Palaeontological Impact Assessment for Mashala Hendrina Coal (Pty) Ltd.'s proposed project, to update the De Wittekrans Coal Mine EIA/EMP, Hendrina, Mpumalanga Province

PALAEONTOLOGICAL IMPACT ASSESSMENT

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

For:

G&A Heritage
PO Box 522
Louis Trichardt, 0920
South Africa

9 July 2023

Table of Contents:

List of Figures:

1. Executive summary

Shale and sandstone of the Vryheid Formation of the Ecca Group of the Karoo Supergroup underlie the largest part of the study site. The southern part of the study site is underlain by dolerite however.

The fossiliferous nature of the Vryheid Formation is well known. The shales inspected at the study site are metamorphosized due to pressure and heat however which lowers the chances of finding fossils in these rocks significantly.

No fossils were found during the site visit. The geology of the study site is mostly obscured with soil and vegetation. Rocky outcrops at the study site and the rubble from the mine pit were inspected during the visit.

In the unlikely event of fossils being discovered during development or mining, the ECO should follow the guidelines as stipulated under the Chance Find Procedure on p. 20-21.

2. Introduction

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.

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.

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.

Fossils and palaeontological sites are protected by law in South Africa. Construction in fossiliferous areas may be mitigated in exceptional cases but there is a protocol to be followed.

This is a Palaeontological Impact Assessment that was prepared in line with the South African Heritage Resources Act (Act 25 of 1999) and Appendix 6 of the Environmental Impact Assessment Regulations 2014 as amended and the General Assessment Protocol for Site Sensitivity Verification. This involved an overview of the literature on the palaeontology and associated geology of the area and a site visit for a Palaeontological Impact Assessment.

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 African Heritage Resources Act (Act 25 of 1999) and Appendix 6 of the Environmental Impact Assessment Regulations 2014 as amended and the General Assessment Protocol for Site Sensitivity Verification. 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:

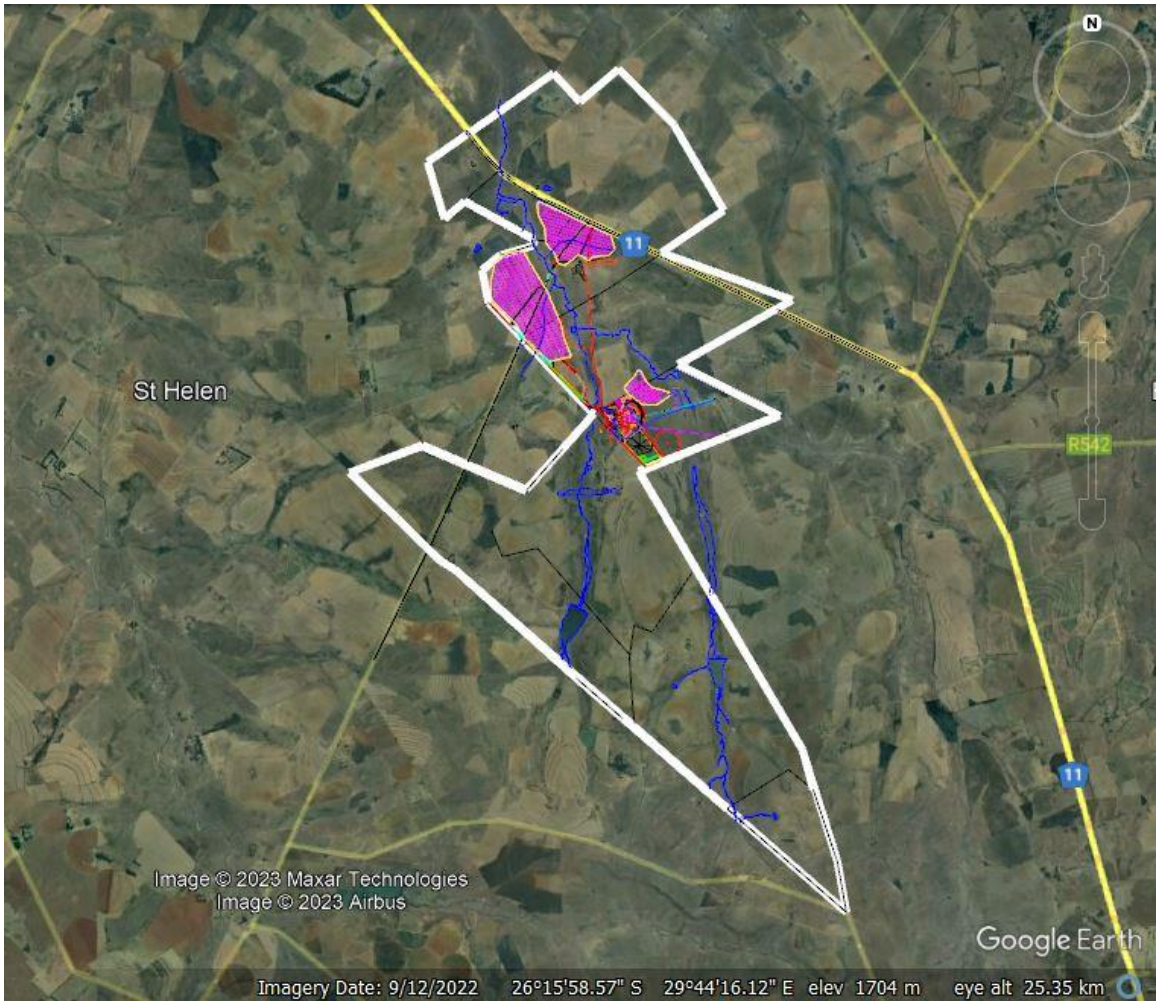


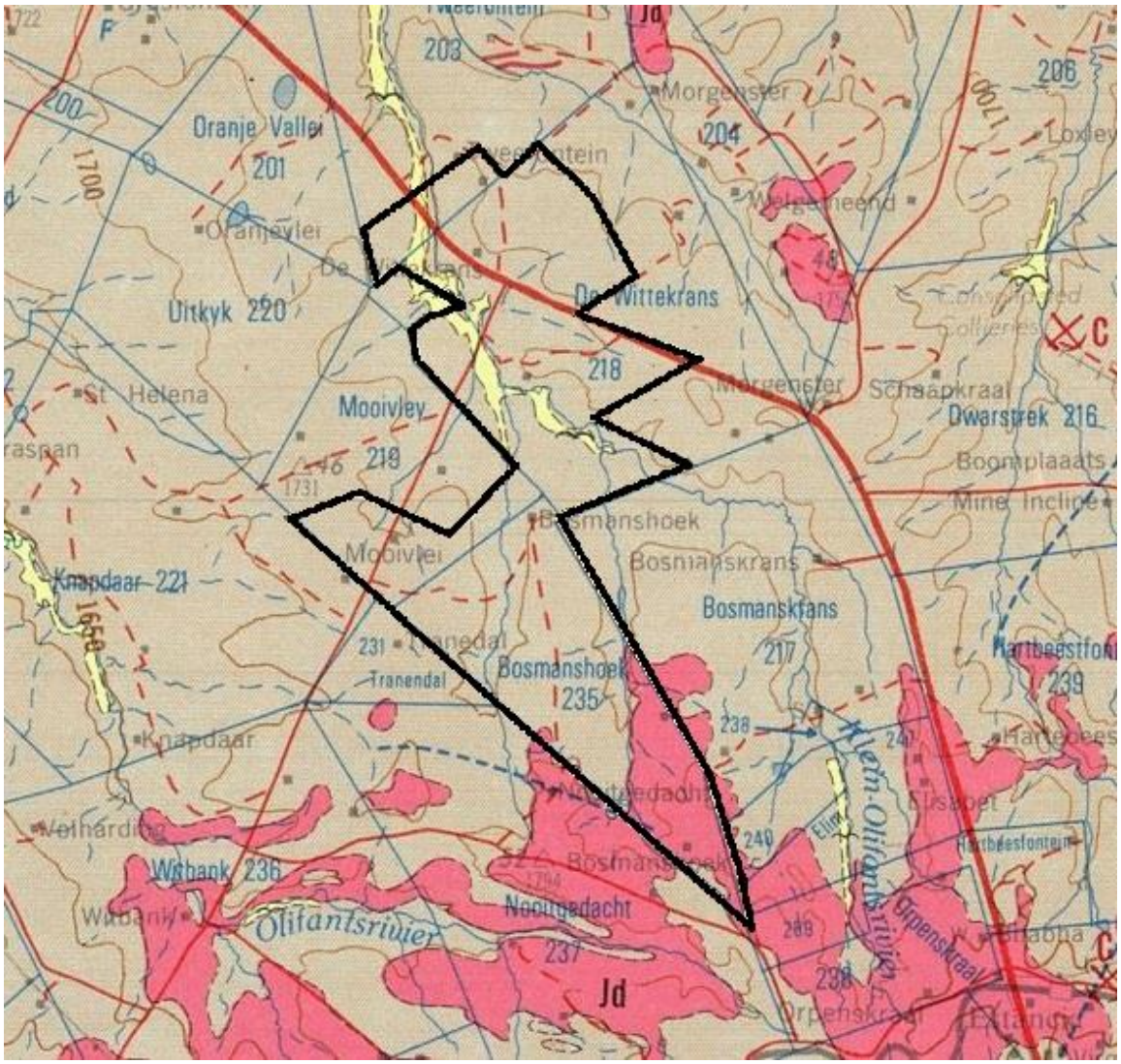
Figure 1: Google Earth photo of the study site (white polygon)

The study area (indicated by the white polygon in Fig. 1) is situated approximately 9 km southwest from Hendrina on the N11. The region is used for farming.

Geomorphologically 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 and dolerite.

The site was inspected and the relevant literature and geological maps for the region in which the development is proposed to take place, have been studied for a Palaeontological Impact Assessment.

5. Geological setting



The study area is indicated by the black polygon.

GEOLOGICAL LEGEND

Legend				
	Lithology	**Stratigraphy**		**Age**
	Alluvium			Quaternary
Jd	Dolerite			Jurassic
Pv	Shale, subordinate sandstone, coal	Vryheid Formation of the Ecca Group	Karoo Supergroup	Permian

Figure 2: Geology Map of the study site (adapted from the 2628 EAST RAND 1:250 000 Geology Map, Geological Survey, 1986)

The largest part of the study site is underlain by shale (metamorphosed mudstone), shaly sandstone, sandstone, grit, gravel, conglomerate and coal of the Vryheid Formation of the Ecca Group of the Karoo Supergroup. Dolerite underlies the southern part of the study site (see Fig. 2).

The Vryheid Formation was formed when glacial and fluvio-glacial sediments were deposited in shallow marine to fluvio-deltaic environments approximately 280 Ma ago. In places coal seams are associated with these fluvial valley deposits. The coal seams formed in peat swamps which originated on alluvial plains or more rarely in back swamps (Johnson, *et al*., 2009).

Dolerite intruded into the Karoo Supergroup approximately 183.0 to 182.3 Mya and served as the feeders to the overlying Drakensberg basalts (Svensen et al., 2012).

Alluvium is found adjacent to the Klein Olifantsrivier that runs through the northern part of the study site (see Fig. 2).

6. Site visit

Figure 3: Facing north from 26°13'58.69"S 29°46'35.53"E

Figure 4: Facing south-southeast from 26°13'59.04"S 29°46'36.49"E

Figure 5: Facing southwest from 26°13'38.47"S 29°47'08.22"E

Figure 6: Facing southwest from 26°13'20.83"S 29°46'33.34"E

Figure 7: Sandstone outcrop at 26°13'01.69"S 29°46'16.03"E

Figure 8: Facing southwest from 26°13'00.26"S 29°46'18.64"E

Figure 9: De Wittekrans Coal Mine

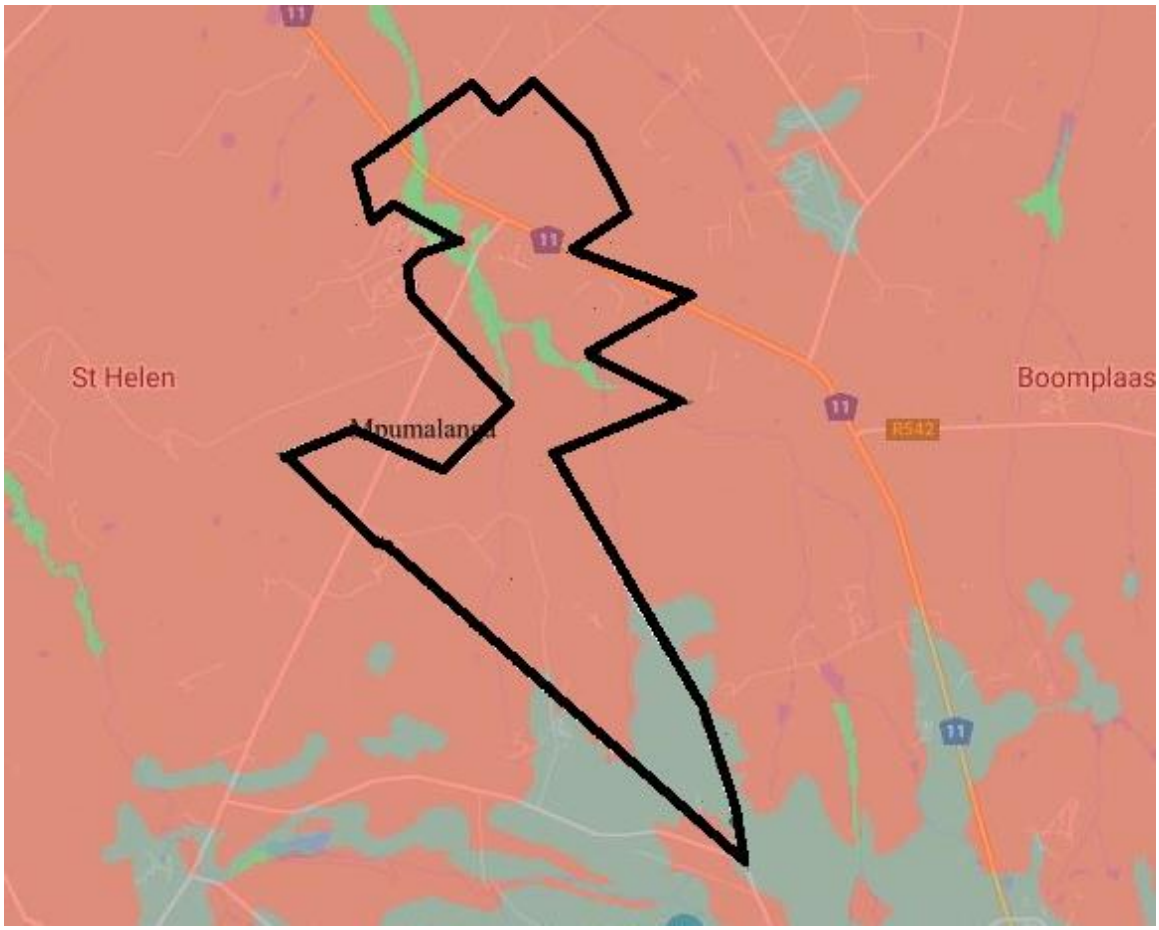
Figure 10: Mine pit

Figure 11: Shale rubble from mine pit

Figure 12: Shale with mica from mine pit

7. Palaeontology potential of the study area

The geology of the fossil site is mostly covered by soil and vegetation (Figs 5, 6, 8 & 9). The shales from the mine pit and outcrops of rocks in the study site were inspected.



LEGEND:

Colour	Palaeontological Significance	Action
RED	VERY HIGH	Field assessment and protocol for finds are required.
GREEN	MODERATE	Desktop study is required.
GREY	INSIGNIFICANT / ZERO	No palaeontological studies are required.

Figure 13: Palaeosensitivity map showing the position of the study site (black polygon) (SAHRA, 2023)

The fossiliferous content of the Vryheid Formation of the Ecca Group of the Karoo Supergroup, that underlies the northern and central part of the study site, is renowned for its fossil content and is considered by SAHRA as having a Very

High Palaeontological Sensitivity (Fig. 13). These Permian fossils are mostly leaf and stem imprints of *Glossopteris*, lycopods, ferns, horsetails, cordaitaleans, conifers and ginkgoaleans (Groenewald & Groenewald, 2014a).

The Ecca Group of the Karoo Supergroup is characterized by shale, mudstone, sandstone and seams of coal (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 sandy soil. 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 and the mines in the region. The soil cover and weathered rock are exposed in a trench on the western side of the study area (see Fig. 7).

The Ecca Group contain vast amounts of Permian leaf imprints of plants such as *Glossopteris* in places (Kovács-Endrödy, 1991, Groenewald & Groenewald 2014b) (see Fig. 9). 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 (Pack *et al*., 2000).

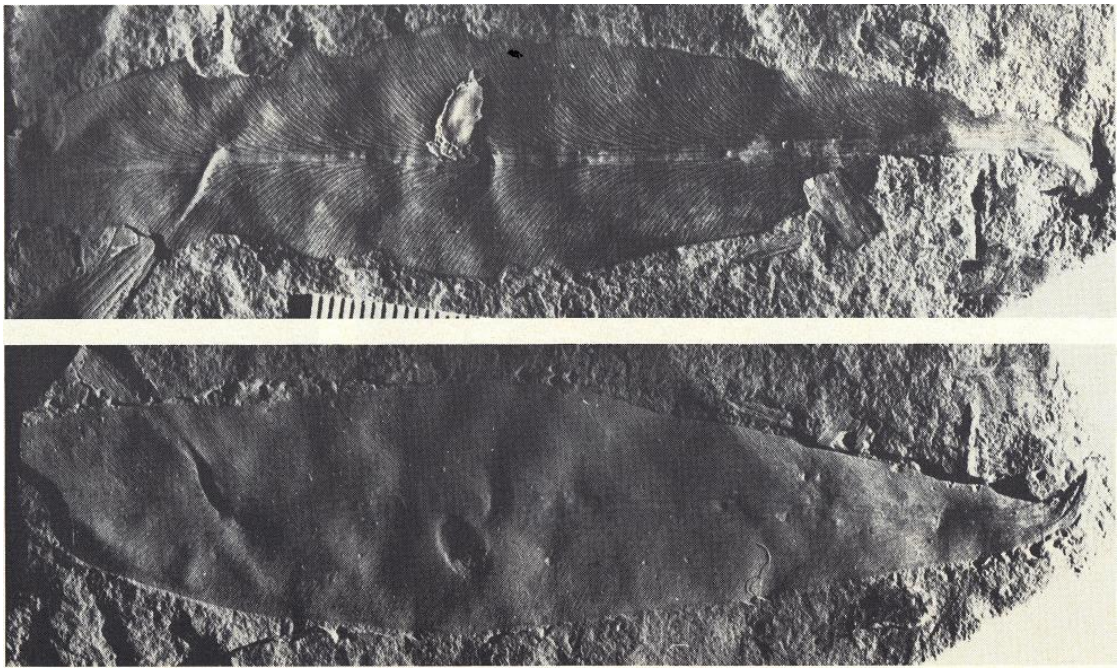


Figure 14: *Glossopteris* leaf imprint (from Kovács-Endrödy, 1976)

Fossilised leaf imprints are not found ubiquitously throughout the Ecca 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. 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, 2014b).

There is a high volume but low species diversity of fossil material from this region. Large and well described collections of fossil material from this region are housed at the Council for Geoscience, the Bernard Price Institute for Palaeontology at the University of the Witwatersrand and the Botanical Research Institute. *Glossopteris* leaves are abundant in Ecca Group sediments in Gauteng, Free State, Mpumalanga and KwaZulu-Natal and could be considered to be amongst the most common fossils in South Africa.

No fossils were found during the site visit. The shales at the mine contain mica - bama mineral that forms during metamorphosis due to pressure and heat which also would be instrumental in destroying the delicate fossil leaf imprints that may have been in the rock originally.

References:

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

Geological Survey (1986) 2628 EAST RAND 1:250 000 Geology Map.

Groenewald, G. & Groenewald, D. (2014a). Palaeontological heritage of Gauteng. SAHRA Palaeotechnical Report.

Groenewald, G. & Groenewald, D. (2014b). Palaeontological heritage of Mpumalanga. 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 (2023) Palaeosensitivity Map http://www.sahra.org.za/sahris/map/palaeo

Svensen, H.; Corfu, F.; Polteau, S.; Hammer, Ø & Planke, S. (2012). Rapid magma emplacement in the Karoo Large Igneous Province. *Earth and Planetary Science Letters* 325–326:1–9.

8. Conclusion and recommendations:

Although the region is known for the fossiliferous shales and sandstones of the Vryheid Formation of the Ecca Group of the Karoo Supergroup, the chances of finding fossils in these layers are low because of the metamorphosis that the shales were exposed to. No fossils were found in the sandstone outcrops in the study site. The dolerite is non-fossiliferous and the shales adjacent to the dolerite would have been subjected to thermal metamorphosis that would have destroyed the fossils if there were any in the shales originally.

In the unlikely case of fossils being discovered in the shales and sandstone at the study site during construction and mining, the ECO must follow the Chance Palaeontological Find Procedure as stipulated below and contact a palaeontologist for further advice.

PROCEDURE FOR CHANCE PALAEONTOLOGICAL 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.

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