Map of the study area (adapted from the 2626 WEST RAND 1:250 000 Geology Map, Geological Survey, 1986)

Undifferentiated granite and gneiss of the Archaean Basement, Shales and quartzites of the of the Hospital Hill Subgroup of the Witwatersrand Supergroup and sandstones and shales of the Vryheid Formation of the Eccca Group of the Karoo Supergroup underlie the study area (see Fig. 2). The underlying geology is exposed only at a few places along the study site such as quartzite ridges and the quarry located at 26°53'26.7"S 27°38'04.5"E (see Fig. 7) where the contact between a diabase intrusion into the Transvaal Supergroup can be seen.

The layers that constitute the Witwatersrand Sequence were deposited as sediments when deltas, fed by large river systems, fed into an inland sea in the Witwatersrand Basin approximately 2.8 Ga (McCarthy and Rubidge, 2005) and overlie the Archaean Basement rocks unconformably. The resulting 7500 m thick sedimentary sequence forms a syncline as it dips towards the centre of the Vredefort Dome (Truswell, 1977).

The 8000 m thick Witwatersrand Supergroup is subdivided into two main divisions, the lower unit called the West Rand Group and an upper unit known as the Central Rand Group. The West Rand Group is in turn subdivided into three units: the Hospital Hill Subgroup, Government Reef Subgroup and Jeppestown Subgroup (McCarthy and Rubidge, 2005, Viljoen and Reimold, 2002).

The Vryheid Formation of the Ecca Group of the Karoo Supergroup, consists of sedimentary rocks consisting mostly of shale (metamorphosed mudstone), shaly sandstone, sandstone, grit, gravel, conglomerate and coal (see Fig. 2) (Johnson *et al.*, 2009). The Vryheid Formation was formed when glacial and fluvio-glacial sediments were deposited in shallow marine to fluvio-deltaic environments approximately 280 Ma ago. The Karoo Supergroup sediments were deposited in valleys and basins that existed in the pre-Karoo topography in the region. The Karoo Supergroup rocks unconformably overlie the older Witwatersrand Supergroup rocks (Johnson *et al.*, 2009).

The near horizontal layering of the geological strata and erosion of the adjacent and underlying rock strata results in a gently undulating landscape covered to a great extent by soil and vegetation (Figs. 5-15). Exposures of the underlying geology are therefore exceptionally scarce in the northern part of the Main Karoo Basin and are mostly limited to gullies, river banks, road cuttings, quarries and the mines in the region.

6. Site visit



Figure 3: Facing north-northwest from 26°54'01.8"S 27°37'48.6"E



Figure 4: Facing southeast from 26°53'30.4"S 27°37'40.8"E



Figure 5: Facing east from 26°53'24.1"S 27°37'44.1"E



Figure 6: Facing east from 26°53'12.5"S 27°37'47.8"E



Figure 7: Facing north from 26°53'26.7"S 27°38'04.5"E



Figure 8: Facing west from 26°53'28.8"S 27°38'16.8"E



Figure 9: Facing west from 26°53'41.7"S 27°38'27.2"E



Figure 10: Facing west from 26°54'13.1"S 27°38'41.8"E



Figure 11: Facing east from 26°54'33.4"S 27°38'51.0"E



Figure 12: Facing west from 26°54'33.4"S 27°38'51.0"E



Figure 13: Facing northwest from 26°54'43.5"S 27°38'11.6"E



Figure 14: Facing east from 26°54'44.7"S 27°37'59.7"E

7. Palaeontology of the study area

The south-eastern half of the study site is potentially fossil rich and is considered by SAHRA as having a Very High Palaeontological Sensitivity (Fig. 15). These Permian fossils found in the Vryheid Formation in the Free State are mostly leaf and stem imprints of *Glossopteris*, lycopods, ferns, horsetails, cordaitaleans, conifers and ginkgoaleans. Rare fossils of silicified and coalified wood, insects, bivalves, conchostrachans and fish scales have also been found in the shales and sandstones of the Vryheid Formation in Mpumalanga (Groenewald & Groenewald, 2014) and it is possible that these may also occur in the Vryheid Formation in the Free State.

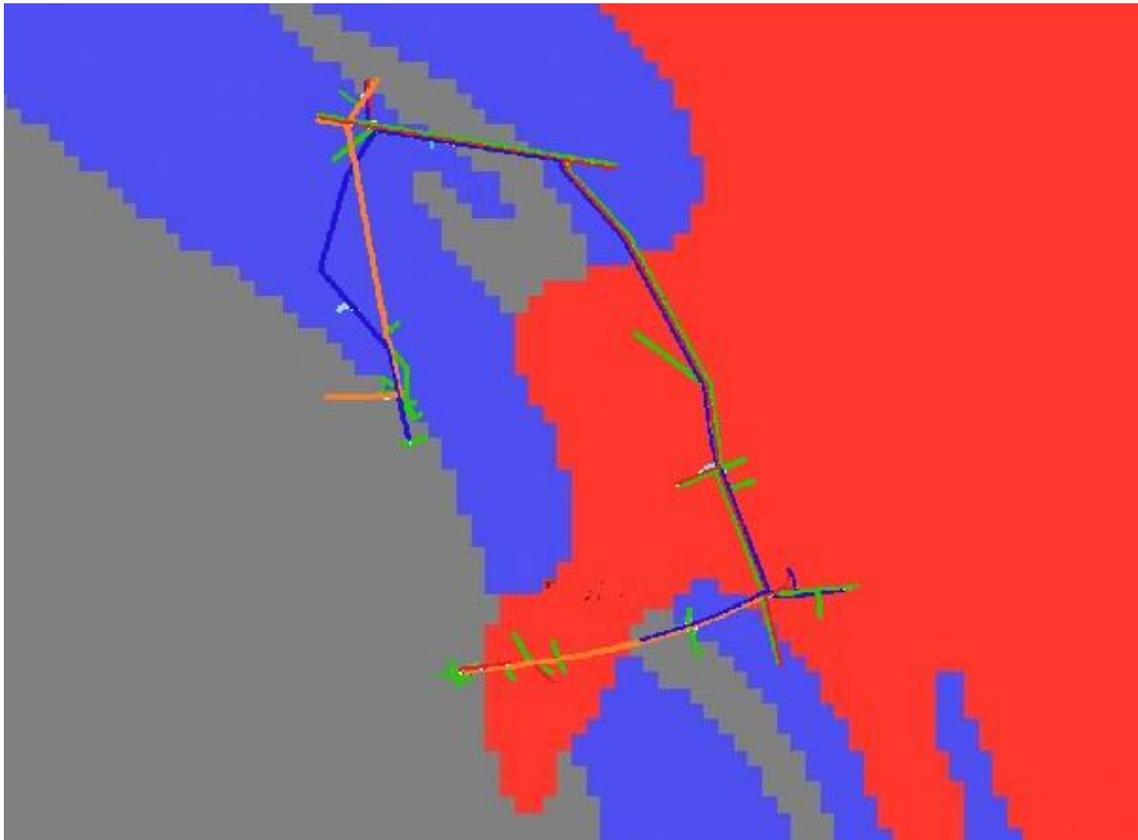


Figure 15: Palaeosensitivity map of the study site (SAHRA, 2021)

LEGEND:

Colour	Palaeontological Significance	Action
RED	VERY HIGH	Field assessment and protocol for finds are required.
BLUE	LOW	No palaeontological studies are required however a protocol for finds is required.
GREY	INSIGNIFICANT / ZERO	No palaeontological studies are required.

Although the formations representing the West Rand Group of the Witwatersrand Supergroup are indicated in blue on the Palaeosensitivity Map (Fig. 15) which would indicate a Low Palaeontological Sensitivity, these rocks are in fact devoid of macroscopic fossils (Groenewald & Groenewald, 2014) and are of no palaeontological concern.

The Eccra Group of the overlying Karoo Supergroup contain vast amounts of Permian leaf imprints of plants such as *Glossopteris* in places (Kovács-Endrödy, 1991). Millions of tons of fossiliferous material yielding mostly *Glossopteris* leaf imprints have been exposed at well studied sites in the northern rim of the main Karoo Basin such as Hammanskraal (Kovács-Endrödy, 1976), Witbank (Bamford, 2004) and Vereeniging (Rayner, 1986) and the ferromanganese mine at Ryedale (see Fig. 16) (Pack *et al.*, 2000).



Figure 16: *Glossopteris* leaf imprints found at Ryedale

Fossilised leaf imprints are not found ubiquitously throughout the Eccra Group, but in pockets such as in the eMalahleni and Vereeniging areas where the physical and chemical conditions during deposition resulted in the preservation of not only the structure of the leaves but also in some cases the organic material itself. The structure of the fossilised leaves is better preserved in the shales than in the sandstone units. The leaf structures are mostly lost in the coal layers.

No fossils were found during the field assessment. The geology is mostly obscured by soil and vegetation.

References:

Bamford, M.K. (2004) Diversity of the woody vegetation of Gondwanan Southern Africa. *Gondwana Research* 7(1):153-164.

Geological Survey (1986) 2626 WEST RAND 1:250 000 Geology Map.

Groenewald, G. & Groenewald, D. (2014). *Palaeontological heritage of the Free State*. SAHRA Palaeotechnical Report.

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. & Brandl, G. (2009). Sedimentary rocks of the Karoo Supergroup. In: Johnson, M.R.; Anhaeusser, C.R. & Thomas, R.J. (Eds.) *The geology of South Africa*. Johannesburg: GSSA. Pp. 461-499.

Kovács-Endrödy, E. (1976) Notes on some *Glossopteris* species from Hammanskraal (Transvaal). *Palaeontologia africana* 19:67-95.

Kovács-Endrödy, E. (1991) On the Late Permian age of *Ecca Glossopteris* Floras in the Transvaal Province with a key to and descriptions of twenty five *Glossopteris* species. *Memoirs of the Geological Survey, South Africa* 77:1-111.

Pack, A.; Gutzmer, J.; Beukes, N.J. and Van Niekerk, H.S. (2000) Supergene ferromanganese wad deposits along the Late Cretaceous-Mid Tertiary African Land Surface, Ryedale, South Africa. *Economic Geology* 95(1):203-220.

Rayner, R.J. (1986) *Azaniadendron*, a new genus of lycopod from South Africa. *Review of Palaeobotany and Palynology* 47:129–143.

SAHRA (2021) Palaeosensitivity Map <http://www.sahra.org.za/sahris/map/palaeo>

Truswell, J.F. (1977). *The geological evolution of South Africa*, Purnell and Sons (SA) Pty. Ltd, Cape Town, South Africa, 218pp.

Viljoen, M.J. & Reimold, W.U. (2002). *An introduction to South Africa's geological and mining heritage*. Geological Society and Mintek.

8. Conclusion and recommendations:

The study site is covered with soil and vegetation and is used for farming. Loose rocks can be seen in ploughed fields and where furrows were dug, but no uneroded outcrops of the Vryheid Formation were found at the study site. It is likely however that uneroded shales and sandstones may be exposed during excavations. If an exceptionally fossil-rich layer of shale or sandstone is exposed during construction in the south-eastern part of the study area, it is advised that the ECO must follow the Chance Palaeontological Find Procedure as stipulated below and to contact a palaeontologist for further advice.

PROCEDURE FOR CHANCE PALAEOLOGICAL FINDS

Extracted and adapted from the National Heritage Resources Act, 1999 Regulations Reg No. 6820, GN: 548.

The following procedure must be considered in the event that previously unknown fossils or fossil sites are exposed or found during the life of the project:

1. Surface excavations should continuously be monitored by the ECO and any fossil material be unearthed the excavation must be halted.
2. If fossiliferous material has been disturbed during the excavation process it should be put aside to prevent it from being destroyed.
3. The ECO then has to take a GPS reading of the site and take digital pictures of the fossil material and the site from which it came.
4. The ECO then should contact a palaeontologist and supply the palaeontologist with the information (locality and pictures) so that the palaeontologist can assess the importance of the find and make recommendations.
5. If the palaeontologist is convinced that this is a major find an inspection of the site must be scheduled as soon as possible in order to minimise delays to the development.

From the photographs and/or the site visit the palaeontologist will make one of the following recommendations:

- a. The material is of no value so development can proceed, or:
- b. Fossil material is of some interest and a representative sample should be collected and put aside for further study and to be incorporated into a recognised

fossil repository after a permit was obtained from SAHRA for the removal of the fossils, after which the development may proceed, or:

c. The fossils are scientifically important and the palaeontologist must obtain a SAHRA permit to excavate the fossils and take them to a recognised fossil repository, after which the development may proceed.

7. If any fossils are found then a schedule of monitoring will be set up between the developer and palaeontologist in case of further discoveries.

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.



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