

**PALAEONTOLOGICAL IMPACT ASSESSMENT OF THE PROPOSED MINING OF THE FARM
ZANDVOORT 10 IN THE ALBERT LUTHULI LOCAL MUNICIPALITY, GERT SIBANDE DISTRICT
MUNICIPALITY, MPUMALANGA PROVINCE**

Prepared for:

PGS HERITAGE (PTY) LTD

DATE: 5 April 2017

By

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EXECUTIVE SUMMARY

Banzai Environmental Pty (Ltd) was appointed by PGS Heritage to undertake a Palaeontological Impact assessment assessing the potential palaeontological impact of the planned mining activities on the farm Zandvoort 10IT, Albert Luthuli Local Municipality, Gert Sibande District Municipality, Mpumalanga Province.

This report forms part of the Environmental Impact Assessment and complies with the requirements of the South African National Heritage Resource Act No 25 of 1999. According to the National Heritage Resources Act (Act No 25 of 1999, section 38), a palaeontological impact assessment is required to detect the presence of fossil material within the proposed development footprint and to assess the impact of the construction and operation of the project on the palaeontological resources.

The proposed Zandvoort 10IT Study Area is entirely underlain by sedimentary rocks of the Permo-Carboniferous Dwyka Group; the Permian aged Vryheid Formation (Ecca Group, Karoo Supergroup) and Jurassic aged Dolerite of the Karoo Supergroup. The rocks of the Dwyka are of low palaeontological sensitivity as the fossil assemblages is generally scarce, while the rocks of the Vryheid Formation have a very high fossiliferous potential and thus a very high palaeontological sensitivity. The Dolerite of the Jurassic has a very low Palaeontological Sensitivity as these rocks are unfossiliferous.

During a thorough field survey of the proposed development footprint no fossils were found. For this reason, a moderate palaeontological sensitivity is allocated to the development footprint. Regardless of the sparse and sporadic occurrence of fossils in this biozone a single fossil can have a huge scientific importance as many fossil taxa are known from a single fossil.

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 immediately. 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 palaeontologist.

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.

Recommendations:

It is therefore considered that the construction and operation of the mine on Zandvoort 10IT is deemed appropriate and feasible and will not lead to detrimental impacts on the palaeontological resources of the area. Thus, the construction and operation of the mine may be authorised as the whole extent of the development footprint is not considered sensitive in terms of palaeontological resources.

1. The EAP as well as the ECO for the Pembani mine must be notified to the fact that the sediments of the Vryheid Formation, Ecca Group contains important fossil remains, although they are mostly trace fossil and plant fossil assemblages.
2. In areas that are allocated a Very High and High Palaeontological sensitivity (e.g. Vryheid Formation) and specifically where deep excavation into bedrock is foreseen (following the geotechnical investigation), or where fossils are recorded during the geotechnical investigations, a qualified palaeontologist must be appointed to evaluate and record fossils at the development footprint.
3. These recommendations should form part of the EMP of the Pembani project.

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1 INTRODUCTION

Banzai Environmental Pty Ltd has been appointed by PGS Heritage in assessing the palaeontological impact in the proposed mining activities on Zandvoort 10IT, Albert Luthuli Local Municipality, Gert Sibande District Municipality, Mpumalanga Province. Zandvoort 10 IT is 3 km east of Carolina (Fig. 1).

This report forms part of the Environmental Impact Assessment (EIA) and complies with the requirements of the South African National Heritage Resource Act No 25 of 1999. According to the National Heritage Resources Act (Act No 25 of 1999, section 38), a palaeontological impact assessment is required to detect the presence of fossil material within the proposed development footprint and to assess the impact of the construction and operation of the project on the palaeontological resources.

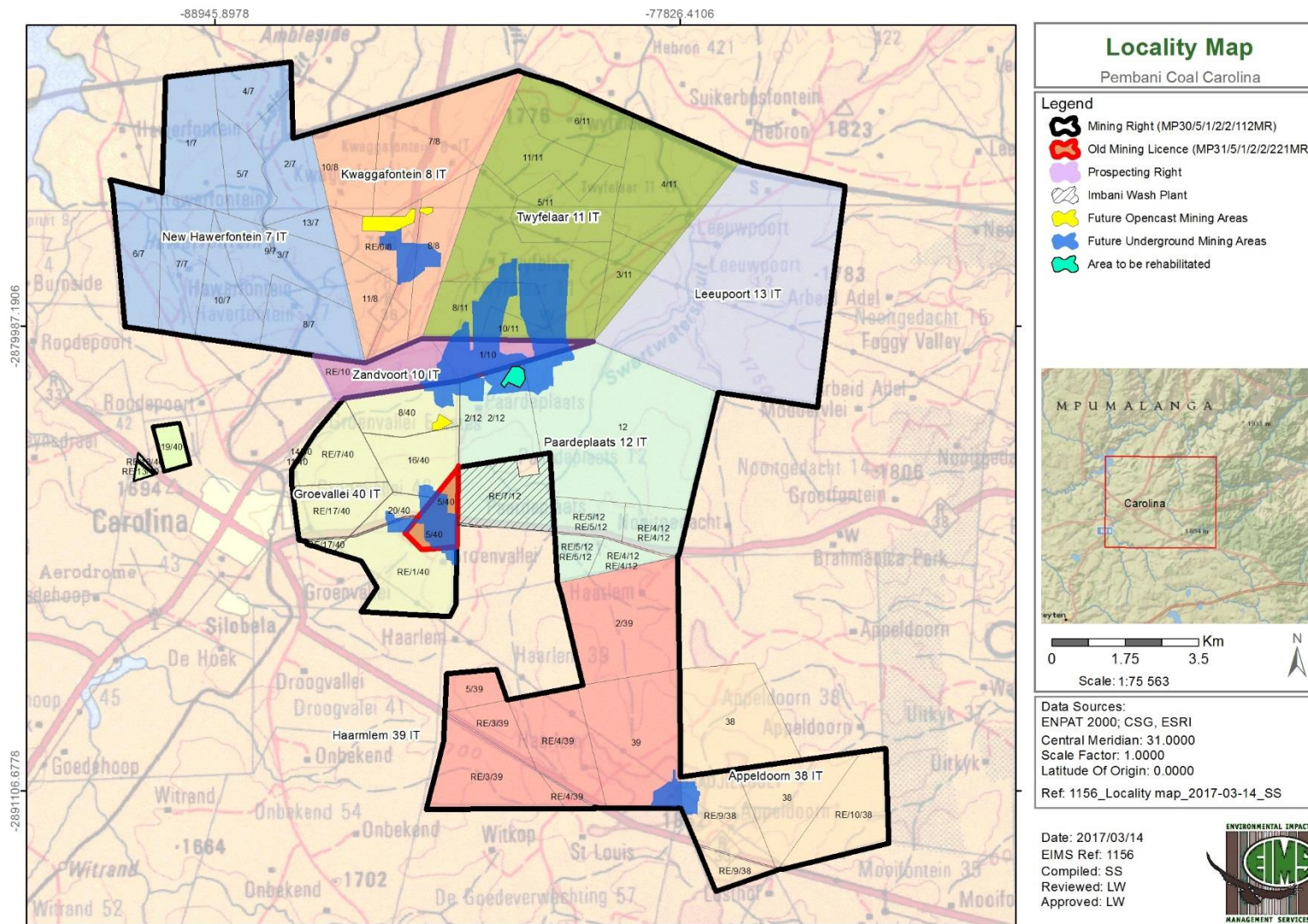


Figure 1: The location of the Pembani Colliery, 3 km east of Carolina, in Mpumalanga, South Africa. (Map provided by EIMS Environmental).

2 SCOPE

According to the South African Heritage Resources Agency (SAHRA) Archaeology, Palaeontology and Meteorites (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.

The objective is therefore to conduct a Palaeontological Impact Assessment, which forms of part of the Heritage Impact Assessment (HIA) and the EIA Report, to determine the impact of the development on potential palaeontological material at the site.

When a palaeontological desktop/scoping 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 maps; 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 study area on a desktop level. The likely impact of the proposed development on local fossil heritage is subsequently established on the basis of the palaeontological sensitivity of the rocks and the nature and scale of the development itself (extent of new bedrock excavated).

If rocks of moderate to high palaeontological sensitivity are present within the study area, a Phase 1 field-based assessment by a professional palaeontologist is necessary. Generally, damaging impacts on palaeontological heritage occur during the construction phase. These excavations will modify the existing topography and may disturb, damage, destroy or permanently seal-in fossils at or below the ground surface that are then no longer available for scientific study.

When specialist palaeontological mitigation is suggested, it may take place prior to construction or, even more successfully, during the construction phase when new, potentially fossiliferous bedrock is

still exposed and available for study. Mitigation usually involves the careful sampling, collection and recording of fossils, as well as relevant data concerning the surrounding sedimentary matrix. Excavation of the fossil heritage will require a permit from SAHRA and the material must be housed in a permitted institution. With appropriate mitigation, many developments involving bedrock excavation will have a *positive* impact on our understanding of local palaeontological heritage.

2.1 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 computerised. 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 the possible occurrence of fossils in an unexplored area. Desktop studies 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-survey by a professional palaeontologist.

2.2 LEGISLATION

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

SECTION 35 OF THE NATIONAL HERITAGE RESOURCES ACT 25 OF 1999

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

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

- 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; and/or

- 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.

3 GEOGRAPHICAL LOCATION OF THE SITE

The proposed site is located at Pembani Colliery, 3 km east of Carolina, in Mpumalanga, South Africa (Fig.1).

4 GEOLOGICAL AND PALAEOLOGICAL HISTORY

The proposed underground mining on the farm Zandvoort 10 IT is entirely underlain by sedimentary rocks of the Permo-Carboniferous aged Dwyka Group, Permian aged Vryheid Formation (Ecca Group, Karoo Supergroup) and Jurassic aged Dolerites (Fig. 2).

4.1 GEOLOGY

DWYKA GROUP

The Permo-Carboniferous Dwyka Group forms the lowermost and oldest deposit in the Karoo Supergroup. Dwyka deposits were deposited in a cold, glacially-dominated environment which occurred when South Africa lay below a massive ice sheet about 4km thick. The Dwyka Group consists almost throughout of gravelly sediments with subordinate varved shale and mudstone containing scraped and faceted pebbles. Dark-grey tillite was deposited by retreating glaciers. This rock unit is characterized by a rich assemblage of dropstones that vary in size from millimeters to nearly a meter in diameter.

VRYHEID FORMATION

The Vryheid Formation consists mainly of light grey coarse-to fine grained sandstone and siltstone sediments. Dark coloured siltstones can be attributed to the occurrence of carbon enrichment and coal beds. Deltaic mudrocks and sandstones, locally coastal and fluvial deposits, and occasional coal seams are also present. The sediments are interpreted as been deposited on a sandy shoreline, beyond massive swamps. The coal deposits that are mined today were formed by plant material accumulating within these swamp areas (Johnson et al, 2006).

DOLORITE

The Karoo Dolerite Suite is a widespread network of basic igneous bodies (dykes, sills) that were intruded into sediments of the Main Karoo Basin in the Early Jurassic Period (approximately 183 million years ago). These igneous rocks are unfossiliferous and not discussed further in this report.

4.2 PALAEOLOGICAL HERITAGE

DWYKA GROUP

Trackways, produced mostly by fish and arthropods (invertebrates), have been recovered in shales from the uppermost Dwyka Formation. Other trace fossils include coprolites (fossilized faeces) of chondrichthyans (sharks, skates and rays). Body fossils include Aranceous foraminifera and radiolarians (single-celled organisms), bryozoans, sponge spicules (internal support elements of sponges), primitive starfish, orthoceroid nautiloids (marine invertebrates similar to the living *Nautilus*), goniatite cephalopods (*Eosinities* sp.), gastropods (marine snails such as *Peruvispira viperdorfensis*), bivalves (*Nuculopsis* sp., *Phestia* sp., *Aphanaia haibensis*, *Eurydesma mytiloides*), brachiopods (*Attenuatella* sp.) and palaeoniscoid fish such as *Namaichthys schroederi* and *Watsonichthys lotzi*. Fossil plants have also been found, including lycopods (*Leptophloem australe*), moss, leaves and stems (possibly belonging to a proto-glossopterid flora). Fossil spores and pollens (moss, fern and horsetail spores and primitive gymnosperm pollens) as well as fossilized wood probably belonging to primitive gymnosperms have also been recorded from Dwyka deposits (MacRae, 1999; McCarthy and Rubidge, 2005).

VRYHEID FORMATION

The Vryheid Formation of the Ecca Group is world renowned for the occurrence of coal beds which has been formed due to the accumulation of plant material over long periods of time. Plant fossils that Bamford (2011) described are: *Azaniodendron fertile*, *Cyclodendron leslii*, *Sphenophyllum hammanskraalensis*, *Annularia* sp., *Raniganjia* sp., *Asterotheca* spp., *Liknopetalon enigmata*, *Glossopteris* more than 20 species, *Hirsutum* 4 spp., *Scutum* 4 spp., *Ottokaria* 3 spp., *Estcourtia* sp., *Arberia* 4 spp., *Lidgettonia* sp., *Noeggerathiopsis* sp. and *Podocarpidites* sp. According to Bamford (2011) "Little data have been published on these potentially fossiliferous deposits. Around the coal mines there is most likely to be good material and yet in other areas the exposures may be too poor to be of interest. When they do occur fossil plants are usually abundant and it would not be feasible to preserve and maintain all the sites, however, in the interests of heritage and science such sites should be well recorded, sampled and the fossils kept in a suitable institution".

This trace fossil assemblage of the non-marine *Mermia lchnofacies*, is dominated by the ichnogenera *Umfolozia* (arthropod trackways) and *Undichna* (fish swimming trails), the unique mesosaurid reptiles,

palaeoniscoid fish, small eocarid crustaceans, insects, trace fossils (king crab track ways. shark coprolites?), palynomorphs (organic-walled spores and pollens), petrified wood (mainly of primitive gymnosperms, silicified or calcified) and sparse vascular plant remains (Glossopteris leaves, lycopods etc).

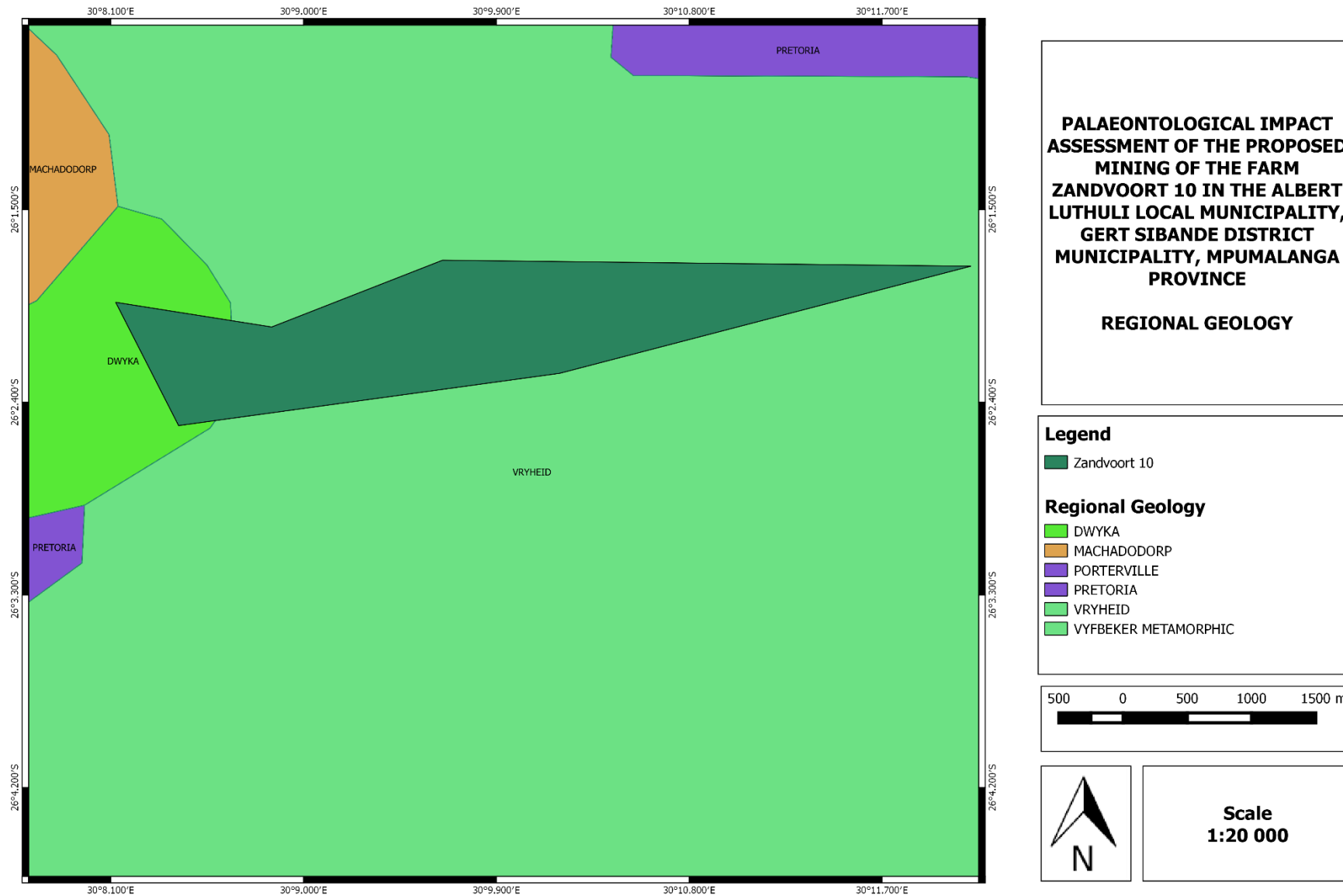


Figure 2: The geology of the proposed underground mining operations on the farm **Zandvoort 10 IT**, in Mpumalanga, South Africa. The proposed operations is entirely underlain by sedimentary rocks of the Permo-Carboniferous aged Dwyka Group (light green), Permian aged Vryheid Formation (dark green) (Ecca Group, Karoo Supergroup) and Jurassic aged Dolerites (not shown on map)

5 METHODS

As part of the Palaeontological Impact Assessment, a field-survey of the proposed development footprint was conducted on 1 April 2017, to assess the potential risk to palaeontological material in the proposed footprint of the development. A physical field-survey was conducted on foot within the proposed development footprint. The results of the field-survey, the author's experience, aerial photos (using Google Earth, 2016) topographical and geological maps and other reports from the same area were used to assess the proposed development footprint. No consultations were undertaken for this Impact Assessment.

6 FIELD OBSERVATIONS

The following photographs were taken on a site visit to the proposed development site near Carolina on the 1st April 2017.



Figure 3: Adit to the underground mine on the farm Groenkloof 40 IT (TZP4), in Mpumalanga, South Africa.



Figure 4: Sediments (mudstone) at the adit of the underground mine on the farm Groenkloof 40IT (TZP4), in Mpumalanga, South Africa.



Figure 5: The low relief of the proposed development area on the farm Zandvoort 10, in Mpumalanga, South Africa.

7 IMPACT ASSESSMENT

The Dwyka Group is known for its trackways of arthropoda and fish, body fossils of foraminifera, bryozoans, sponges, marine invertebrates, palaeoniscoid fish and even fossil plants and was allocated a low Palaeontological Sensitivity. The Vryheid Formation, with a Very High palaeontological sensitivity, is world renown for the occurrence of coal beds and various plant fossils, trace fossil assemblages of the non-marine *Mermia* Ichnofacies, palaeoniscoid fish, small eocarid crustaceans, insects, trace fossils (king crab track ways. shark coprolites?), palynomorphs, petrified wood and sparse vascular plant remains. The unique mesosaurid reptile, *Mesosaurus* may also be present in the development site.

During a thorough field survey of the proposed development footprint no fossils were found. For this reason, a moderate palaeontological sensitivity is allocated to the development footprint. Regardless

of the sparse and sporadic occurrence of fossils in these biozones a single fossil can have a huge scientific importance as many fossil taxa are known from a single fossil.

Impacts from mining are rated as medium significance ([Table 1](#)).

Table 1 - Assessment of impact of mining on palaeontological resources

D. Destruction of palaeontology - All Alternatives					
Destruction of palaeontology					
All Alternatives					
Construction					
Environmental Risk					
Attribute	Pre-mitigation	Post-mitigation	Attribute	Pre-mitigation	Post-mitigation
Nature of Impact	-1	-1	Magnitude of Impact	3	2
Extent of Impact	1	1	Reversibility of Impact	3	1
Duration of Impact	5	5	Probability	3	1
Environmental Risk (Pre-mitigation)					-9.00
Mitigation Measures					
<p>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.</p> <p>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 immediately. Such discoveries ought to be protected (preferably <i>in situ</i>) and the ECO should alert SAHRA (South African Heritage Research Agency) so that appropriate mitigation (<i>e.g.</i> recording, sampling or collection) can be taken by a professional palaeontologist.</p>					
Environmental Risk (Post-mitigation)					-2.25
Degree of confidence in impact prediction:					medium

Impact Prioritisation	
Public Response	1
<i>Low: Issue not raised in public responses</i>	
Cumulative Impacts	2
<i>Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.</i>	
Degree of potential irreplaceable loss of resources	3
<i>The impact may result in the irreplaceable loss of resources of high value (services and/or functions).</i>	
Prioritisation Factor	1.50
Final Significance	-3.38

8 FINDINGS AND RECOMMENDATIONS

The proposed development site on Zandvoort 10 in the Carolina Magisterial District, Mpumalanga Province is completely underlain by the Dwyka Group, Vryheid Formation of the Ecca Group and Jurassic Dolerite.

Trackways, produced mostly by fish and arthropods (invertebrates), have been recovered in shales from the uppermost Dwyka Formation. Other trace fossils include coprolites (fossilized faeces) of chondrichthyans (sharks, skates and rays). Body fossils include Araneous foraminifera and radiolarians (single-celled organisms), bryozoans, sponge spicules (internal support elements of sponges), primitive starfish, orthoceroid nautiloids (marine invertebrates similar to the living Nautilus), goniatite cephalopods (Eosinities sp.), gastropods (marine snails such as *Peruvispira viperdorfensis*), bivalves (*Nuculopsis* sp., *Phestia* sp., *Aphanaia haibensis*, *Eurydesma mytiloides*, brachiopods (*Attenuatella* sp.) and palaeoniscoid fish such as *Namaichthys schroederi* and *Watsonichthys lotzi*. Fossil plants have also been found, including lycopods (*Leptophloem australe*), moss, leaves and stems (possibly belonging to a proto-glossopterid flora). Fossil spores and pollens (moss, fern and horsetail spores and primitive gymnosperm pollens) as well as fossilized wood probably belonging to primitive gymnosperms have also been recorded from Dwyka deposits (MacRae, 1999; McCarthy and Rubidge, 2005).

The Vryheid Formation is world renowned for the occurrence of coal beds and various plant fossils have been described from this formation. This formation has also trace fossil assemblages of the non-marine *Mermia* Ichnofacies, and is dominated by the ichnogenera *Umfolozia* (arthropod trackways) and *Undichna* (fish swimming trails), palaeoniscoid fish, small eocarid crustaceans, insects, trace fossils (king crab track ways, shark coprolites?), palynomorphs (organic-walled spores and pollens), petrified wood (mainly of primitive gymnosperms, silicified or calcified) and sparse vascular plant remains (Glossopteris leaves, lycopods etc). The unique mesosaurid reptile, *Mesosaurus* may also be present in the development site.

The Dwyka has a low palaeontological sensitivity while the Vryheid Formation has a very high palaeontological sensitivity. During a thorough field survey of the proposed development footprint no fossils were found. Mining thus far, has also not recovered any fossils. For this reason, a moderate palaeontological sensitivity is allocated to the development footprint. Regardless of the sparse and sporadic occurrence of fossils in these biozones a single fossil can have a huge scientific importance as many fossil taxa are known from a single fossil.

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 immediately. 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 palaeontologist.

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.

Recommendations:

It is therefore considered that the construction and operation of the mine on the remaining portions of Zandvoort 10IT is deemed appropriate and feasible and will not lead to detrimental impacts on the palaeontological resources of the area. Thus, the construction and operation of the mine may be authorised as the whole extent of the development footprint is not considered sensitive in terms of palaeontological resources.

1. The EAP as well as the ECO for the Pembani mine must be notified to the fact that the sediments of the Vryheid Formation, Ecca Group contains important fossil remains, although they are mostly trace fossil and plant fossil assemblages.
2. In areas that are allocated a Very High and High Palaeontological sensitivity and specifically where deep excavation into bedrock is foreseen (following the geotechnical investigation), or where fossils are recorded during the geotechnical investigations, a qualified palaeontologist must be appointed to evaluate and record fossils at the development footprint.
3. These recommendations should form part of the EMP of the Pembani project.

9 REFERENCES

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10 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

The author (Elize Butler) has an MSc in Palaeontology from the University of the Free State, Bloemfontein, South Africa. She has been working in Palaeontology for more than twenty three years. She has been conducting Palaeontological Impact Assessments since 2014.

11 DECLARATION OF INDEPENDENCE

I, Elize Butler, declare that –

General declaration:

- I act as the independent palaeontological specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting palaeontological impact assessments, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in section 38 of the NHRA when preparing the application and any report relating to the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application;
- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not
- All the particulars furnished by me in this form are true and correct;
- I will perform all other obligations as expected a palaeontological specialist in terms of the Act and the constitutions of my affiliated professional bodies; and
- I realise that a false declaration is an offence in terms of regulation 71 of the Regulations and is punishable in terms of section 24F of the NEMA.

Disclosure of Vested Interest

- I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Regulations;

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SIGNATURE:
