# Kimberley Strengthening Phase 3 within John Taolo Gaetsewe District Municipality, Northern Cape Province and Dr Ruth Segomotsi Mompatsi District Municipality, North West Province

## PALAEONTOLOGICAL IMPACT ASSESSMENT

## REPORT

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29 September 2024

**Table of Contents:**



**List of Figures:**

# 1. Executive Summary

The western part of the proposed Ferrum-Mookodi 400kV power line is mainly underlain by dune sand and aeolian sand that are considered with moderate palaeontological sensitivity. The line crosses alluvium associated with a dry riverbed south of Hotazel at 27°17'09.96"S 22°54'59.36"E that has a high palaeontological sensitivity. The Ferrum Substation and the southern end of the power line, east of Kathu, are underlain by surface limestone that is considered to have a high palaeontological sensitivity.

The eastern part of the proposed Ferrum-Mookodi 400kV power line is mainly underlain by aeolian sand that has a moderate palaeontological sensitivity. There are however sections that are underlain by dolomite, limestone and chert of the Ghaap Group of the Griqualand West Supergroup that include rocks that are considered of Very High Palaeosensitivity. A section of the line that crosses over the hills west of Hotazel, in the Ga-Motsemai region, is underlain by the rocks of the Daniëlskuil Member of the Asbesberge Formation of the Asbestos Hills Subgroup that is also considered to have a very high palaeontological sensitivity. A small section, southwest of Vryburg, is underlain by calcrete that has a high palaeontological sensitivity and south of Vryburg there are rocks of the Dwyka Group of the Karoo Supergroup that has a moderate palaeontological sensitivity.

The Palaeontological Impact Assessment that was done in the areas identified as having a Very High Palaeontological Sensitivity between Hotazel and Vryburg did not yield any fossils.

Although no major fossil find was made during the field assessment, the occurrence of stromatolite-bearing dolomite was confirmed. Scientifically important fossils will probably be exposed when the sand, surface limestone, calcrete and overburden are removed during construction and uneroded rocks are exposed. The ECO needs to follow the stipulations as set out in the Chance Find Procedure (pp. 29-30) in case fossils are found during development.

# 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 National Transmission Company South Africa SOC Ltd (NTCSA) a subsidiary of Eskom Holdings SOC Ltd, has to supply reliable power to meet the increasing needs of electricity users. Therefore, NTCSA must continuously maintain, construct, and upgrade its transmission powerlines and substation infrastructure. According to Eskom TDP 2010-2019, some objectives involve transmission network strengthening plans and reliability projects, ensuring the transmission system's reliability and adequacy are sustained as load demand increases. A study done for the Northern Cape and North West grid indicated that based on the anticipated growing electricity demand, there may be a risk that demand will exceed the supply. As a result, they have identified the need to strengthen the transmission system between the Ferrum, Hotazel Transmission and Mookodi Substations by constructing two 400kV transmission powerlines and upgrade substations. The proposed work entails:

i. Construction of a 400kV transmission powerline of ±260km from Ferrum Substation to Mookodi Substation.
ii. Upgrade the Mookodi Substation by installing:
   - 1 x 100MVAr busbar reactor at Mookodi 400kV busbar.
   - 1 x 400kV Mookodi feeder bay.
   - 1 x 400kV Line reactor at Mookodi 400kV.
iii. Upgrade the Ferrum Substation by installing
   - 1 x 100MVAr busbar reactor at Ferrum 400kV busbar.
   - 1 x 400kV Ferrum feeder bay.
   - 1 x 400kV Line reactor at Ferrum 400kV.

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. South Africa is probably best known palaeontologically for having more than half of all the hominin specimens in the world, the greatest variety of hominins in a country and the longest record of continuous hominin occupation in the world.

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 field assessment 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:

The western part of the proposed Ferrum-Mookodi 400kV power line runs over a distance of more than 60 km from the Ferrum Substation east of Kathu to south of Hotazel in the Northern Cape (see Fig. 1). The area is extremely dry and known for its iron, lime and asbestos mines.

Figure 1: Google Earth photo indicating the western part of the proposed Ferrum-Mookodi 400kV power line

The eastern part of the proposed Ferrum-Mookodi 400kV power line runs from south of Hotazel in the Northern Cape to the Mookodi Substation south of Vryburg in Northwest Province. The area is known for its cattle farming and includes part of what used to be Bophuthatswana.

The relevant literature and geological maps for the study area in which the development is proposed to take place have been studied and a field assessment was done for a Palaeontological Impact Assessment.

Figure 2: Google Earth photo indicating the eastern part of the proposed Ferrum-Mookodi 400kV power line from south of Hotazel to Vryburg

# 5. Geological setting of the study area

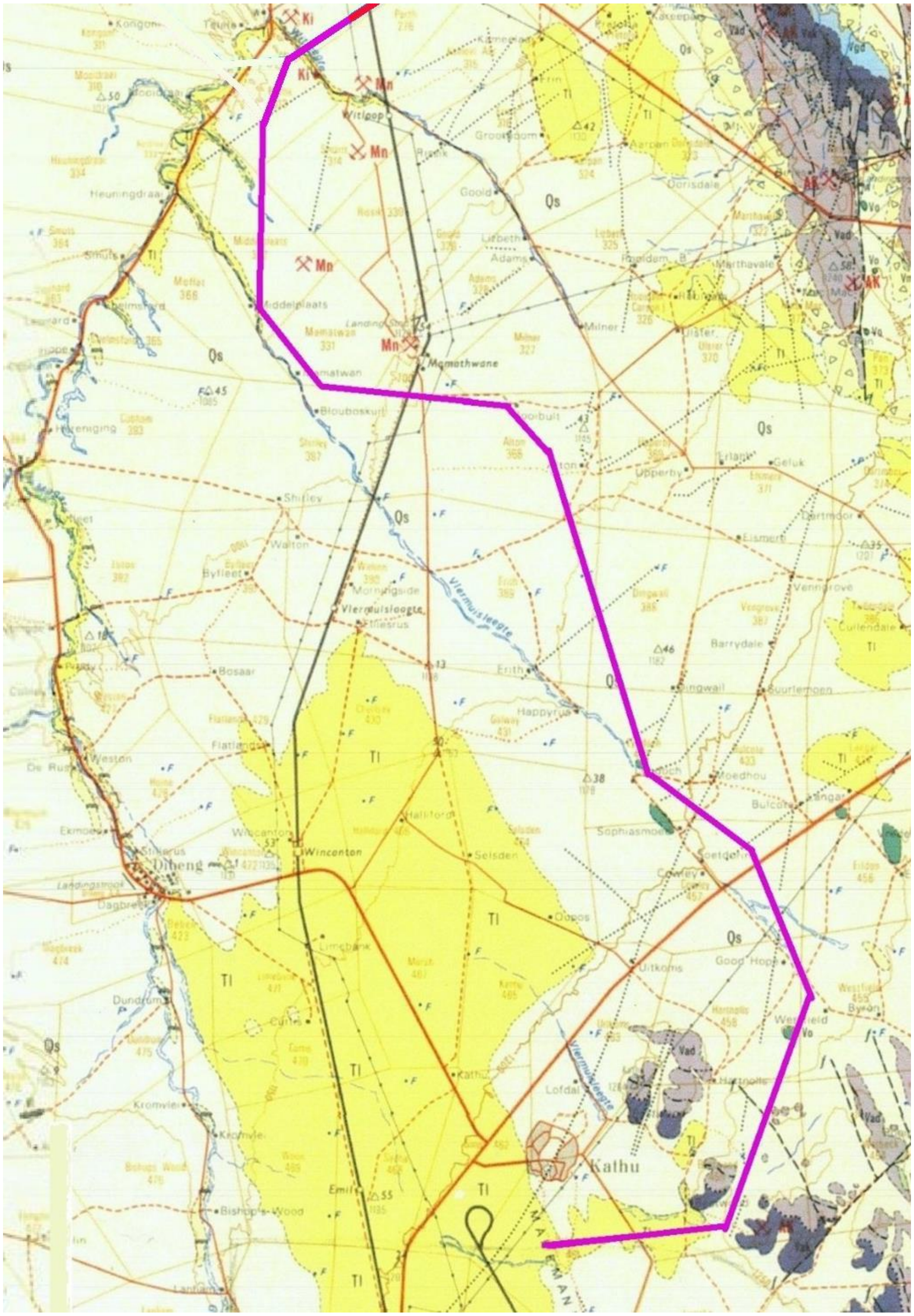



Figure 3: Geology of the western part of the proposed Ferrum-Mookodi 400kV power line (purple line) and surroundings. Adapted from the 2722 Kuruman 1: 250 000 Geology Map (Geological Survey, 1979)

GEOLOGICAL LEGEND FOR FIGURE 3

| | Lithology | Geological unit | | | Age |
|---|---|---|---|---|---|
| Qs | Red to flesh-coloured wind-blown sand | Kalahari Group | | | Tertiary to Quaternary |
| | Rubble | | | | |
| Tl | Surface limestone | | | | |
| | Amygdaloidal andesitic lava with interbeds of tuff, agglomerate, chert and red jasper. | Ongeluk Formation of the Olifantshoek Group | | Griqualand West Supergroup | Vaalium |
| Vm | Diamictite, banded jasper, siltstone, mudstone, sandstone, grit and dolomite with chert. | Makganyene Formation | | | |
| Vad | Yellow brown banded or massive jaspilite with crocidolite, flat pebble con-glomerate | Daniëlskuil Member, Asbestos Hills Formation | Asbestos Hills Subgroup | | |
| Vak | Banded ironstone with subordinate crocidolite, brown jaspilite and chert | Kuruman Formation | | | |
| Vgd | Fine and coarse-grained dolomite, chert and dolomitic limestone with chert | Reivilo Formation | Campbell Rand Sub-group, Ghaap Group | | |

The western part of the proposed Ferrum-Mookodi 400kV power line is mainly underlain by dune sand and aeolian sand. Surface limestone occur along the dry river bed south of Hotazel at 27°17'09.96"S 22°54'59.36"E and the Ferrum Substation and a short section of the power line west of Kathu are underlain by surface limestone however (see Fig. 3).

The eastern part of the proposed Ferrum-Mookodi 400kV power line is mainly underlain by aeolian sand, surface limestone and Vaalian-aged dolomitic limestone, chert and limestone of the Reivilo Formation of the Campbell Rand Subgroup (Erikkson et al., 2009).

The easternmost end of the power line, west of Vryburg, is underlain by the Vaalian-aged oolitic and stromatolitic dolomite, shale and flagstone of the Boomplaas Formation of the Schmidtsdrift Subgroup of the Ghaap Group of the Griqualand West Supergroup. A short section of the line is underlain by the shale, conglomerate, chert and dolomite of the Clearwater Formation of the Schmidtsdrift Subgroup which overlies the rocks of the Boomplaas Formation. The line then crosses a section dominated by Tertiary-aged calcrete before it runs over a section that is underlain by the Carboniferous-aged tillite, mudstone, shale, boulder shale and sandstone of the Dwyka Group of the Karoo Supergroup. The easternmost end of the power line and the Mookodi Substation is underlain by the Vaalian-aged quartzite, flagstone, conglomerate, dolomite and shale, andesitic lava of the Vryburg Formation (see Fig. 4).

The Ventersdorp Supergroup unconformably overlies the Witwatersrand Supergroup and comprises the Klipriviersberg Group at the base, followed by the Platberg Group, the sedimentary Bothaville Formation and the volcanic Allanridge Formation. The Klipriviersberg Group that forms the base of the Ventersdorp Supergroup consists of conglomerates, volcanic assemblages and lavas (Van der Westhuizen et al., 2009).

The Allanridge Formation consists mainly of dark-green amygdaloidal lava, light-greenish-grey porphyritic lava and pyroclastic rocks (Van der Westhuizen et al., 2009). The 2642 Ma Vryburg Formation overlies the Ventersdorp Supergroup in Griqualand West. It comprises of a basal, transgressive conglomerate with quartzites, shales and subordinate stromatolitic carbonates passing up in places into basaltic to andesitic amygdaloidal lavas. It is interpreted as a fluvial to marginal marine deposit (Eriksson et al., 2009).

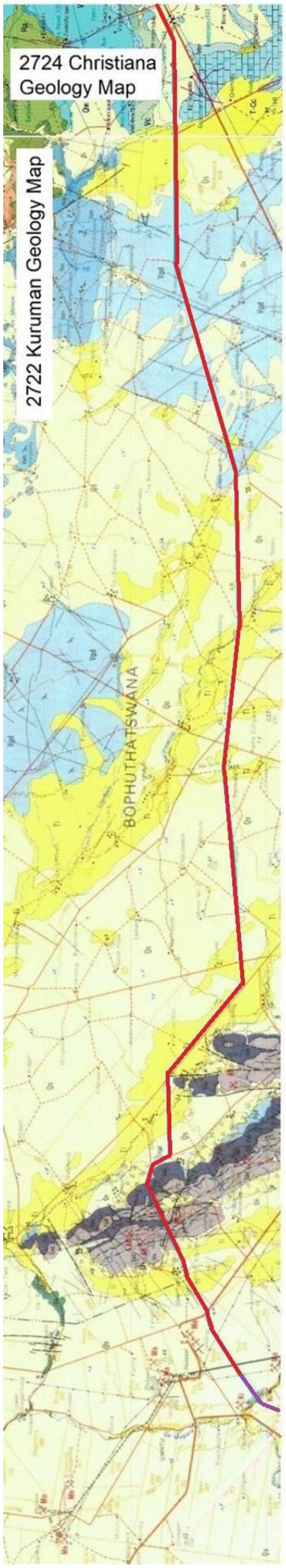
The Ghaap Group in the Griqualand West Basin overlies the Vryburg Formation and is subdivided from oldest to youngest into the Schmidtsdrif, Campbell Rand and Asbestos Hills Subgroups at the study site. The Schmidsdrif Subgroup is represented by the older Boomplaas Formation that comprises of stromatolitic and oolitic marine platform carbonates and the younger overlying Clearwater Formation comprising of shales, tuffites and Banded Iron Formation-like cherts (Eriksson et al., 2009).

The Campbell Rand Subgroup is represented by the Monteville and Reivilo Formations. The Monteville Formation comprises of marine shelf deposits that contain large stromatolitic domes succeeded by microbial laminates, shales and siltstones. The overlying Reivilo Formation forms the largest part of the Campbell Rand Subgroup and consists of dolomite with giant stromatolite domes intercalated with cycles of columnar stromatolites and fenestral facies (Eriksson et al., 2009).

The Asbestos Hills Subgroup is represented by the Kuruman and Daniëlskuil Formations in the western part of the study site in the vicinity of Kathu and Hotazel. The older Kuruman Formation comprises of Banded Iron Formations while the younger overlying Daniëlskuil Formation is considered to comprise of reworked Banded Iron Formations and display a granular texture that is not as finely layered as the Banded Iron Formations of the underlying Kuruman Formation (Eriksson et al., 2009).

The Karoo Supergroup is represented southwest of Vryburg by pockets of Late Carboniferous to Early Permian glacial to fluvioglacial diamictites, conglomerates, sandstones and shales of the Dwyka Group (Johnson et al., 2009).

The Quaternary-aged rubble, dune sand and aeolian sand and Tertiary-aged limestone cover parts of the dolomitic rocks along parts of the eastern part of the proposed Ferrum-Mookodi 400kV power line. The Kalahari sands which occur in large palaeo-valley systems that run in a north-south direction are part of the most extensive body of terrestrial sediments of Cenozoic age in southern Africa (Partridge et al., 2009).



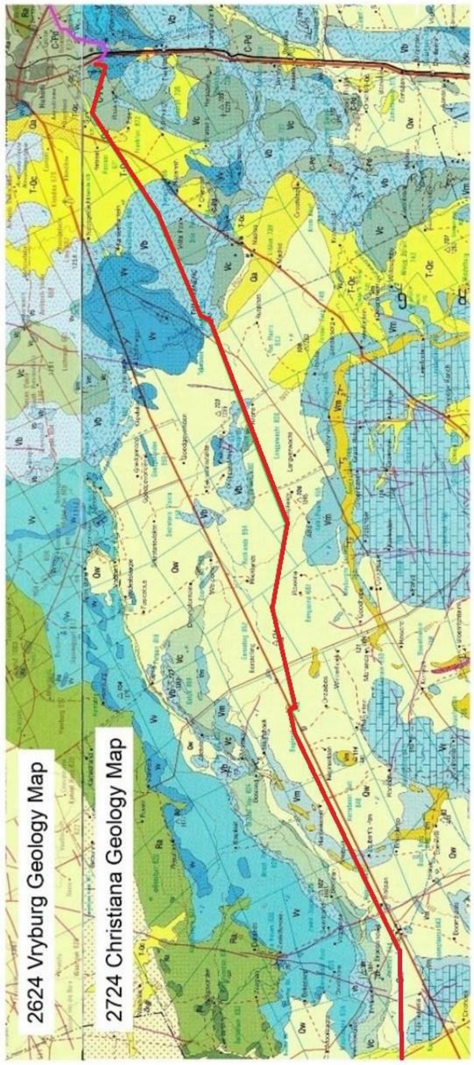




Figure 4: Geology of the eastern part of the proposed Ferrum-Mookodi 400kV power line and surroundings. Adapted from the 2722 Kuruman and 2724 Christiana 1: 250 000 Geology Maps (Council for Geoscience, 1979 & 1994)

GEOLOGICAL LEGEND FOR FIGURE 4

| | Lithology | Geological unit | | | Age |
|---|---|---|---|---|---|
| | Alluvium | | | | Quarter-nary |
| Qw | Aeolian sand | | | | |
| T-Qc | Calcrete | | | | Tertiary |
| Pe | Sandstone and shale | Ecca Group | | Karoo Super-group | Permian |
| C-Pd | Tillite, mudstone, shale, boulder shale and sandstone | Dwyka Group | | | Carboni-ferous |
| Vad | Yellow brown banded or massive jaspilite with crocidolite, flat pebble conglomerate | Daniëlskuil Formation | Asbestos Hills Subgroup | Ghaap Group of the Griqualand West Supergroup | Vaalium |
| Vak | Banded ironstone with subordinate crocidolite, ferruginated brecciated banded ironstone, brown jaspilite and chert | Kuruman Formation | | | |
| Vr | Dolomite, limestone and chert, interbedded shale, banded ironstone marker at top | Reivilo Formation | Campbell Rand Subgroup | | |
| Vm | Dolomite with stromatolitic limestone, interbedded shale, quartzite marker at top | Monteville Formation | | | |
| Vc | Shale, siltstone with interbedded dolomite | Clearwater Formation | Schmidtsdrif Subgroup | | |
| Vb | Oolitic and stromatolitic dolomite, interbedded quartzite, shale and flagstone | Boomplaas Formation | | | |
| Vv | Quartzite, flagstone, conglomerate, dolomite and shale, andesitic lava | Vryburg Formation | | | |
| Ra | Tholeiitic and calc-alkaline basalt and andesite, tuff and pyroclastic breccia | Allanrigde Formation of the Ventersdorp Supergroup | | | Randium |

# 6. Site visit

Ga-Mutsumi region with very high palaeosensitivity

Figure 5: Sandy soil covering the rocks of the Daniëlskuil Formation at 27°12'35.74"S 23°05'04.36"E

Figure 6: Eroded rocks of the Daniëlskuil Formation at 27°12'13.30"S 23°05'48.69"E

Kruisaar-Colston region with very high palaeosensitivity

Figure 7: Sandy soil covering the rocks of the Reivilo Formation north of Thotayamoku at 27°12'13.30"S 23°05'48.69"E

Figure 8: Sandy soil covering the rocks of the Reivilo Formation south of Kruisaar at 27°14'09.64"S 23°49'22.57"E


Figure 9: Sandy soil covering the rocks of the Reivilo Formation north of Colston at 27°13'40.94"S 23°51'21.97"E


Figure 10: Eroded dolomite east of Kokonye at 27°13'11.09"S 23°53'28.88"E

Figure 11: Sandy soil covering the rocks of the Reivilo Formation on the border of Northern Cape and Northwest at 27°12'57.76"S 23°54'50.29"E

Figure 12: Eroded dolomite of the Reivilo Formation exposed in a dry river bed at 27°12'57.65"S 23°55'29.16"E


Figure 13: Eroded dolomite of the Reivilo Formation at 27°12'56.11"S 23°56'05.01"E

Region southwest of Vryburg with a very high palaeosensitivity


Figure 14: Sandy soil covering the rocks of the Boomplaas Formation at 27°06'29.20"S 24°29'22.29"E

Figure 15: Eroded dolomite of the Boomplaas Formation at 27°04'19.58"S 24°38'03.97"E

Figure 16: Sandy soil covering the rocks of the Clearwater Formation at 27°05'48.27"S 24°36'48.11"E

# 7. Palaeontological potential of the study area

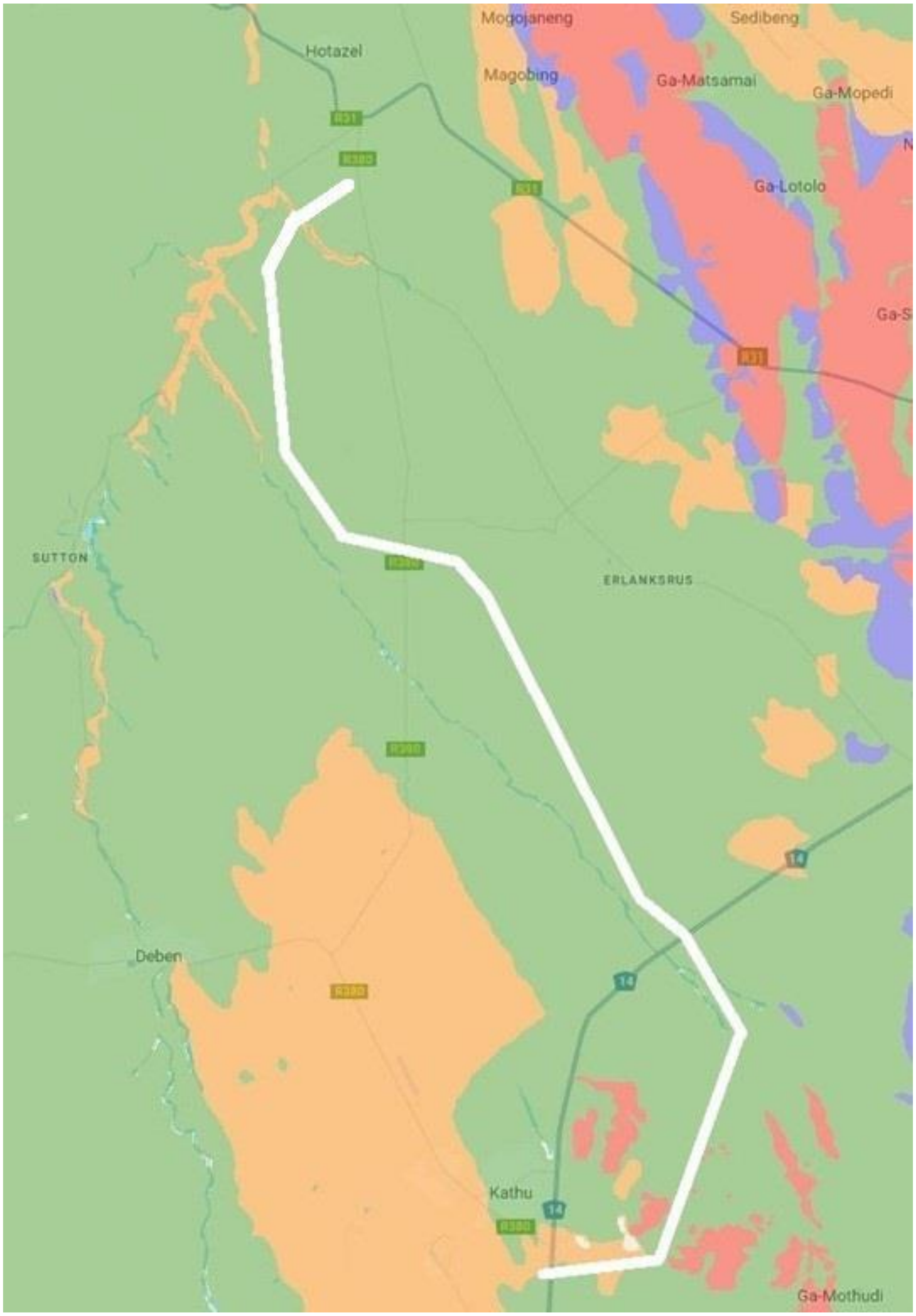



Figure 17: Palaeosensitivity map of the western part of the proposed Ferrum-Mookodi 400kV power line and surroundings (indicated by the white line) (SAHRA, 2024)

| KEY | | |
|---|---|---|
| COLOUR | SENSITIVITY | REQUIRED 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 |
| Blue | Low | No palaeontological studies are required however a protocol for finds is required |


Figure 18: Palaeosensitivity map of the eastern part of the proposed Ferrum-Mookodi 400kV power line and surroundings (indicated by the white line) (SAHRA, 2024)


Figure 19: Palaeosensitivity map of the proposed Ferrum-Mookodi 400kV power line (indicated by the white line) in the Ga-Motsemai region (SAHRA, 2024)

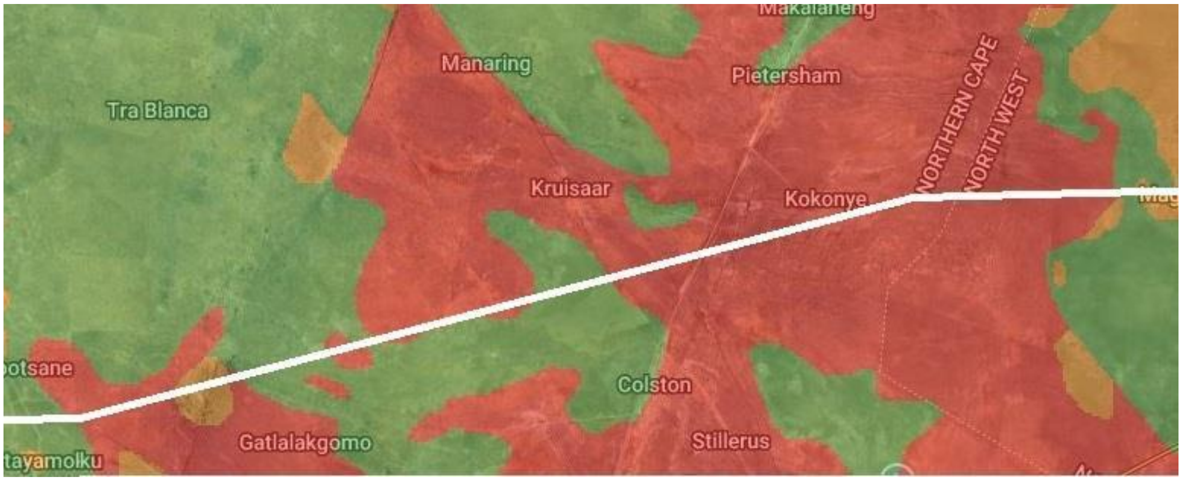



Figure 20: Palaeosensitivity map of the proposed Ferrum-Mookodi 400kV power line (indicated by the white line) in the Kruisaar-Colston region (SAHRA, 2024)

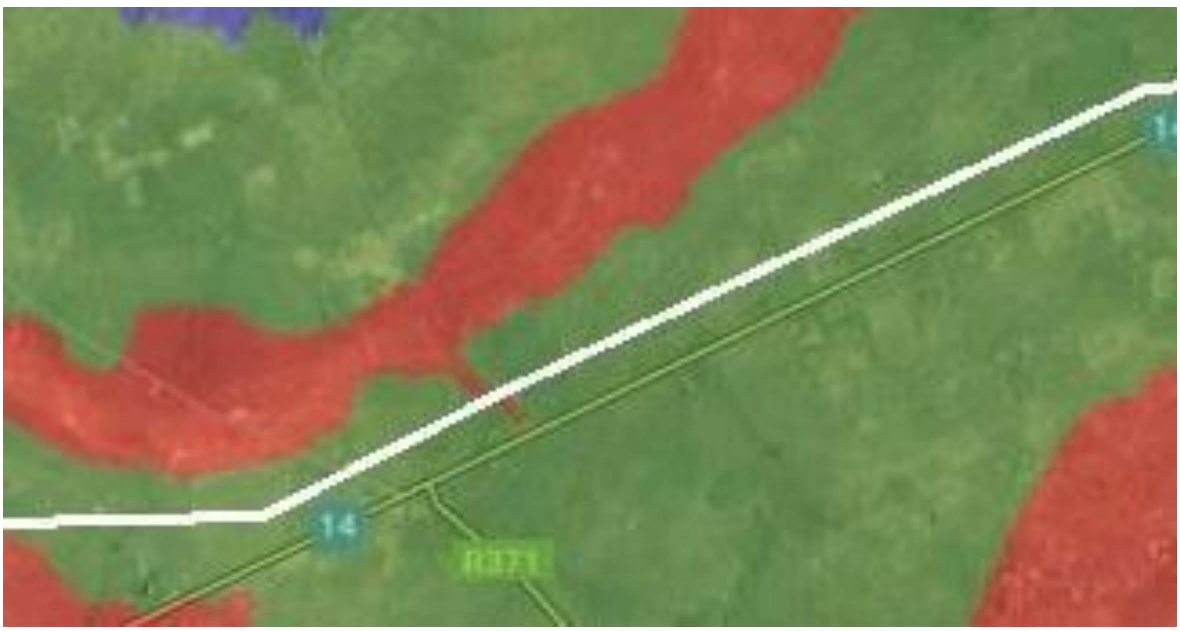



Figure 21: Palaeosensitivity map of the western part of the proposed Ferrum-Mookodi 400kV power line (indicated by the white line) near the N14 - R371 intersection (SAHRA, 2024)

The Late Archaean to Early Proterozoic carbonate rocks with siliclastics and iron formations of the Schmidtsdrif, Campbell Rand and Asbestos Hills Subgroups of the Ghaap Group of the Griqualand West Supergroup that occur in the western half of the study site contain a range of shallow marine and lacustrine stromatolites, oolites, pisolites in carbonates, filamentous and coccoid organic walled microfossils (eg. cyanobacteria). These geological units are considered to have a Very High Palaeontological Sensitivity (Almond & Pether, 2009).

The rocks of the Reivilo Formation are considered to be of Very High Palaeontological Sensitivity while the Monteville, Clearwater and Boomplaas

Formations are considered to have High Palaeontological Sensitivity (Groenewald & Groenewald, 2014).


Figure 22: Palaeosensitivity map of the proposed Ferrum-Mookodi 400kV power line (indicated by the white line) southwest of Vryburg (SAHRA, 2024)

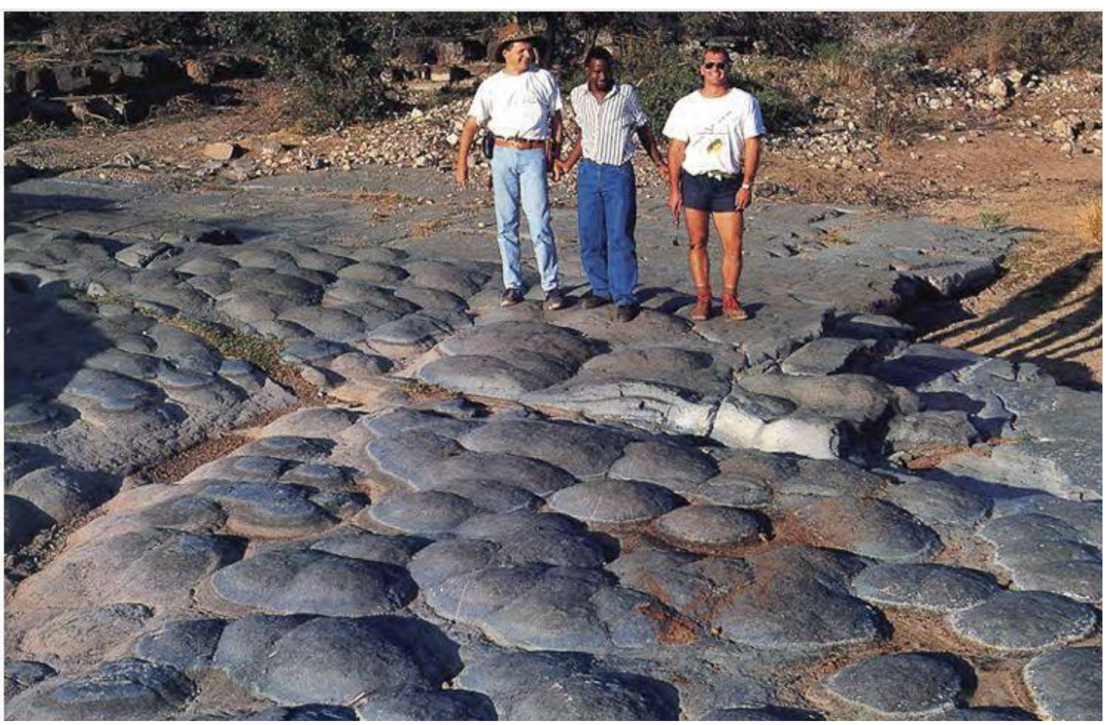


Figure 23: Stromatolite domes seen from above at Boetsap, Northern Cape (from Almond & Pether, 2009)

The 2.64 Ga aged carbonates of the Vryburg Formation of the Transvaal Supergroup contain stromatolites (Almond & Pether, 2009) and are considered to be of Moderate Palaeontological Sensitivity (Groenewald & Groenewald, 2014).

The Triassic to Quaternary-aged aeolian sand, dune sand, surface limestone, calcrete and alluvium in the study area may contain a wide range of fossils including bones, ostrich eggs and invertebrate fossils such as shells and have a Low, Medium to High Palaeontological Sensitivity (SAHRA, 2024; Groenewald & Groenewald, 2014).

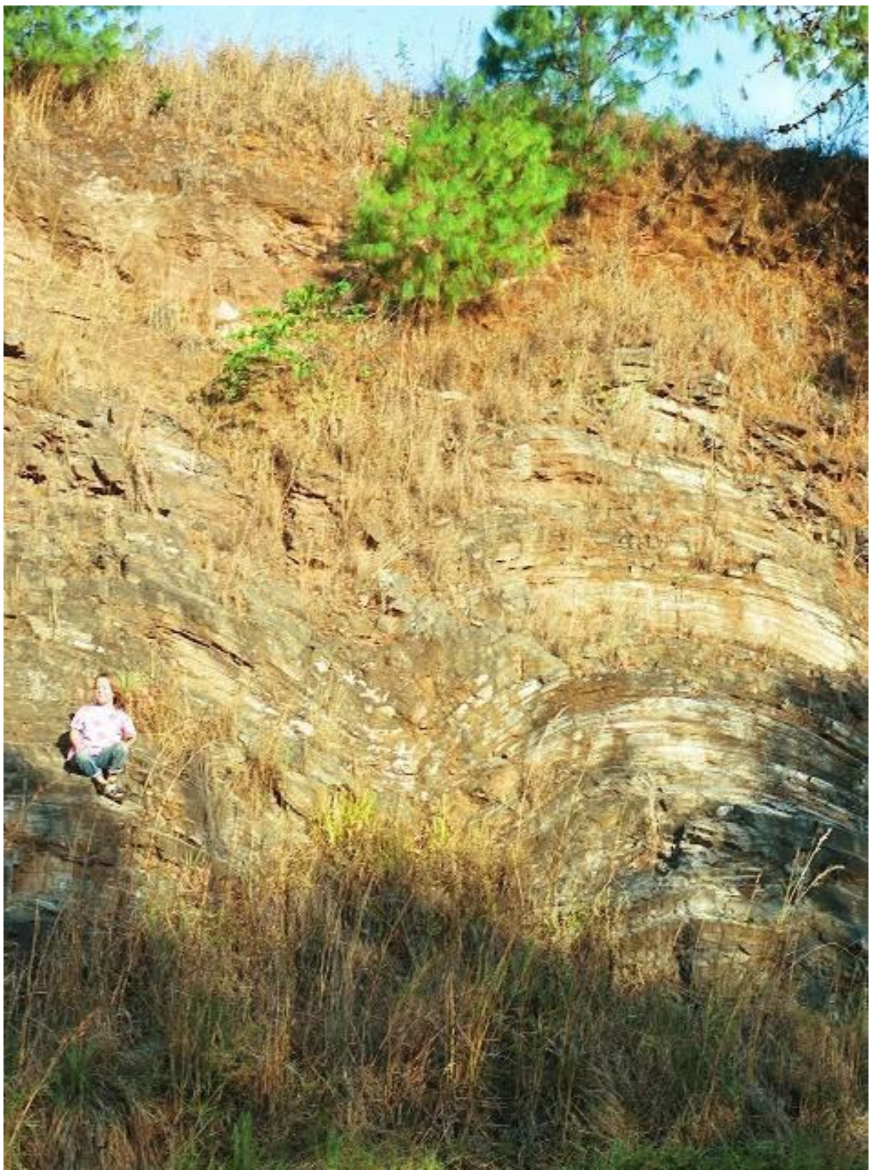


Figure 24: Giant stromatolite domes south of Sabie in Mpumalanga

Impact Assessment and Mitigation Measures (see Appendix 1 & 2)

The significance of impacts is determined using the following criteria:

Extent: The physical extent of impacts on potential palaeontological resources relates directly to the extents of subsurface disturbance. The extent of impacts for the proposed development is LOCALISED.

Duration: If fossils are found they should be preserved for posterity and the duration will therefore be PERMANENT. If the fossils are destroyed during development the impact will also be PERMANENT.

Intensity: The intensity/magnitude of a palaeontological impact is determined by the palaeontological sensitivity of the affected geological formation, together with the extent or volume of excavations made into the formation. The Vaalium-aged formations of the Ghaap Group of the Griqualand West Supergroup contain microfossils and some of the oldest and best-preserved stromatolites on earth.
The intensity of the impact on the fossils that may occur at the study sites is therefore considered to be HIGH.

Probability: (describes the likelihood of the impact actually occurring)
The probability of discovering stromatolites increases when the overburden, sand, calcrete and surface limestone and eroded rocks are stripped from the bedrock.
It is PROBABLE that intact stromatolites will be found in the study areas when development occurs.

| IMPACT ASSESSMENT TABLE | | | | | |
|---|---|---|---|---|---|
| Extent | Duration | Intensity | Probability | Significance | Status |
| 1 | 5 | 8 | 3 | (1+5+8) x 3 = 42 | MEDIUM |
| Significance Sum (Extent + Duration + Intensity) x Probability | | | | | |

Results:

The stromatolites of the Ghaap Group of the Griqualand West Supergroup contain some of the oldest and best-preserved stromatolites on earth. These stromatolites are the subject of scientific research on the palaeoclimatic conditions of the early earth, the origin of photosynthesis and the origin of the oxygen-rich atmosphere.

The occurrence of stromatolite-bearing dolomite was confirmed during the field assessment and the classification of the study area as having a Very High Palaeontological Sensitivity is supported. Where possible intact, well-preserved stromatolites should be preserved (see Figs. 23 & 24). The impact on the palaeontology of the study site is considered to be MEDIUM which implies that, although the stromatolites in the study are scientifically very important, the effect of the impact could be mitigated as long as the Change Find Procedures are followed.

References:

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# 8. Conclusion and recommendations:

The western part of the proposed Ferrum-Mookodi 400kV power line is mainly underlain by dune sand and aeolian sand that are considered with moderate palaeontological sensitivity. Short sections of the line and the Ferrum Substation are underlain by surface limestone that is considered to have a high palaeontological sensitivity.

The eastern part of the proposed Ferrum-Mookodi 400kV power line is mainly underlain by aeolian sand that has a moderate palaeontological sensitivity. There are however sections that are underlain by dolomite, limestone and chert of the Ghaap Group of the Griqualand West Supergroup that include rocks that are considered of Very High Palaeosensitivity. A section of the line that crosses over the hills west of Hotazel, in the Ga-Motsemai region, is underlain by the rocks of the Daniëlskuil Member of the Asbesberge Formation of the Asbestos Hills Subgroup that is also considered to have a very high palaeontological sensitivity. A small section, southwest of Vryburg, is underlain by calcrete that has a high palaeontological sensitivity and south of Vryburg there are rocks of the Dwyka Group of the Karoo Supergroup that has a moderate palaeontological sensitivity.

Although no significant fossil discovery was made during the field assessment, there is high probability of discovering scientifically important fossils when the sand, surface limestone, calcrete and overburden are removed during construction and uneroded rocks are exposed. The ECO needs to follow the stipulations as set out in the Chance Find Procedure in case well-preserved stromatolites are found during development.

**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),
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## APPENDIX 1: PALAEONTOLOGICAL SENSITIVITY RATING

(Palaeontological Sensitivity refers to the likelihood of finding significant fossils within a geologic unit)

**VERY HIGH:** Formations/sites known or likely to include vertebrate fossils pertinent to human ancestry and palaeoenvironments and which are of international significance.

**HIGH:** Assigned to geological formations known to contain palaeontological resources that include rare, well-preserved fossil materials important to on-going palaeoclimatic, palaeobiological and/or evolutionary studies. Fossils of land-dwelling vertebrates are typically considered significant. Such formations have the potential to produce, or have produced, vertebrate remains that are the particular research focus of palaeontologists and can represent important educational resources as well.

**MODERATE:** Formations known to contain palaeontological localities and that have yielded fossils that are common elsewhere, and/or that are stratigraphically long-ranging, would be assigned a moderate rating. This evaluation can also be applied to strata that have an unproven, but strong potential to yield fossil remains based on its stratigraphy and/or geomorphologic setting.

**LOW:** Formations that are relatively recent or that represent a high-energy subaerial depositional environment where fossils are unlikely to be preserved, or are judged unlikely to produce unique fossil remains. A low abundance of invertebrate fossil remains can occur, but the palaeontological sensitivity would remain low due to their being relatively common and their lack of potential to serve as significant scientific resources. However, when fossils are found in these formations, they are often very significant additions to our geologic understanding of the area. Other examples include decalcified marine deposits that preserve casts of shells and marine trace fossils, and fossil soils with terrestrial trace fossils and plant remains (burrows and root fossils)

**MARGINAL:** Formations that are composed either of volcaniclastic or metasedimentary rocks, but that nevertheless have a limited probability for producing fossils from certain contexts at localized outcrops. Volcaniclastic rock can contain organisms that were fossilized by being covered by ash, dust, mud, or other debris from volcanoes. Sedimentary rocks that have been metamorphosed by the heat and pressure of deep burial are called metasedimentary. If the metasedimentary rocks had fossils within them, they may have survived the metamorphism and still be identifiable. However, since the probability of this occurring is limited, these formations are considered marginally sensitive.

**NO POTENTIAL:** Assigned to geologic formations that are composed entirely of volcanic or plutonic igneous rock, such as basalt or granite, and therefore do not have any potential for producing fossil remains. These formations have no palaeontological resource potential.

(Adapted from Society of Vertebrate Paleontology (1995). Assessment and Mitigation of Adverse Impacts to Nonrenewable Paleontologic Resources - Standard Guidelines. News Bulletin 163: 22-27)

## APPENDIX 2:
## METHODOLOGY FOR ASSESSING THE SIGNIFICANCE OF IMPACTS

| | | | |
|---|---|---|---|
| EFFECT | **Extents/Spatial Scale E** | | |
| | Localized | At localized scale and a few hectares in extent. | 1 |
| | Study area | The proposed site and its immediate environs. | 2 |
| | Regional | District and Provincial level. | 3 |
| | National | Country. | 4 |
| | International | Internationally. | 5 |
| | **Duration/Temporal Scale D** | | |
| | Very short | Less than 1 year. | 1 |
| | Short term | Between 2 to 5 years. | 2 |
| | Medium term | Between 5 and 15 years. | 3 |
| | Long term | Exceeding 15 years and from a human perspective almost permanent. | 4 |
| | Permanent | Resulting in a permanent and lasting change. | 5 |
| | **Intensity/Magnitude (Palaeontological Sensitivity) I** | | |
| | No potential | Formations entirely lacking fossils such as igneous rocks. | 0 |
| | Marginal | Limited probability for producing fossils from certain contexts at localized outcrops. | 2 |
| | Low | Depositional environment where fossils are unlikely to be preserved, or are judged unlikely to produce unique fossil remains. | 4 |
| | Medium | Strong potential to yield fossil remains based on stratigraphy and/or geomorphologic setting. | 6 |
| | High | Formations known to contain palaeontological resources that include rare, well-preserved fossil materials. | 8 |
| | Very high | Formations/sites known or likely to include vertebrate fossils pertinent to human ancestry and palaeoenvironments and which are of international significance. | 10 |
| | **Probability/Likelihood P** | | |
| | Very improbable | Probably will not happen. | 1 |
| | Improbable | Some possibility, but low likelihood. | 2 |
| | Probable | Distinct possibility of these impacts occurring. | 3 |
| | Highly probable | The impact is most likely to occur. | 4 |
| | Definite | The impact will definitely occur regardless of prevention measures. | 5 |

| **SIGNIFICANCE = (E+D+I) P** | | |
|---|---|---|
| < 30 | LOW | The impact would not have a direct influence on the decision to develop in the area. |
| 30-60 | MEDIUM | The impact could influence the decision to develop in the area unless it is effectively mitigated. |
| > 60 | HIGH | The impact could render development options controversial or the project unacceptable if it cannot be reduced to acceptable levels; and/or the cost of management intervention will be a significant factor in mitigation. |