Palaeontological Impact Assessment for the Boskloof -Laingsburg 132kV line repairs and maintenance, Western Cape Province

Site Visit Study (Phase 2)

Subcontracted by

Ufefe Development Consultants

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1. Executive Summary

A Palaeontological Impact Assessment was requested for the Boskloof-Laingsburg 132kV line repairs and maintenance, Western Cape Province. Initially ESKOM will replace the towers/poles that were damaged in the high winds but the whole line has been assessed because other repairs and maintenance will be carried out in the near future. The section between Boskloof Substation (near Worcester) and the Laingsburg Substation were walked down at the end of July 2025 (winter). Most of the route is covered by sandy soil and there were no rocky outcrops, except for cutting at the intersection of the powerline and the road to Montagu (S 33° 29' 09.65"; E 19° 49' 15.29").
This site is a no-go area until a palaeontologist has searched for and collected any fossils. The rest of the route appears to be devoid of fossils.

To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development.

Along the western powerline route, it lies on some of the potentially very highly sensitive quartzites of the Cape Supergroup. Along the eastern section the route crosses some of the potentially very highly sensitive shales of the Ecca Group. Therefore, a Fossil Chance Find Protocol should be added to the MMP. Based on this information it is recommended that no further palaeontological impact assessment is required unless fossils are found by the contractor, environmental officer or other designated responsible person once excavations or drilling activities have commenced. Since the impact will be moderate to low, as far as the palaeontology is concerned, the project should be authorised.

ASPECT	SCREENING TOOL SENSITIVITY	VERIFIED SENSITIVITY	OUTCOME STATEMENT/ PLAN OF STUDY	RELEVANT SECTION MOTIVATING VERIFICATION
Palaeontology	Very High to Moderate	Moderate to Low	Palaeontological Impact Assessment	Section 7.2. SAHRA Requirements

2. **Declaration of independence and summary of expertise**.

a. Declaration

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Ufefe Development Consultants, Centurion, South Africa. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision-making process for the Project.

Specialist: Prof Marion Bamford

Signature: 

b. Expertise

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, mASSAf, PSSA
Experience: 36 years research and lecturing in Palaeontology; over 28 years PIA studies and over 450 projects completed.

c. Specialist declaration of independence and statement of objectivity for the assessment.

Declaration of Independence
I, Marion Bamford, declare that –
General declaration:

- I act as the independent palaeontology practitioner 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 from a heritage practitioner 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.

d. **Summary of the specialist's expertise**

I, Marion Bamford, a professional Palaeontologist with a PhD in Palaeontology (Wits University, 1990). I have more than 35 years of experience in palaeontological research and have published over 190 papers in peer-reviewed journals and published more than 14 scholarly book chapters. I reviewed manuscripts for international and local journals and also reviewed funding proposals for international funding bodies. Currently I am the Director of the Evolutionary Studies Institute, the only palaeontological institute in Southern Africa.

I have completed more than 450 palaeontological impact assessments (desktop and site visit studies) in the last 28 years for a variety of projects (solar energy projects, wind energy projects, powerlines, roads, infrastructure, housing and retail projects and from all over South Africa. I have been subcontracted by over 30 different companies. From my own projects and training provided by me and other staff in the ESI for Palaeontological Impact Assessments, I am familiar with the legislation.

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3. Project Background

A fault occurred when 7 suspension lattice towers collapsed on the section of the 132kV double circuit power line between Boskloof and Laingsburg Sub-Stations. The towers collapsed due to a high northern wind that occurred during a major local storm event which took place late in February of 2024. Eskom restored the power by installing temporal wood pole structures. Currently Eskom is planning to normalize the network on the 132kV Boskloof-Laingsburg power line by constructing new monopole structures and reconnecting the line.

The power line was constructed approximately 60 years ago prior to the promulgation of the National Environmental Management Act: Act No. 107 of 1998 and the associated regulations. According to our understanding Listing Notice 1, Activity 11 would have been triggered if this was a construction of a new power line and or development. The proposed repairs for the 132kV double circuit Boskloof-Laingsburg power line will be undertaken on the same servitude, using the same footprint and the capacity of the power line will remain the same. The only change would be the replacement of lattice towers with monopole structures which cover almost the same footprint when being installed, and the projected impact is minimal. The total length of the proposed power line repair is approximately 2700m. Existing access roads will be used to get to the working areas and no new access roads will be created and or required. However, a Basic Assessment and MMP is required for the entire line to ensure that future maintenance is undertaken without requiring approval.

The following is the proposed scope of work for the section of the power line which had collapsed:

1. Restore the section of the double circuit 132kV Boskloof-Laingsburg power line that fell down by constructing 8 new monopole towers on the same servitude and line route to normalize the supply.
2. Install 10kA OPGW between towers T270 and T278, connect to the newly installed joint boxes.
3. Replace the damaged earth peak on T278 (1LAI-TOU 178).
4. Decommission and remove existing temporary wood pole structures from the site.

Please note that future maintenance technical scope of work is unknow. However, assessment must be undertaken in anticipation of potential environmental impacts when maintenance activities are being undertaken on the entire line.

The powerline route is presented in Figures 1-3.

A Palaeontological Impact Assessment was requested for the Boskloof-Laingsburg 132 kV powerline route repair and maintenance project. To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a site visit Palaeontological Impact Assessment (PIA) was completed for the proposed development and is reported herein, according to the minimum standards (Table 1).

Table 1: National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and Environmental Impact Assessment (EIA) Regulations, 2014 (as amended) - Requirements for Specialist Reports (Appendix 6). Includes the requirements from GNR Appendix 6 of GN 326 EIA Regulation 2017.

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
ai	Details of the specialist who prepared the report,	Section 2
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Section 2
b	A declaration that the person is independent in a form as may be specified by the competent authority	Section 2
c	An indication of the scope of, and the purpose for which, the report was prepared	Section 3
ci	An indication of the quality and age of the base data used for the specialist report: SAHRIS palaeosensitivity map accessed – date of this report	Yes
cii	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 6
d	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
e	A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 4
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 6
g	An identification of any areas to be avoided, including buffers	N/A
h	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 7
j	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 8
k	Any mitigation measures for inclusion in the EMPr	Section 10, Appendix A
l	Any conditions for inclusion in the environmental authorisation	Section 10, Appendix A
m	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 10, Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 8

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	Relevant section in report
nii	If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Sections 8, 10
o	A description of any consultation process that was undertaken during the course of carrying out the study	EAP
p	A summary and copies of any comments that were received during any consultation process	EAP
q	Any other information requested by the competent authority.	None
2	Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/A

Figure 1: Google Earth map of the general area to show the relative land marks. The entire Touwsrivier-Laingsburg 132kV line route is shown by the blue line.

Figure 2: Google Earth Map of the western half of the powerline route, from Boskloof SS to Pietermeintjies Traction SS shown by the blue outline.

Figure 3: Google Earth Map of the eastern half of the powerline route, from Pietermeintjies Traction SS to Laingsburg SS, shown by the blue line.

4. Methods and Terms of Reference

The Terms of Reference (ToR) for this study were to undertake a PIA and provide feasible management measures to comply with the requirements of SAHRA.
The methods employed to address the ToR included:

1. Consultation of geological maps, literature, palaeontological databases, published and unpublished records to determine the likelihood of fossils occurring in the affected areas. Sources include records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases, e.g https://sahris.sahra.org.za/map/palaeo
2. Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance (*not applicable to this assessment*);
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*not applicable to this assessment*); and
4. Determination of fossils' representativity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (*not applicable to this assessment*).

5. Geology and Palaeontology

i. Project location and geological context

Note, the geology is divided into two sections, western (Figure 4) and the eastern (Figure 5).

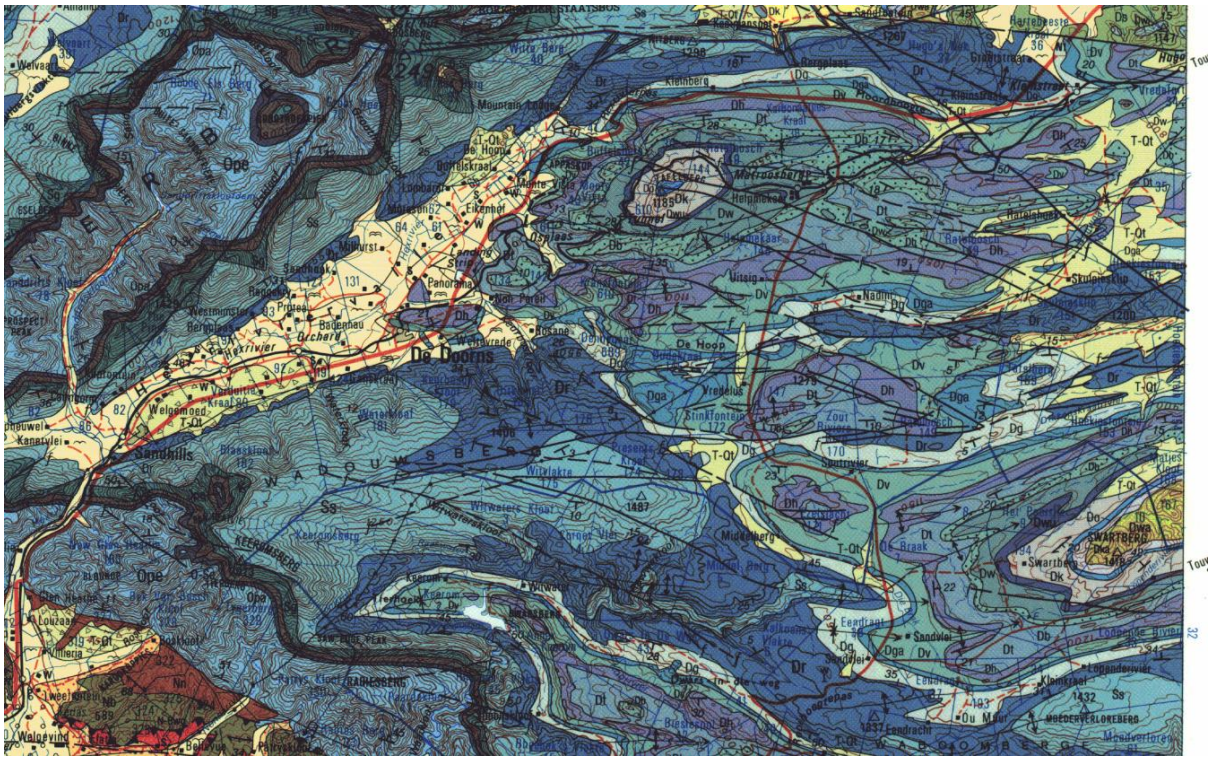


Figure 4: Geological map of the area along the western section from Worcester to west of Touwsrivier as indicated within the yellow rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 3319 Worcester.

Table 2: Explanation of symbols for the geological map and approximate ages (Johnson et al., 2006; Roberts et al., 2006; Thamm and Johnson, 2006). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary	Sands, alluvium, colluvium	Quaternary. Last 1.0Ma to Present
Cw	Waaipoort Fm, Lake Mentz Subgroup, Witteberg Group Cape SG	Mudrock, sandstone	Carboniferous
Cf	Floriskraal Fm, Lake Mentz Subgroup, Witteberg Group, Cape SG	Shale, sandstone	Carboniferous
Ck	Kweekvlei Fm, Lake Mentz Subgroup, Witteberg Group, Cape SG	Shale	Carboniferous
Dwi	Witpoort Fm, Witteberg Group, Cape SG	Sandstone	Devonian
Ds	Swartruggens Fm, Weltevrede Subgroup, Witteberg Group, Cape SG	Shale, siltstone, sandstone	Devonian
Dbl	Blinkberg Fm, Weltevrede Subgroup, Witteberg Group, Cape SG	Sandstone, siltstone	Devonian
Dwa	Wagon Drift Fm, Weltevrede Subgroup, Witteberg Group, Cape SG	Shale, siltstone, sandstone	Devonian
Dka	Karoopoort Fm, Bidouw Subgroup, Bokkeveld Group, Cape SG	Mudrock, siltstone, sandstone	Devonian
Do	Osberg Fm, Bidouw Subgroup, Bokkeveld Group, Cape SG	sandstone	Devonian
Dk	Klipbokkop Fm, Bidouw Subgroup, Bokkeveld Group, Cape SG	Mudrock, siltstone, sandstone	Devonian
Dwu	Wuppertal Fm, Bidouw Subgroup, Bokkeveld Group, Cape SG	Sandstone, siltstone	Devonian
Dw	Waaboomberg Fm, Bidouw Subgroup, Bokkeveld Group, Cape SG	Mudrock, siltstone, sandstone	Devonian
Db	Boplaas Fm, Ceres Subgroup, Bokkeveld Subgroup, Cape SG	Sandstone	Devonian
Dt	Tra-Tra Fm, Ceres Subgroup, Bokkeveld Subgroup, Cape SG	Mudrock, siltstone	Devonian
Dh	Hex River Fm, Ceres Subgroup, Bokkeveld Subgroup, Cape SG	Sandstone	Devonian
Dv	Voorsteenhoek Fm, Ceres Subgroup, Bokkeveld Subgroup, Cape SG	Mudrock, siltstone	Devonian
Dga	Gamka Fm, Ceres Subgroup, Bokkeveld Subgroup, Cape SG	Sandstone	Devonian

Symbol	Group/Formation	Lithology	Approximate Age
Dg	Gydo Fm, Ceres Subgroup, Bokkeveld Subgroup, Cape SG	Mudrock, siltstone	Devonian
Dr	Rietvlei Fm, Nardouw Subgroup, Table Mountain Group, Cape SG	Sandstone	Devonian
Ss	Skurweberg Fm, , Nardouw Subgroup, Table Mountain Group, Cape SG	Sandstone (thick bedded)	Silurian
Sg	Goudini Fm, , Nardouw Subgroup, Table Mountain Group, Cape SG	Sandstone (red, brown)	Silurian
O-Sc	Cedarberg Fm, Table Mountain Group, Cape SG	Shale, siltstone (Soom shale)	Ordovician
Opa	Pakhuis Fm., Table Mountain Group, Cape SG	Diamictite, sandstone	Ordovician
Ope	Peninsular Fm, Table Mountain Group, Cape SG	Sandstone	Ordovician
Og	Graafwater Fm, Table Mountain Group, Cape SG	Sandstone, siltstone, shale	Ordovician
Op	Piekenierskloof Fm, Table Mountain Group, Cape SG	Sandstone, conglomerate	Ordovician

The western part of the project (Figure 2) lies in the Cape Basin where the Ordovician to Devonian rocks of the Cape Supergroup are exposed (Figure 4), Much younger sands and alluvium of Quaternary age unconformably overlie the older rocks in the valleys and depressions.

The **Cape Supergroup** comprises a series of siliciclastic sediments that were deposited in a passive margin basin and is underlain by Cambrian rocks of the Saldanian Orogeny and Pan African depositional cycles. It is overlain by the Karoo Basin sequence (Thamm and Johnson, 2006). Representing some 170 million years of earth history, and up to 10km of strata, the Cape Supergroup has since been deformed by the Cape Orogeny. It extends along the southern Cape coast for about 1000km (ibid). There are three major subdivisions, the basal Table Mountain Group, Bokkeveld and Witteberg Groups ranging from the Early Ordovician (ca 500 Ma) to the Early Carboniferous (ca 330 Ma). The subgroups and formations differ slightly between the western and eastern regions.

The **Table Mountain Group** is sandstone dominated and was deposited in shallow marine, glacial and fluvial environments. No subgroup name is given to the basal formations but the upper formations, Silurian to Devonian, are grouped into the Nardouw Subgroup.

Five formations are recognised in the Ordovician component of this Group and west of ca 21°E are from the base upwards, the Pieknierskloof, Graafwater, Peninsula, Pakhuis and Cedarberg Formations. East of 21° only three formations are recognised, namely the Sardinia, Peninsula and Cedarberg Formations.

The Nardouw Subgroup comprises three formations, with the basal Goudini and Skurweberg Formations. The upper formation west of 21°E is known as the Rietvlei Formation, and to the east as the Baviaanskloof Formation.

The **Bokkeveld Group** has fossiliferous shale and sandstone units with a series of upward coarsening cycles that were attributed to repeated basin-ward progradation of wave-dominated deltas (Thamm and Johnson, 2006). Penn-Clarke et al. (2018) have reinterpreted the setting to rather have been a succession that accumulated in a storm-and-wave dominated deltaic palaeoenvironment.

The middle Devonian Bokkeveld Group has been divided into the basal **Ceres Subgroup** with five formations that stretch across the whole of the southern Cape. From the base upwards these formations are the Gydo, Gamka, Voorstehoek, Hex River, Tra-Tra and Boplaas Formations (Thamm and Johnson, 2006; Penn-Clarke et al., 2018a, b). To the west of 21°E the upper Bokkeveld **Bidouw Subgroup** five formations are recognised, the Waboom, Wupperthal, Klipbokkop, Osberg and Karoopoort Formations. To the east of 21°E the equivalent is the Traka Subgroup with three formations, the Karies, Adolphspoort and Sandpoort Formations (ibid).

The **Witteberg Group** is composed of sandstone and mudrock that was deposited in shallow marine, paralic and deltaic environments (Thamm and Johson, 2006). Three subgroups are recognised. The Devonian **Weltevrede Subgroup**, west of 22°E, has three formations, the Wagendrift, Blinkberg and Swartruggens Formations, and is overlain by the Witpoort Formation. In the eastern section only the Weltevrede Formation is recognised, and also overlain by the Witpoort Formation.

Weltevrede sG - West of 22°E the basal Wagendrift Formation is composed of bioturbated shale and siltstone with interbedded thin quartzitic sandstone. Invertebrate and trace fossils occur in this formation such as *Zoophycos, Spirophyton* and *Skolithos*. Marine invertebrates such as molluscs, trilobites and brachiopods occur. Plant fragments have been reported, such as psilophytes and lycopod stems (Boucot et al, 1983 in Thamm and Johnson, 2006).

The overlying Blinkberg Formation is made up of several prominent, white quartz arenites that are separated by subordinate siltstones. There are records of trace fossils and lycopod stems from this formation (Thamm and Johnson, 2006).

The upper formation of the Weltevrede Subgroup, the Swartruggens Formation, is composed of interbedded thin silty/sandy mudrock and sandstone layers, rhythmites, and generally two thick quartzitic sandstone units. The trace fossil *Zoophycos* has been reported by De Beer (1990) from this formation (ibid).

Between the Weltevrede and Lake Mentz Subgroups is the terminal Devonian formation the **Witpoort Formation** that is composed of quartzitic sandstones and minor mudrocks. Fragments of lycopod stems occur in this formation. This formation occurs both east and west of the 22°E line.

The Early Carboniferous **Lake Mentz Subgroup** and three formations occur across the whole region, and are known as the Kweekvlei, Floriskraal and Waaipoort Formations. In the west there are no middle Carboniferous rocks, but to the east the **Kommadagga Subgroup** comprises four formations, the basal Miller, Swartwaterpoort, Soutkloof and Dirkskraal Formations (Thamm and Johnson, 2006).

Kweekvlei Formation shales and dark mudstones represent offshore shelf and shelf transition zones and grades into the overlying Floriskraal Formation. The latter formation is composed of micaceous shales and sandstones, silty mudrock and arenites that were deposited in a shelf transition zone and shallow marine setting with coarsening upwards cycles (ibid). Overlying the Floriskraal Formation is the Waaipoort Formation that comprises dark-grey, lenticular bedded and massive mudrock with subordinate feldspathic sandstone. These sediments were deposited in shelf, lagoon, distal delta front and an interdistributary bay (Thamm and Johnson, 2006).

The basal facies of the Kommadagga Subgroup is the Miller Formation and it represents a glacial setting as it is composed of diamictites from a receding glacier. The overlying sandstone facies of the Swartwatersrspoort Formation represents beach and fluvioglacial deposits. The shales and rhythmites of the Soutkloof Formation are from a lacustrine (proglacial?) setting as well as off-shore shelf and prodelta slope in the middle Carboniferous. The upper sandstone, Dirkskraal Formation, sediments represent beach, shoreface and delta-front settings (Thamm and Johnson, 2006).

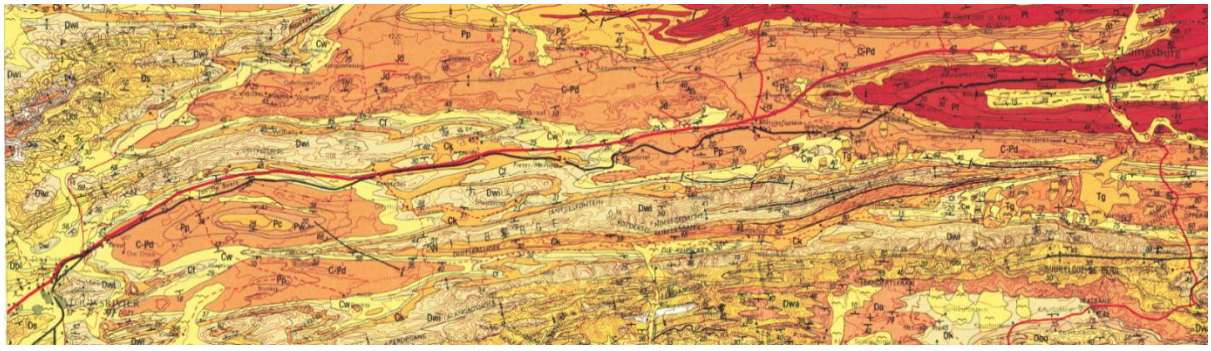


Figure 5: Geological map of the area along the eastern section from Touwsrivier to Laingsburg as indicated within the yellow rectangle. Abbreviations of the rock types are explained in Table 3. Map enlarged from the Geological Survey 1: 250 000 map 3320 Ladismith.

Table 3: Explanation of symbols for the geological map and approximate ages (Johnson et al., 2006). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary	Alluvium, sand, calcrete	Quaternary ca 1.0 Ma to Present
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, Ca 183. 180 Ma
Pwa/Pc	Waterford Fm, Ecca Group, Karoo SG (Carnarvon Fm) old	Sandstone, shale	Middle Permian ca 269 – 266 Ma

Symbol	Group/Formation	Lithology	Approximate Age
Pf	Tierberg/Fort Brown Fm, Ecca Group, Karoo SG	Brown to grey shale	Middle Permian ca 269 – 266 Ma
Pr	Laingsburg/Ripon Fm, Ecca Group, Karoo SG	Sandstone, shale	Middle Permian ca 269 – 266 Ma
Pc	Collingham Fm, Ecca Group, Karoo SG	shale	Middle Permian, ca 275 – 269 Ma
Pw	Whitehill Fm, Ecca Group, Karoo SG	Carbonaceous shale	Middle Permian, ca 283 – 275 Ma
Ppr	Prince Albert Fm, Ecca Group, Karoo SG	shale	Early Permian, ca 290- 283 Ma
C-Pd	Elandsvlei Fm, Dwyka Group, Karoo SG	Tillites, diamictites, sandstone , mudstone, shale	Early Permian, ca 298 – 290 Ma

The eastern part of the Boskloof-Laingsburg 132 kV powerline route lies in the western part of the Main Karoo Basin where the older rocks of the sequence are present (Figure 5). Much of the area is unconformably overlain by the much younger Quaternary sands and alluvium.

The Karoo Supergroup rocks cover a very large proportion of South Africa and extend from the northeast (east of Pretoria) to the southwest and across to almost the KwaZulu Natal south coast. It is bounded along the southern margin by the Cape Fold Belt and along the northern margin by the much older Transvaal Supergroup rocks. Representing some 120 million years (300 – 183Ma), the Karoo Supergroup rocks have preserved a diversity of fossil plants, insects, vertebrates and invertebrates.

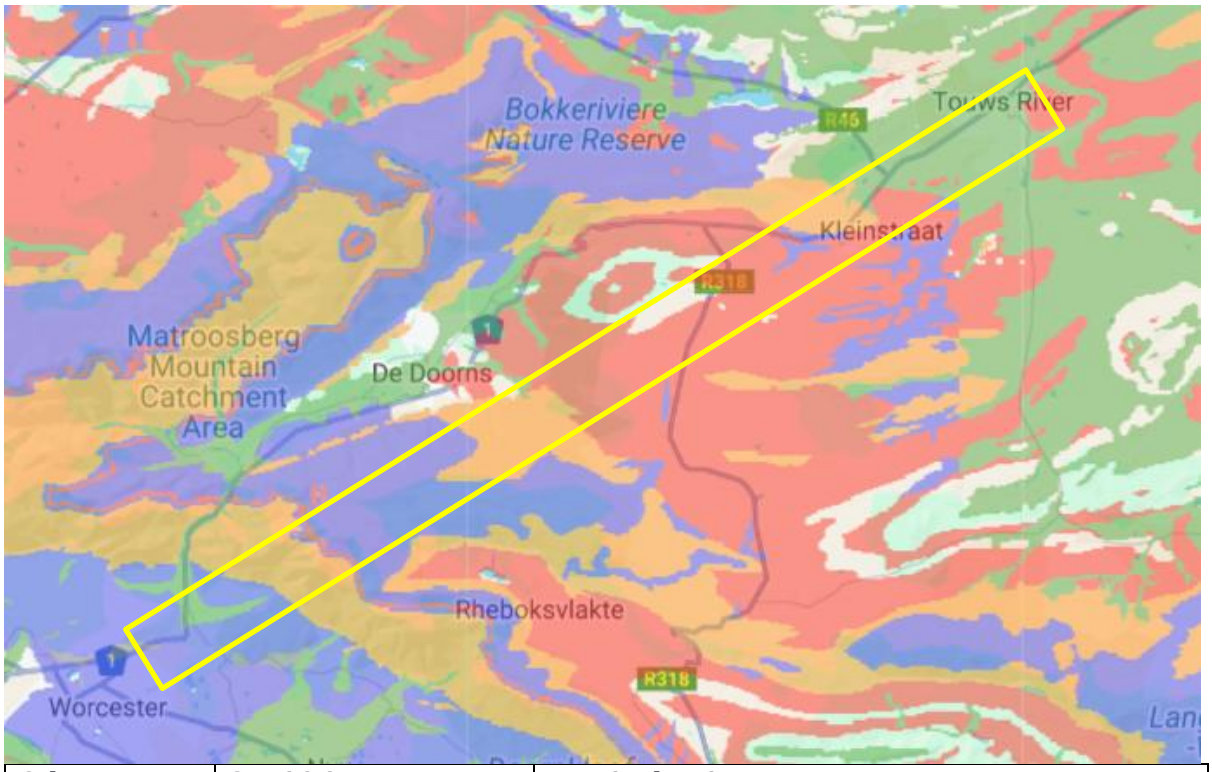
Overlying the Dwyka Group rocks are rocks of the Ecca Group that are Early Permian in age. There are eleven formations recognised in this group but they do not all extend throughout the Karoo Basin. In the west and central part are the following formations, from base upwards: Prince Albert Formation, Whitehill Formation, Collingham Formation, Laingsburg / Ripon Formations, Tierberg / Fort Brown Formations, and Waterford Formation. All of these sediments have varying proportions of sandstones, mudstones, shales and siltstones and represent shallow to deep water settings, deltas, rivers, streams and overbank depositional environments.

ii. Palaeontological context

The palaeontological sensitivity of the western area under consideration is presented in Figure 6. The powerline route is in the moderately sensitive Quaternary sands (green and the highly to very highly sensitive rocks of the Cape Supergroup (orange to red, respectively).

The time period of the Ordovician – Silurian – Devonian (about 485 – 350 Ma) is when the first terrestrial plants, bony fish and insects evolved and spread on the land, from precursors in the seas. The Cape Supergroup represents this period, and although southern Africa (in the middle of Gondwanaland) was positioned over or close to the South Pole, and was covered by a series of ice sheets (Visser, 1989; Isbell et al., 2012),

some of the fine-grained shallow water and marginal mudstones and siltstones have fossils preserved within them (Plumstead, 1969; Theron, 1972; MacRae, 1999; Thamm and Johnson, 2006; Penn-Clarke et al., 2018). With the repeated cycles of sealevel rise and fall and resulting shifts from marine to shoreline to fluvial and delta settings and back again, there is a complex series of environments with the resident faunas.



Colour	Sensitivity	Required Action
RED	VERY HIGH	field assessment and protocol for finds is required
ORANGE/ YELLOW	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
GREY	INSIGNIFICANT/ZERO	no palaeontological studies are required
WHITE/CLEAR	UNKNOWN	these areas will require a minimum of a desktop study. As more information comes to light, SAHRA will continue to populate the map.

Figure 6: SAHRIS palaeosensitivity map for the western section route of the Boskloof-Laingsburg 132 kV powerline route shown within the yellow rectangle.

The Ordovician lower Table Mountain Group preserves trace fossils, and invertebrates such as brachiopods, trilobites, eurypterids, conodonts and chitinozoans. There are records of invertebrate fossils, known as the **Malvinokaffric Faunal Assemblage**, in the Silurian – early Devonian upper Nardouw Subgroup and the whole of the Bokkeveld Group, while the Witteberg Group has records of fish and plants as well as invertebrates such as brachiopods, bivalves, gastropods and trilobites. More recent research has shown that the Malvinokaffric fauna of Gondwanaland (Bokkeveld Group) is somewhat different from the northern hemisphere fauna (Penn-Clarke et al., 2018b).

Witteberg Group plants comprise fragments of the lycopods *Palaeostigma sewardii* and *Haplostigma irregularis* (both taxa need revising). Collections were made by Johannes Theron and farms are listed in Anderson and Anderson (1985, p. 21) but do not include this route.

From the Waaipoort Formation plant remains, such as lycopods stems and ferns, and invertebrate remains such as giant eurypterids and palaeoniscoid and acanthodian fish, have been described (in Thamm and Johnson, 2006).

The Ceres Subgroup has abundant marine benthic (bottom-dwelling) invertebrate fossils such as brachiopods, bivalves, trilobites, cephalopods, crinoids, ophiutoids, hyoliths, cricoconarids, corals and gastropods (Hiller and Theron, 1988; Theron and Johnson, 1991; Thamm and Johnson et al., 2006; Penn-Clarke et al., 2018a). These marine fossils occur mostly in the mudrock units while plant fossils occur in the sandstone units. Some units also show extensive bioturbation based on the presence of trace fossils of burrows, such as *Planolites, Skolithos* and *Arenicolites.*

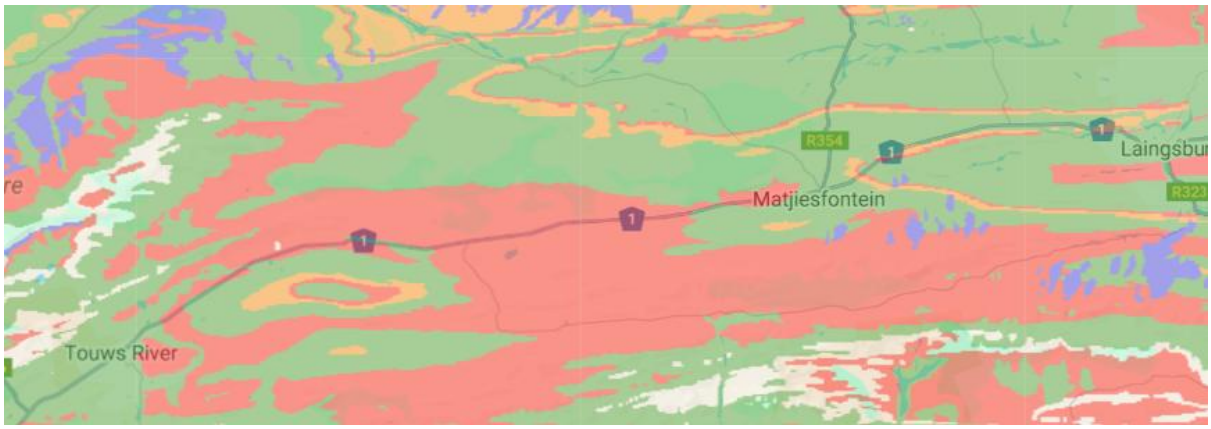


Figure 7: SAHRIS palaeosensitivity map for the eastern route section of the Boskloof-Laingsburg 132 kV powerline route, shown within the yellow rectangle. Colour coding as for Figure 6.

West and east of 24°E, the Ecca Group comprises the basal **Prince Albert Formation**, in the southwestern half of the Karoo Basin, and comprises shales and silty shales. In the west where is overlies the Dwyka Group there are fining upward sequences of sandstones, siltstones, silty shales and rhythmites. Marine fossils such as cephalopods, lamellibranches and brachiopods, and fragmentary plant fossils and palaeoniscoid fish remains (Douglas area; McLachlan and Anderson, 1973). The southern facies of the Prince Albert Formation has darker shales, chert and carbonaceous nodules produced under a reducing environment, with rare marine fossil fragments (Johnson et al., 2006).

The next facies is the **Whitehill Formation** which is composed of mudrocks that weather white on the surface, so they are easy to recognise. Un-weathered mudstones are dark. This western stratum can be considered a distal equivalent of part of the Vryheid formation in the central and western part of the Karoo Basin (Johnson et al., 2006), but as a distal equivalent of the Pietermaritzburg Formation (Rubidge, 2005). The Whitehill Formation has marine fossils such as the swimming reptile *Mesosaurus* (Oelofson and

Araujo, 1987; Modesto, 2010) and the arthropod *Notocharia/Spirophyton*, as well as some terrestrial fossils of the *Glossopteris* flora typical of the Vryheid Formation.

The next stratum is the **Collingham Formation** and its outcrops are confined to the southern and western margins of the Karoo Basin. These show centimetre-scale finely alternating layers of hard, dark grey siliceous mudrocks and soft yellow tuffs (K-bentonite). Trace fossils (trackways) and rare pollen have been recorded from the Collingham Formation (Johnson et al., 2006; Barbolini et al., 2018, respectively).

The Collingham Formation is overlain by the **Vischkuil Formation** in the west and by the **Laingsberg Formation** in the west-central. The former is predominantly argillaceous and becomes more arenaceous to the east where it grades into the Ripon Formation (Johnson et al., 2006). The Laingsburg Formation has four sandstone-rich intervals separated by shale units, in general (Johnson et al. 2006). The environment has been interpreted as turbidites in a sub-marine fan deposit. Trace fossils of grooves produced by ventral spines of fish dragging on the floor have been recorded (Anderson, 1974).

The thick **Ripon Formation** consists of poorly sorted, fine- to very fine-grained lithofeldspathic sandstone alternating with dark-grey clastic rhythmites and mudrock (Johnson et al., 2006). Volcanic rocks have contributed to the sandstones. Trace fossils of trackways (Anderson, 1974) occur along with ripplemarks. Johnson et al. (2006) mentioned fossil logs but no references were provided.

The overlying **Fort Brown Formation** extends west and east of the 24°E line but outcrops are confined to the southern margin of the basin. It is composed of rhythmites and mudrock with minor sandstone intercalations and displays an overall upward coarsening pattern (Johnson et al., 2006). The depositional environment was that of prodelta and distal-delta fronts. Trace fossils in this formation are those of worm burrows, *Cruziana* and *Skolithos* and indicate a progressive decrease in water depth in addition to the evidence from an increase in grain size and ripple marks (Johnson et al., 2006).

In the southern part of the basin the **Waterford Formation** comprises alternating very fine-grained lithofeldspathic sandstones and mudrock or clastic rhythmite units. These sediments represent fairly shallow water accumulations with deformation and dewatering features. A delta front setting is implied and trace fossils of trails, tubes and burrows have been reported (Johnson et al., 2006). Structures indicate a shoreline facies.

In the westernmost part of the basin the **Tierberg Formation** is predominantly argillaceous. In the northwest of its occurrence where it is in contact with the Collingham or Whitehill Formations, it grades up into the arenaceous overlying Waterford Formation (Johnson et al., 2006). Trace fossils of *Nereites, Planolites* and *Zoophycus* can be found in the fine mudstones (Johnson et al., 2006).

iii. Site visit observations.

The powerline route walked down from Laingsburg westwards then south-westwards to the Boskloof Substation from 28-30 July 2025 (winter). Not all sections were accessible, especially the steep hillsides. Observations are listed in the table below (Table 4). GPS

points are recoded at various stops along the way. A selection of photographs is shown in Figures 8-23. No fossil were found along the powerline route except for one site (Stop 11, Figure 21).

Table 4: Coordinates for the site visit stops, observations and relevant figures.

Site, GPS	Observations	Figures
Point 1 S 33° 11' 37.94" E 20° 52' 19.03"	Near Laingsburg Substation. View of the powerlines, veld with no rocky outcrops and the nearby buildings	Geol 5 Palaeo 7 Site 8
Point 2 S 33° 13' 59.69" E 20° 39' 04.11"	East of Matjiesfontein. General view of the area, powerlines in the distance, cell phone tower.	Geol 5 Palaeo 7 Site 9
Point 3 S 33° 13' 57.40" E 20° 35' 20.67"	Near Matjiesfontein SS. Gravel common on the surface. Windmill near the gate. No rocky outcrops and no potential fossils sites	Geol 5 Palaeo 7 Site 10, 11
Point 4 S 33° 16' 03.25" E 20° 27' 26.18"	Southeast line from Matjiesfontein SS. Sandy soils cover the area.	Geol 5 Palaeo 7 Site 12
Point 5 S 33° 15' 08.92" E 20° 25' 319.58"	Near Pietermeintjies Tract Substation. General view along the powerline, gravel cover common and typical Karoo semi-arid vegetation.	Geol 5 Palaeo 7 Site 13, 14
Point 6 S 33° 10' 01.49" E 20° 11' 21.21"	East of Quarry Traction Substation. General views. Sandy roads retaining water after recent rains. No rocky outcrops along the powerline.	Geol 5 Palaeo 7 Site 15
Point 7 S 33° 17' 26.74" E 20° 09' 07.68"	Southwest of Quarry Tract SS, along a farm road. General views of the area. No rocky outcrops.	Geol 5 Palaeo 7 Site 16
Point 8 S 33° 21' 46.57" E 20° 02' 36.03"	Intersection of Touw River and the powerline. Low rise hill. Sandy soils cover the area along the powerline.	Geol 5 Palaeo 7 Site 17
Point 9 S 33° 23' 09.61" E 19° 56' 25.00"	Along the powerline, no markers. Sisal planted near the entrance gate. Sandy roads and a building in a cleared area. No rocky outcrops.	Geol 4 Palaeo 6 Site 18
Point 10 S 33° 28' 21.86" E 19° 50' 55,64"	East of the Montagu road. Cutting expose the shales . More views of the shales and fine laminations. No invertebrate fossils or traces seen.	Geol 4 Palaeo 6 Site 19, 20
Point 11 S 33° 29' 09.65" E 19° 49' 15.29"	Intersection of Road to Montagu and the powerline, road cutting with fossil. Possible ammonoid but only specimen in the cutting along side the road and powerline.	Geol 4 Palaeo 6 Site 21
Point 12 S 33° 37' 40.87" E 19° 33' 12.23"	East of Boskloof SS and to the outskirts of the SS. Gravel on the rad in the surrounds below the powerline.	Geol 4 Palaeo 6 Site 22, 23

Figure 8: Boskloof-Laingsburg 132 kV powerline route site photographs. Stop 1 and beyond - Near Laingsburg Substation,

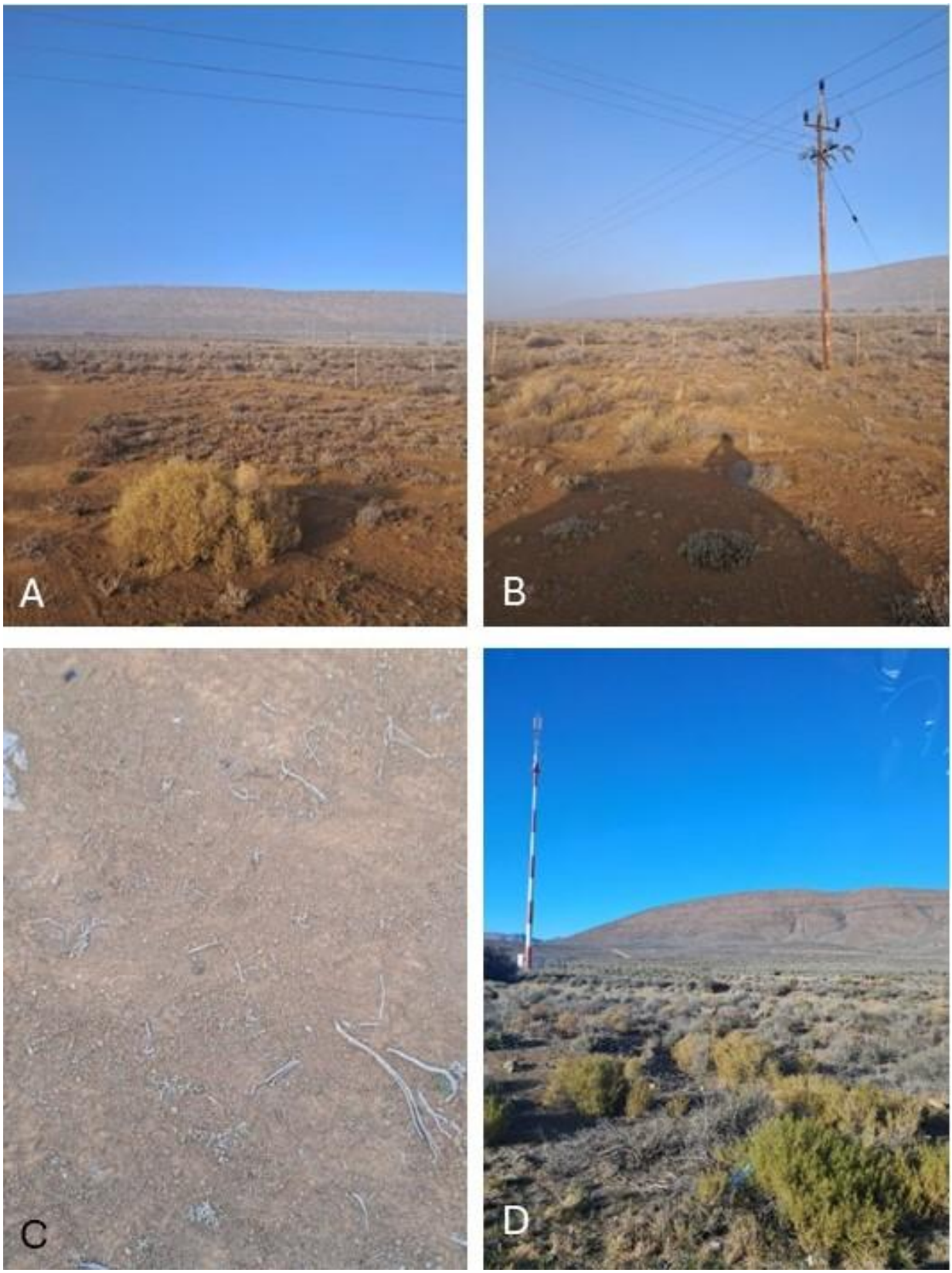


Figure 9: Site photographs East of Matjiesfontein

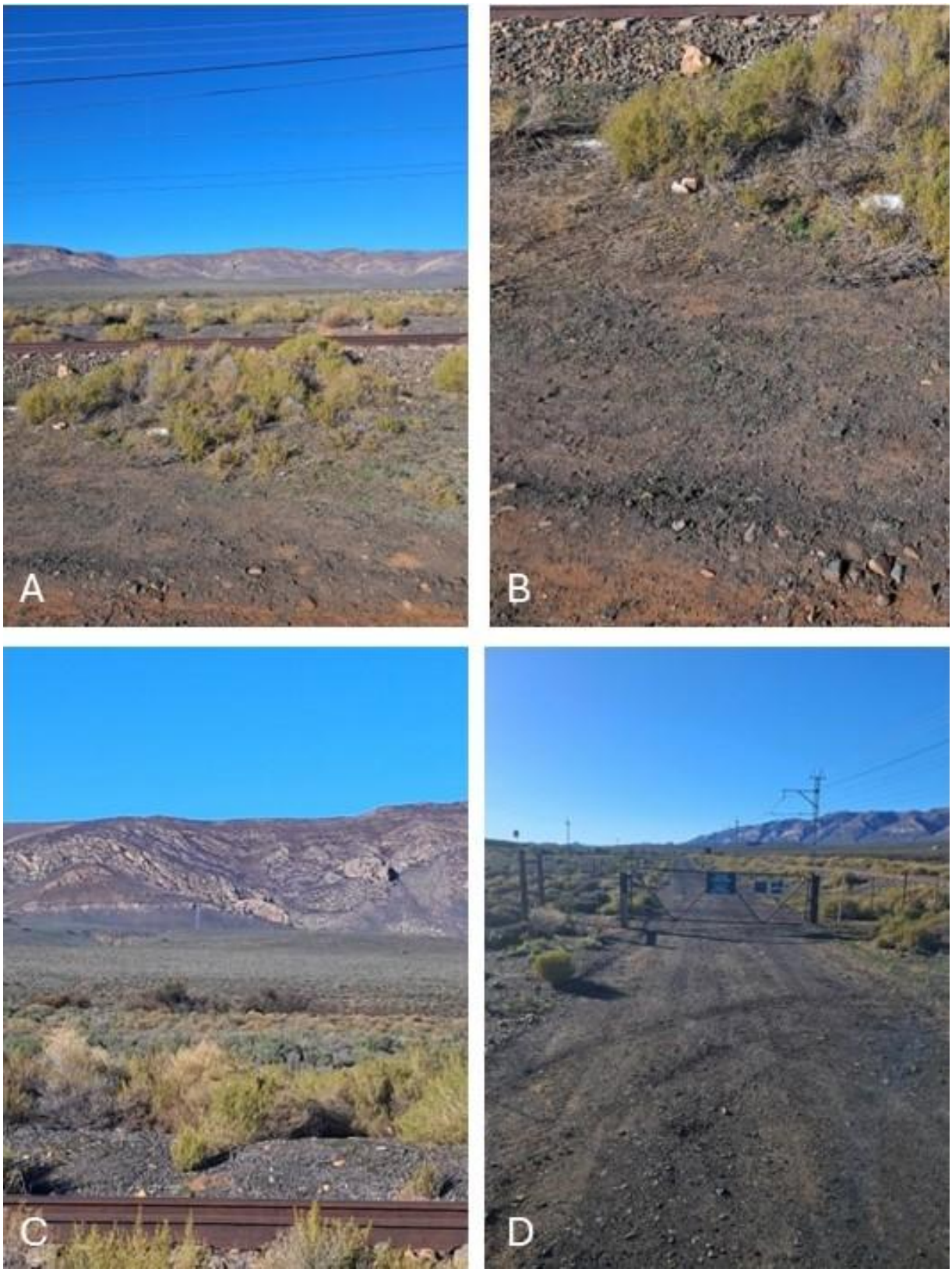


Figure 10: Stop 3 - Near Matjiesfontein SS

Figure 11: Near Matjiesfontein SS

Figure 12: Southeast line from Matjiesfontein SS.

Figure 13: Near Pietermeintjies Tract Substation

Figure 14: West of Pietermeintjies Tract Substation

Figure 15: East of Quarry Traction Substation

Figure 16: Southwest of Quarry Tract SS, along a farm road

Figure 17: Intersection of Touw River and the powerline

Figure 18: Along the powerline, no markers

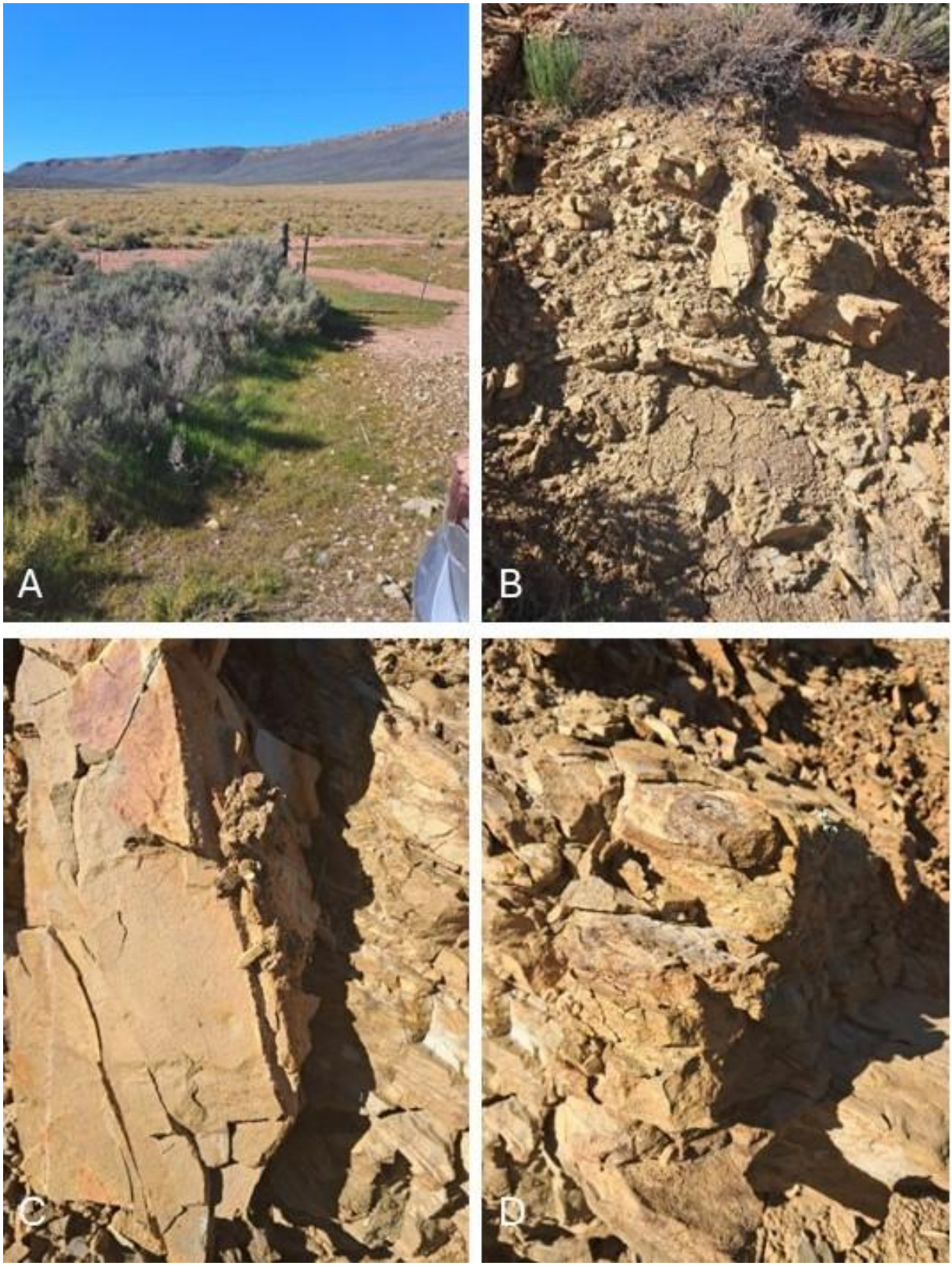


Figure 19: East of the Montagu road

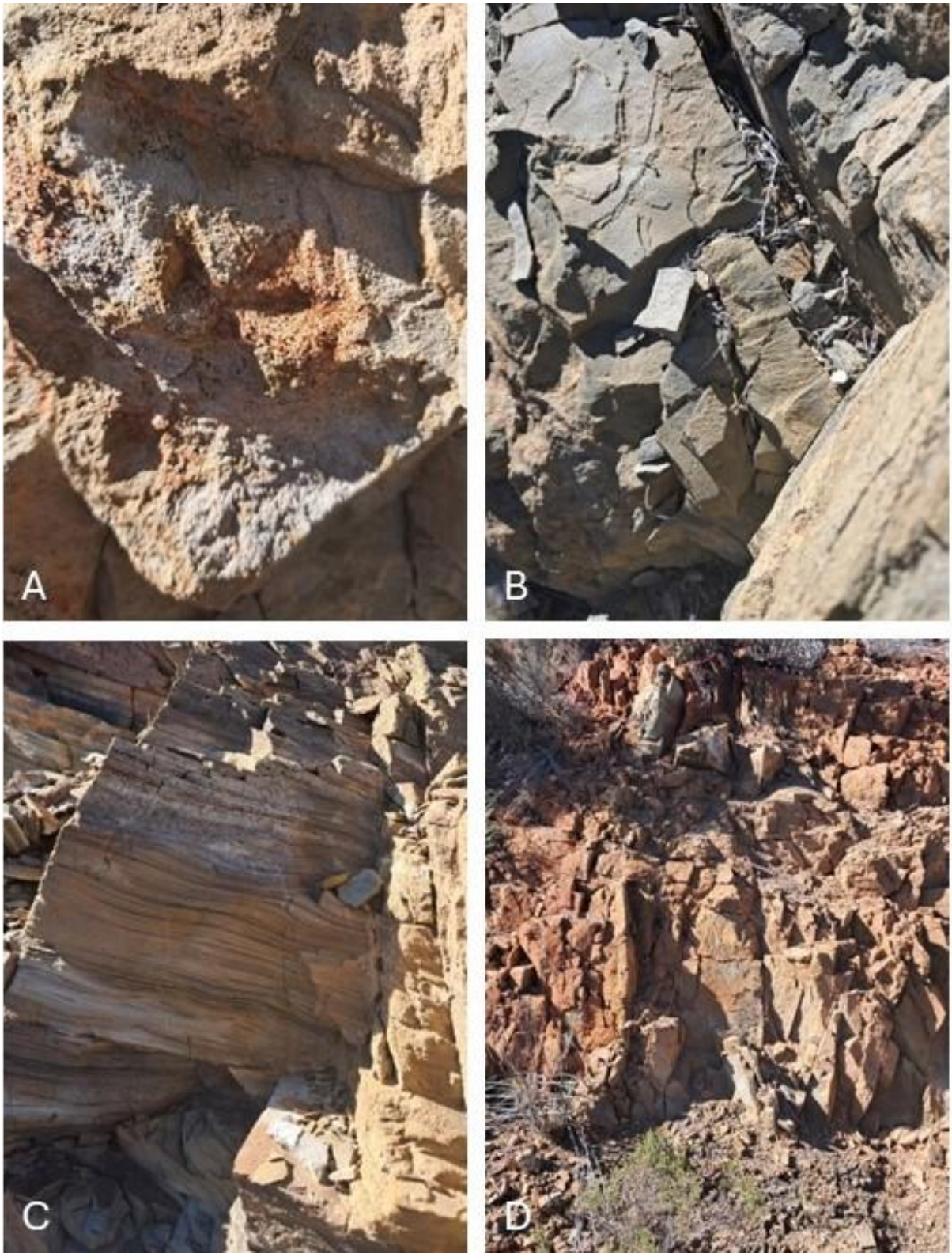


Figure 20: Further East of the Montagu road

Figure 21: Intersection of Road to Montagu and the powerline, road cutting with fossils

Figure 22: East of Boskloof SS and to the outskirts of the SS

Figure 23: Around Boskloof SS.

6. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 5:

Table 5a: Criteria for assessing impacts

PART A: DEFINITION AND CRITERIA		
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	**L**	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national
PROBABILITY (of exposure to impacts)	**H**	Definite/ Continuous
	M	Possible/ frequent
	L	Unlikely/ seldom

Table 5b: Impact Assessment

PART B: Assessment		
SEVERITY/NATURE	**H**	-
	M	-
	L	Soils do not preserve fossils; so far there are no records from the various formations of plant or animal fossils in this region so it is very unlikely that fossils occur on the site. The impact would be negligible
	L+	-
	M+	-
	H+	-
DURATION	**L**	-

PART B: Assessment		
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	**L**	Since the only possible fossils within the area would be fossil invertebrates and traces in the Cape Supergroup strata and the Ecca strata in the shales and mudstones, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	It is extremely unlikely that any fossils would be found in the loose soils and sands that cover the area. It is possible that invertebrate fossils could be found in various strata, below the ground surface, therefore, a Fossil Chance Find Protocol should be added to the eventual EMPr**-**
	L	.

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks are the correct age and type to contain fossils but only one fossil was found in a cutting alongside the powerline. Since there is a small chance that fossils occur below the soils in unweathered shales and quartzites and may be disturbed, a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is low.

7. Assumptions and uncertainties

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the dolomites, sandstones, shales and sands are typical for the country and only some might contain early fossil plants, insect, and invertebrate material. The sands of the Quaternary period would not preserve fossils.

8. Recommendation

Based on the site visit and walkdown in late July 2025 (winter) and the lack of any previously recorded fossils from the route, it is extremely unlikely that any fossils would be preserved in the overlying soils of the Quaternary. There is a small chance that fossils may occur below ground in the shales of the Ecca Group or the quartzites of many of the Cape Supergroup Formations, so a Fossil Chance Find Protocol should be added to the MMP. If fossils are found by the environmental officer, or other responsible person once new excavations for pole foundations and infrastructure have commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample. The impact on the palaeontological heritage would be low, as far as the palaeontology is concerned, so the project should be authorised.

The only no-go area is the cutting near the intersection of the powerline and the road to Montagu, Point 11 - S 33° 29' 09.65" E 19° 49' 15.29". The rest of the route does not appear to have fossils on the land surface.

ASPECT	SCREENING TOOL SENSITIVITY	VERIFIED SENSITIVITY	OUTCOME STATEMENT/ PLAN OF STUDY	RELEVANT SECTION MOTIVATING VERIFICATION
Palaeontology	Very High to Moderate	Moderate to Very Low	Palaeontological Impact Assessment	Section 7.2. SAHRA Requirements

9. References

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10. Fossil Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations / drilling activities begin.

1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations commence.
2. When excavations begin the rocks and discard must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (invertebrates, traces, plants, insects or bone) should be put aside in a suitably protected place. This way the project activities will not be interrupted.
3. Photographs of similar fossils must be provided to the developer to assist in recognizing the fossil plants, vertebrates, invertebrates or trace fossils in the shales and mudstones (for example see Figures 24-26). This information will be built into the EMP's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. If there is any possible fossil material found by the developer/environmental officer then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a HWC permit must be obtained. Annual reports must be submitted to HWC as required by the relevant permits.
7. If no good fossil material is recovered then no site inspections by the palaeontologist will be necessary. A final report by the palaeontologist must

be sent to HWC once the project has been completed and only if there are fossils.

8. If no fossils are found and the excavations have finished then no further monitoring is required.

11. **Appendix A** – Examples of fossils from the Cape Supergroup

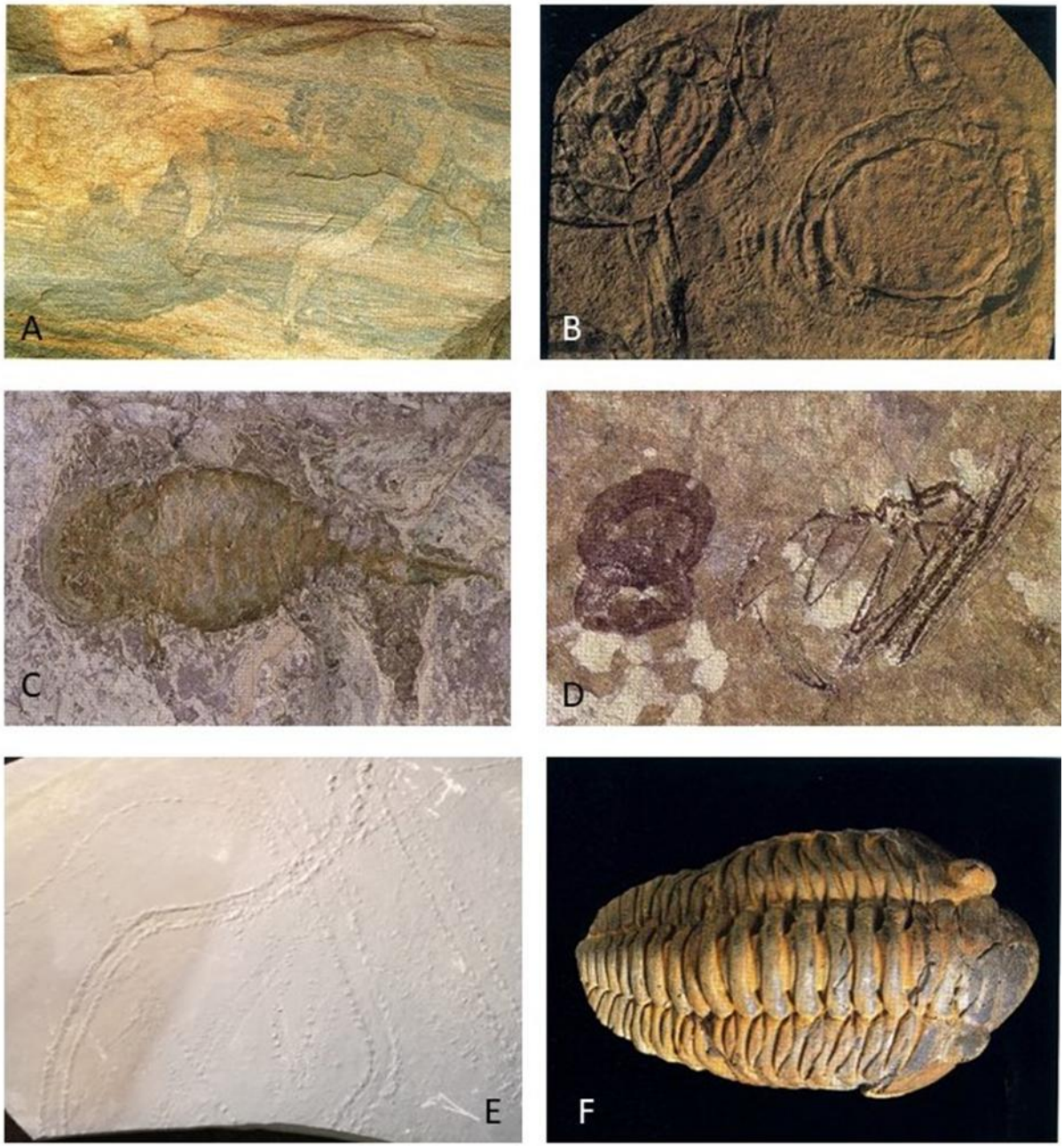

Figure 24: Photographs of trace fossils and invertebrates from the Table Mountain Group (Silurian-Devonian), to assist the responsible person in the field.

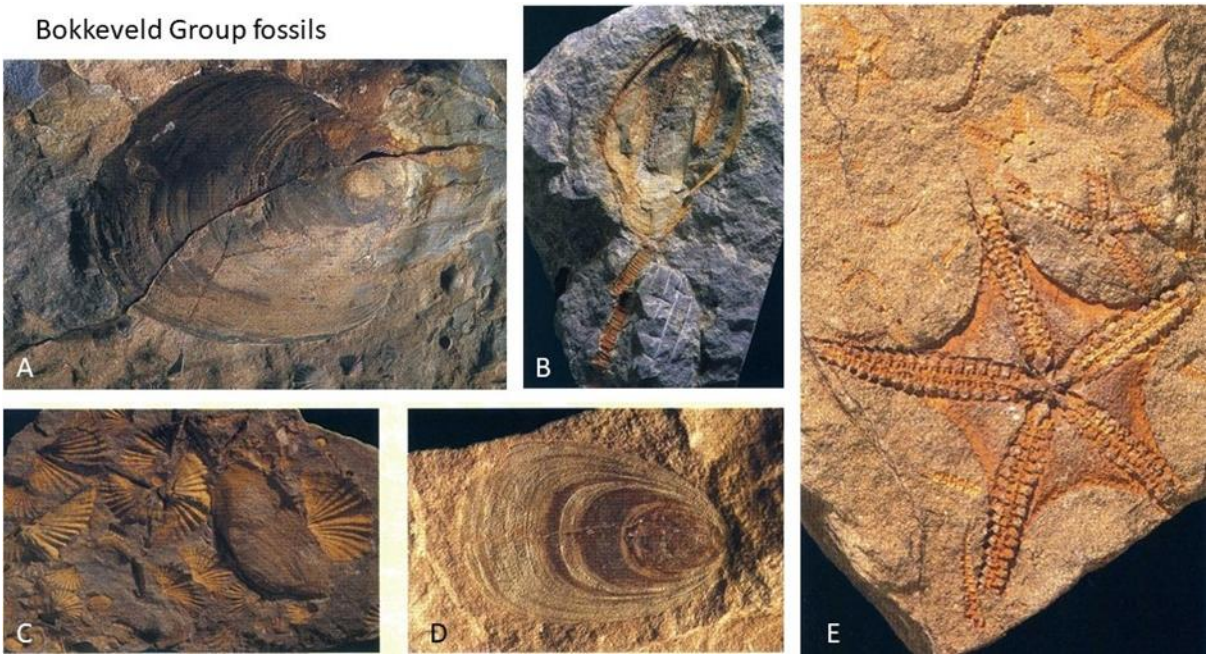

Figure 25: Photographs of invertebrate and shelly fossils from the Bokkeveld Group (Devonian), to assist the responsible person on site.

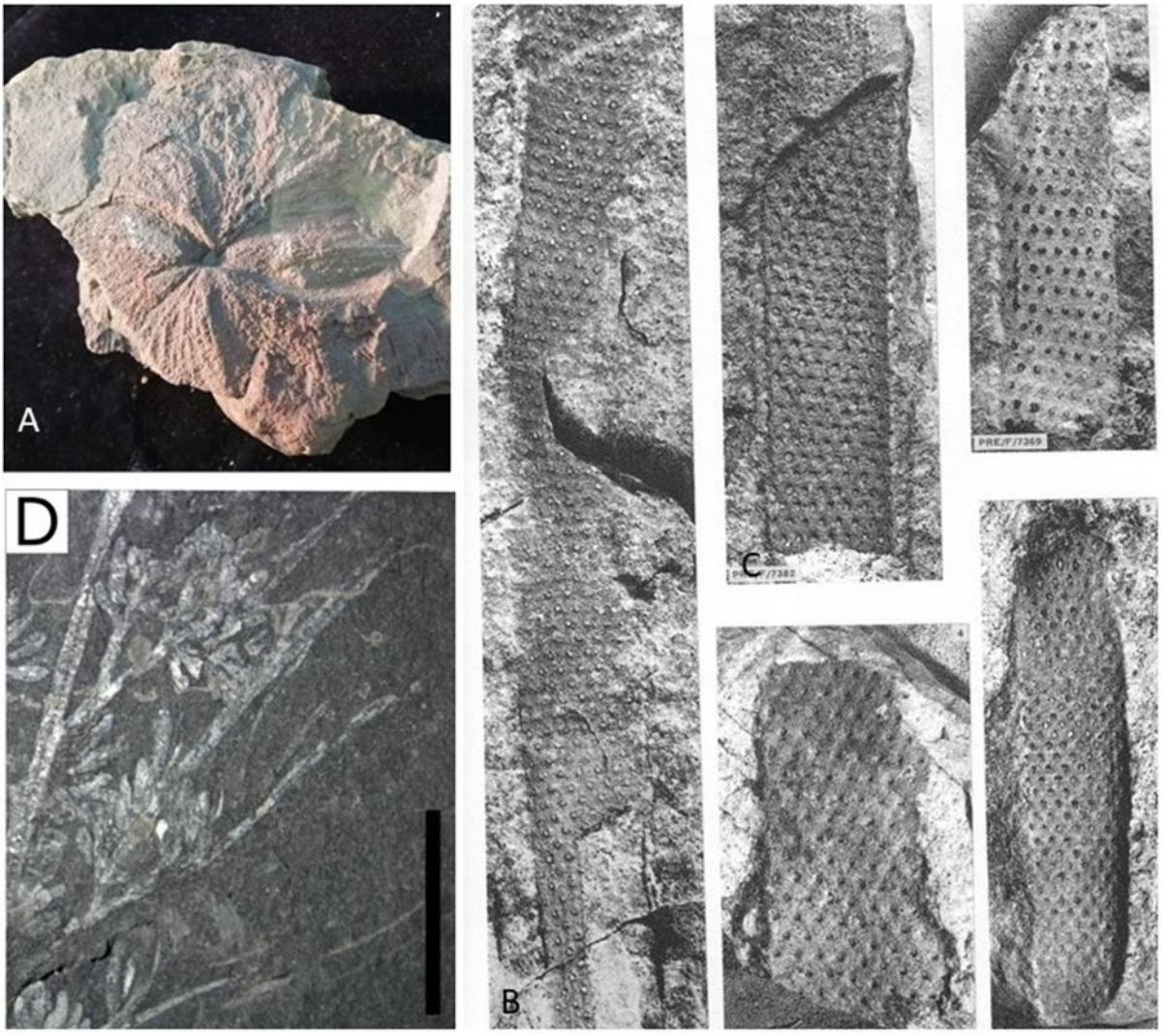

Figure 26: Photographs of fossil plants from the Witteberg Group (Devonian to Carboniferous) to assist the responsible person on site.