PALAEONTOLOGICAL FIELD ASSESSMENT OF THE PROPOSED SWAZILAND-MOZAMBIQUE BORDER PATROL ROAD AND MOZAMBIQUE BARRIER STRUCTURE

Prepared for:

Royal Haskoning DHV

Royal HaskoningDHV (Pty) Ltd trading as Royal HaskoningDHV

Reg No. 1966/001916/0

Building No. 5 Country Club Estate

21 Woodlands Drive, Woodmead, 2191

PO Box 867, Gallo Manor, 2052, Gauteng, South Africa

15-11-2019

Prepared by:

BANZAI ENVIRONMENTAL (PTY) LTD

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;

PALAEONTOLOGICAL CONSULTANT: Banzai Environmental (Pty) Ltd

CONTACT PERSON: Elize Butler

Tel: +27 844478759

Email: elizebutler002@gmail.com

SIGNATURE: 

The heritage impact assessment report has been compiled considering the NEMA Appendix 6 requirements for specialist reports as indicated in the table below.

Section in EIA Regulations 2014 (as amended)		**Clause**	**Section in Report**
Appendix 6	(1)	A specialist report prepared in terms of these Regulations must contain —	
	(a)	details of –	
		(i) the specialist who prepared the report; and	Page ii of the report, Contact details and company
		(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae.	Section 4
	(b)	A declaration that the person is independent in a form as may be specified by the competent authority;	Page ii of the report
	(c)	An indication of the scope of, and the purpose for which, the report was prepared;	Section 3
	(cA)	An indication of the quality and age of base data used for the specialist report;	Section 5- Geological and Palaeontological History
	(cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 9
	(d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 1 and 8
	(e)	A description of the methodology adopted in preparing the report or carrying out the specialised process; inclusive of equipment and modelling used;	Section 7

	(f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section 5
	(g)	An indication 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;	Section 5
	(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 or activities;	Section 9
	(k)	Any mitigation measures for inclusion in the EMPr;	Section 9
	(l)	Any conditions for inclusion in the environmental authorization;	N/A
	(m)	Any monitoring requirements for inclusion in the EMPr or environmental authorization;	Section 10
	(n)	A reasoned opinion –	
		(i) as to whether the proposed activity, activities or portions thereof should be authorized;	Section 9
		(iA) regarding the acceptability of the proposed activity or activities; and	Section 9
		(ii) if the opinion is that the proposed activity, activities or portions thereof should be authorized, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 9

	(o)	A description of any consultation process that was undertaken during the course of preparing the specialist report;	Not applicable. A public consultation process will be handled as part of the BA process.
	(p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Not applicable. To date not comments regarding heritage resources that require input from a specialist have been raised
	(q)	Any other information requested by the authority.	Not applicable
	(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.	Not applicable

EXECUTIVE SUMMARY

Royal HaskoningDHV has appointed Banzai Environmental (Pty) Ltd to undertake a Palaeontological Impact Assessment (Phase 1) assessing the palaeontological impact of the proposed Swaziland-Mozambique Border Patrol Road and Mozambique Barrier Structure. 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 evaluate the impact of the construction and operation of the barrier on the palaeontological resources.

The proposed project and base camp are underlain by various sedimentary rocks of which the **Quaternary** and the **Undifferentiated Karoo** has a **high Palaeontological sensitivity** and **the Zululand Group** which has a **very high palaeontological sensitivity**. The various intrusive rocks have an igneous origin and is thus unfossiliferous and has a zero palaeontological sensitivity. As part of the Palaeontological Impact Assessment, a field-survey of the development footprint was conducted in February 2018 to assess the potential risk to palaeontological material in the proposed footprint of the development. A physical field-survey of the proposed development and camping site was conducted on foot and by vehicle and during this field survey, **no fossiliferous outcrops** were found in the development footprint. For this reason, a **low palaeontological sensitivity** is allocated to the development footprint. Although fossils are uncommon and only occur periodically a single fossil may be scientifically valuable as many fossil taxa are known from a single fossil. The recording of fossils will expand our knowledge of the Palaeontological Heritage of the development area.

The scarcity of fossil heritage at the proposed development footprint indicate that the impact of the proposed development will be of a low significance in palaeontological terms. It is therefore considered that the proposed Swaziland-Mozambique Border Patrol Road and Mozambique Barrier Structure 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 facility may be authorised as the whole extent of the development footprint is not considered sensitive in terms of palaeontological resources.

However, if fossil remains are discovered during any phase of construction, either on the surface or exposed by new excavations the **Chance Find Protocol** must be implemented by the ECO in charge of these developments. These discoveries ought to be protected (*in situ* if possible) and the ECO must report to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) so that suitable mitigation (recording and collection) can be carry out by a paleontologist.

Preceding any collection of fossil material, the specialist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an accredited collection (museum or university collection), while all fieldwork and reports should meet the minimum standards for palaeontological impact studies suggested by SAHRA.

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1 INTRODUCTION

The National Department of Public Works has appointed **Royal HaskoningDHV** to undertake the design of the border control structure and to obtain environmental authorisations for the proposed Mozambique barrier structure as well as the Swaziland-Mozambique Border Patrol Road.

The Mozambique **Border Barrier** extends in two sections from the eastern boundary of the iSimangaliso Wetland Park west to the eastern boundary of the Tembe Elephant Reserve (excluding Tembe Elephant Reserve) (Figure. 1). The second section is a narrow section between Tembe and the eastern Boundary of the Ndumo Game Reserve.

The **Border Patrol Infrastructure** consists of two main components – **a border patrol road and the international fence**, of which both will be upgraded. This component is the longest section and extends westward from Kosi Bay (Indian Ocean), west along the KZN-Mozambique border and the entire length of the Mpumalanga-Swaziland Border to the point in the Lowveld where the Mpumalanga Swaziland Border ends (a total length of approximately 529 km).

In sections of the 529 km the existing road will be upgraded to a 5 m wide gravel road, in other areas the road is absent, and, in these sections, a new 5m-wide road will be developed. Due to topographic limitations, the road will not always follow the international border. Along certain areas of the border, where no road is planned, a 2 m wide footpath will be developed to permit border patrols.

The fence is generally in place along the entire border, although there are certain sections where no fence is proposed and instead beacons are proposed. These are in areas where the boundary is formed by a river or where the terrain is extremely mountainous. Two important examples are the KZN-Mozambique border within the Ndumu Game Reserve where the international border is the Usuthu River, and the highly mountainous section of the international border in the vicinity of the Songimvelo Game Reserve.

The **Royal HaskoningDHV** Route Determination team are still busy with the conceptual design, and a corridor of 50 m from the existing fence position will be assessed during the EIA process. This corridor ought to be enough to cater for any minor route realignments.

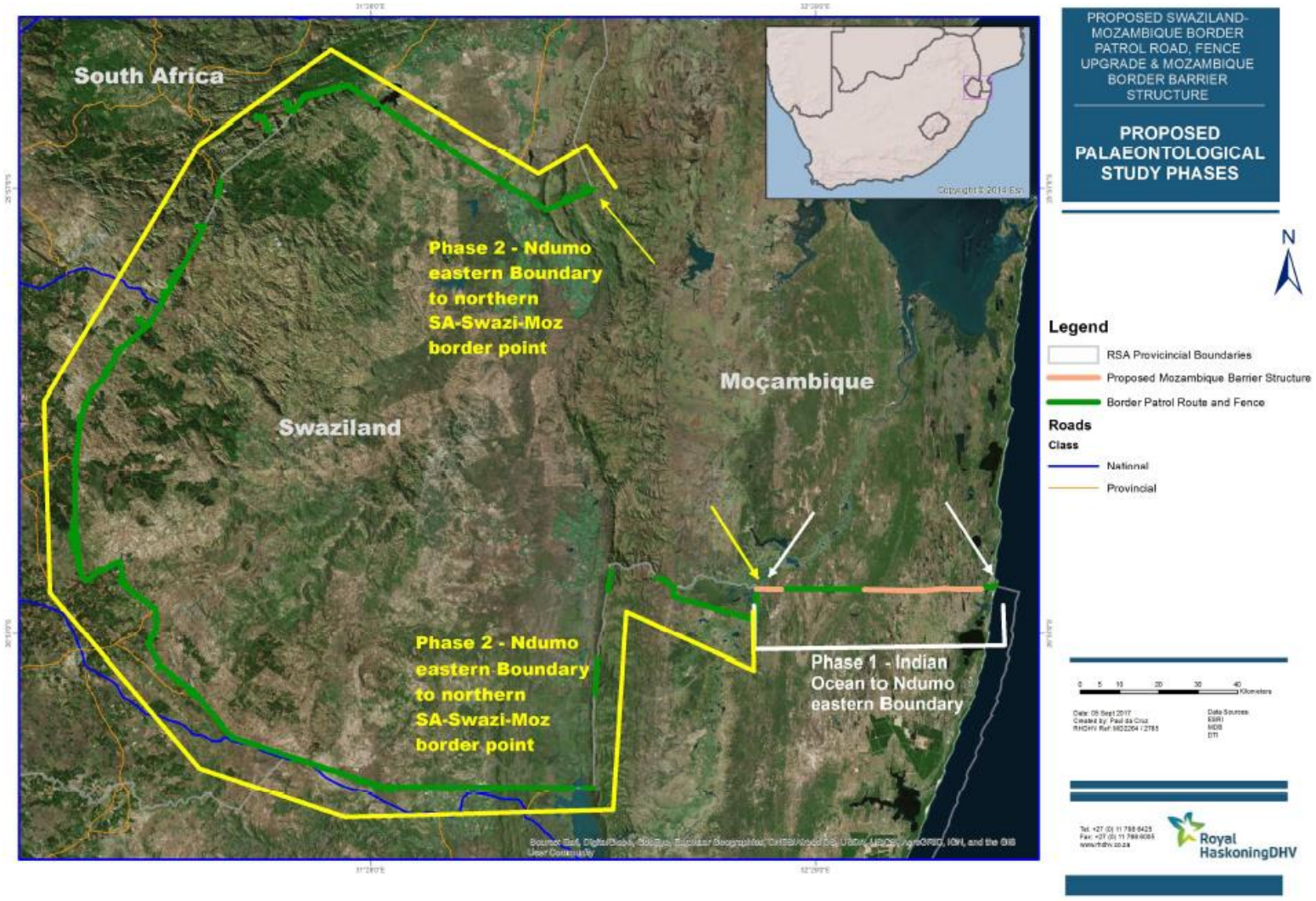


Figure 1: Locality map of the planned construction of the proposed Swaziland-Mozambique Border Patrol Road and Mozambique Barrier Structure. (Map provided by Royal HaskoningDHV).

2 LEGISLATION

2.1 NATIONAL HERITAGE RESOURCES ACT (25 OF 1999)

Cultural Heritage in South Africa, includes all heritage resources, is protected by the National Heritage Resources Act (Act 25 of 1999) (NHRA). Heritage resources as defined in Section 3 of the Act include **"all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens**".

Palaeontological heritage is unique and non-renewable and is protected by the NHRA. Palaeontological resources may not be unearthed, moved, broken or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority as per section 35 of the NHRA.

This Palaeontological Impact Assessment forms part of the Heritage Impact Assessment (HIA) and adhere to the conditions of the Act. According to **Section 38 (1)**, an HIA is required to assess any potential impacts to palaeontological heritage within the development footprint where:

- the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length;
- the construction of a bridge or similar structure exceeding 50 m in length;
- any development or other activity which will change the character of a site—
- (exceeding 5 000 m^2 in extent; or
- involving three or more existing erven or subdivisions thereof; or
- involving three or more erven or divisions thereof which have been consolidated within the past five years; or
- the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority
- the re-zoning of a site exceeding 10 000 m^2 in extent;
- or any other category of development provided for in regulations by SAHRA or a Provincial heritage resources authority.

3 OBJECTIVE

The objective of a Palaeontological Impact Assessment (PIA) is to determine the impact of the development on potential palaeontological material at the site.

According to the "SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports" the aims of the PIA are: 1) to **identify** the palaeontological status of the exposed as well as rock formations just below the surface in the

development footprint 2) to estimate the **palaeontological importance** of the formations 3) to determine the **impact** on fossil heritage; and 4) to recommend how the developer ought to protect or mitigate damage to fossil heritage.

The terms of reference of a PIA are as follows:

General Requirements:

- Adherence to the content requirements for specialist reports in accordance with Appendix 6 of the EIA Regulations 2014, as amended;
- Adherence to all applicable best practice recommendations, appropriate legislation and authority requirements;
- Submit a comprehensive overview of all appropriate legislation, guidelines;
- Description of the proposed project and provide information regarding the developer and consultant who commissioned the study,
- Description and location of the proposed development and provide geological and topographical maps
- Provide Palaeontological and geological history of the affected area.
- Identification sensitive areas to be avoided (providing shapefiles/kmls) in the proposed development;
- Evaluation of the significance of the planned development during the Pre-construction, Construction, Operation, Decommissioning Phases and Cumulative impacts. Potential impacts should be rated in terms of the direct, indirect and cumulative:
    a. **Direct impacts** are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity.
    b. **Indirect impacts** of an activity are indirect or induced changes that may occur as a result of the activity.
    c. Cumulative impacts are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities.
- Fair assessment of alternatives (infrastructure alternatives have been provided):
- Recommend mitigation measures to minimise the impact of the proposed development; and
- Implications of specialist findings for the proposed development (such as permits, licenses etc)

4 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-four years. She has extensive experience in locating, collecting and curating fossils, including exploration field trips in search of new localities in the Karoo Basin. She has been a member of the Palaeontological Society of South Africa for 13 years. She has been conducting PIAs since 2014.

5 GEOLOGICAL AND PALAEONTOLOGICAL HERITAGE

The geology of the KZN- Mozambique Barrier Structure footprint is represented by the 1:250 000 2632 Kosi Bay Geological map (Figure 2), while the Geology of the Swaziland-Mozambique Border Patrol Road is represented in the 3530 Barberton geological map (Figure 3). Geological Maps are provided by the Counsel of Geosciences. Discussions will be based on the above-mentioned Geological Maps as well as the QGIS maps. The abbreviations of the Geological maps are explained in Table 1.

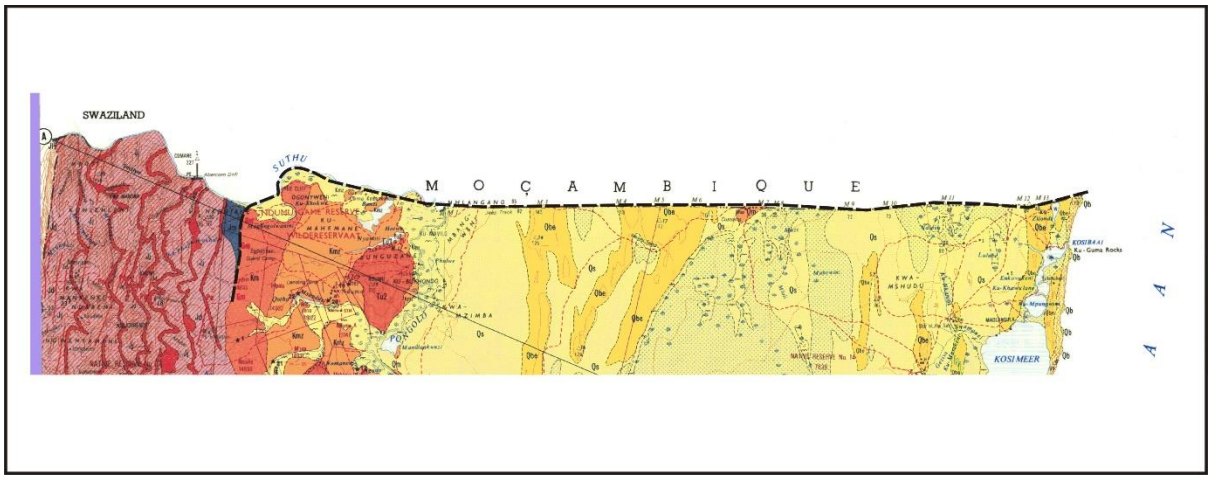


Figure 2: Geological map (1:250 000, 2632 Kosi Bay) of the proposed development footprint of the KZN-Mozambique Barrier Structure. The approximate location is indicated by the black dashed line. Geological Maps are provided by the Counsel of Geosciences. Abbreviations of the rock types are explained in Table 1.

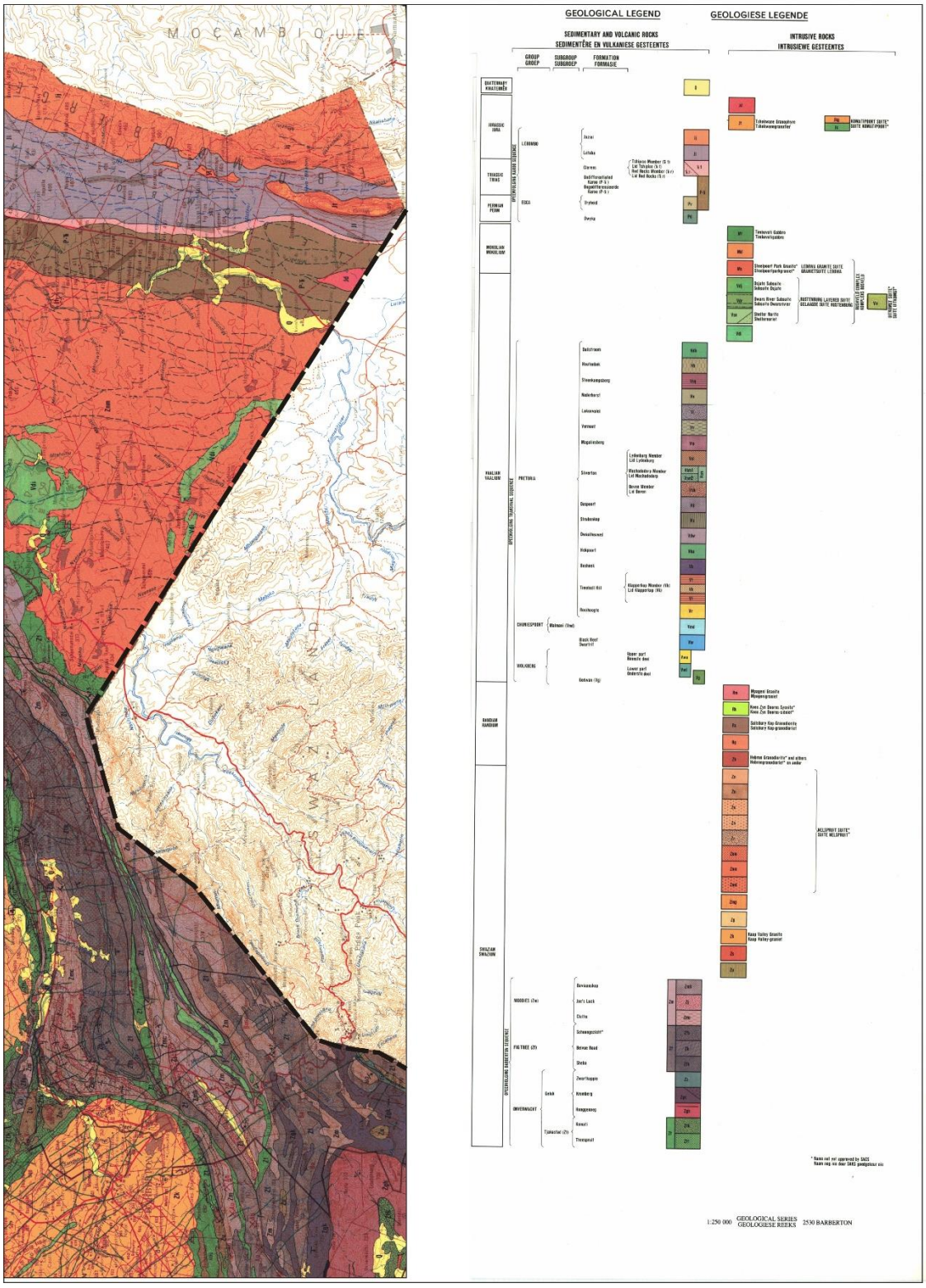
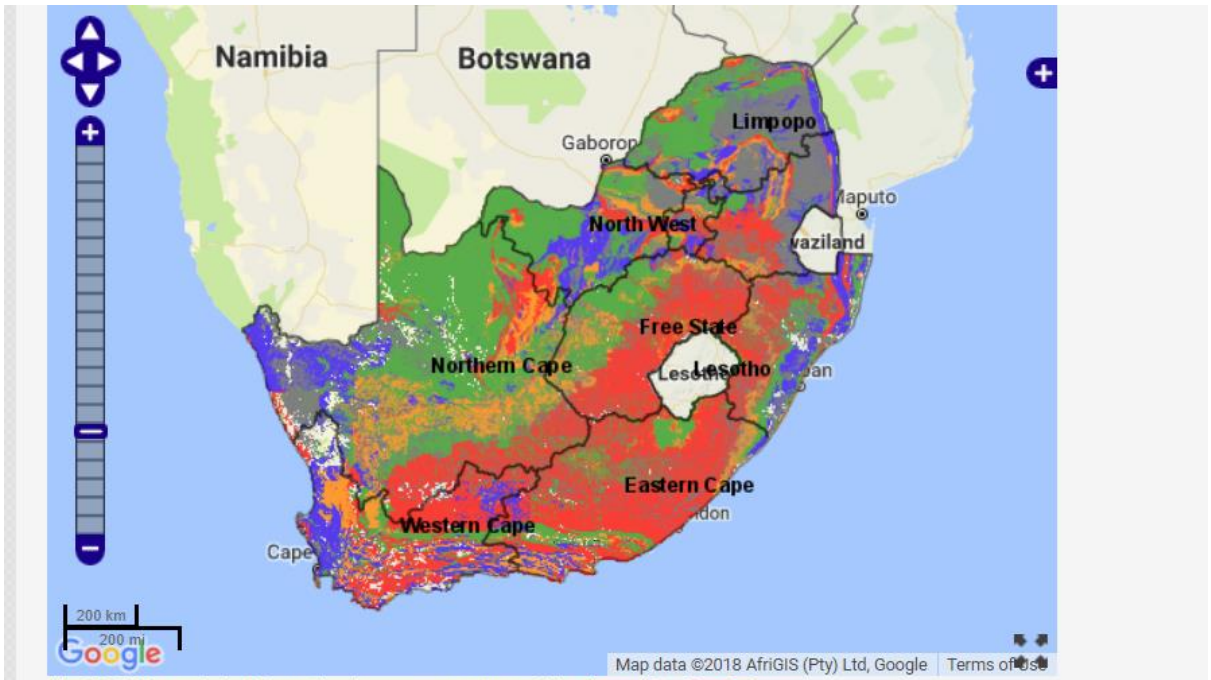


Figure 3: Geological map (1: 250 000, 3530 Barberton) of the proposed development footprint of the Swaziland-Mozambique Border Patrol Road. The approximate location is indicated by the black dashed line. Geological Maps are provided by the Council of Geosciences. Abbreviations of the rock types are explained in Table 1.

Table 1: Explanation of symbols for the geological map and Period. SG = Supergroup; Gr-Group; Fm = Formation. Palaeontological sensitivity is indicated by colour codes: Very High=-Red; High = orange. According to the SAHRIS PalaeoMap site visits is required for areas of High to Very High Palaeontological Sensitivity.

Symbol	Group/Formation	Lithology	Period	Paleo-Sensitivity
2632 Kosi Bay Geological Map Published in 1986 Sheet Explanation by Du Preez and Wolmarans 1986				
Qs	Quaternary	Yellowish redistribute sand	Cenozoic	High
Qbe	Berea Fm	Red dune cordon sand	Cenozoic	Very High
Qb	Bluff Fm	Calcareous sandstone	Cenozoic	High
Qm	Muzi Fm	Argillaceous sandstone	Cenozoic	Zero
Kmz	Zululand Gr Mzinene Fm	Marine siltstone with shelly and concretionary horizons	Cenozoic	High
3530 Barberton Geological map Published in 1986 Sheet Explanation by F. Walraven and F.J. Hartzer				
Q	Quaternary	Superficial deposit, alluvium and scree	Cenozoic	Very High
Jd	Karoo dolerite		Jurassic	Zero
Jl	Lebombo Gr Letaba Fm	Green, fine-grained mafic lava, locally porphyritic, amygdaloidal interlayered rhyolite especially near top	Jurassic	Zero
Jt	Tshokwane Granophyre	Intrusive rocks Pink, medium grained quartz feldspar granophyre, microgranite and syenite	Jurassic	Zero
Jj	Lebombo Gr Josini Fm	Red to light brown, fine grained rhyolitic lava, porphyritic rhyolite and tuf	Jurassic	Zero
P-T	Undifferentiated Karoo	Mudrock and sandstone	Permian to Triassic	Very High
Znm	Nelspruit Suite	Intrusive rocks	Swazian	Zero
Zu	Kaap Valley Granite		Swazian	Zero
Zm Zf Zgk	Barberton Supergroup: Onverwacht Group Moodies Gr Fig Tree Gr Onverwach Gr	Predominantly volcanic igneous rocks, plus some igneous intrusions, minor sediments such as banded iron formation, chert,	Swazian	Low

Symbol	Group/Formation	Lithology	Period	Paleo-Sensitivity
Zt	Geluk Subgroup Kromberg Fm ……Tjakastad Subgroup	quartzite, conglomerate, schists		



1 in 250 000 geological formation layers are courtesy of the Council for GeoScience

For more information, go to How to Use the Palaeontological (fossil) Sensitivity Map

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.

Maps

Figure 4: 1 in 250 000 geological formation layers (Courtesy of the Council of GeoSciences. http://www.sahra.org.za/sahris/map/palaeo

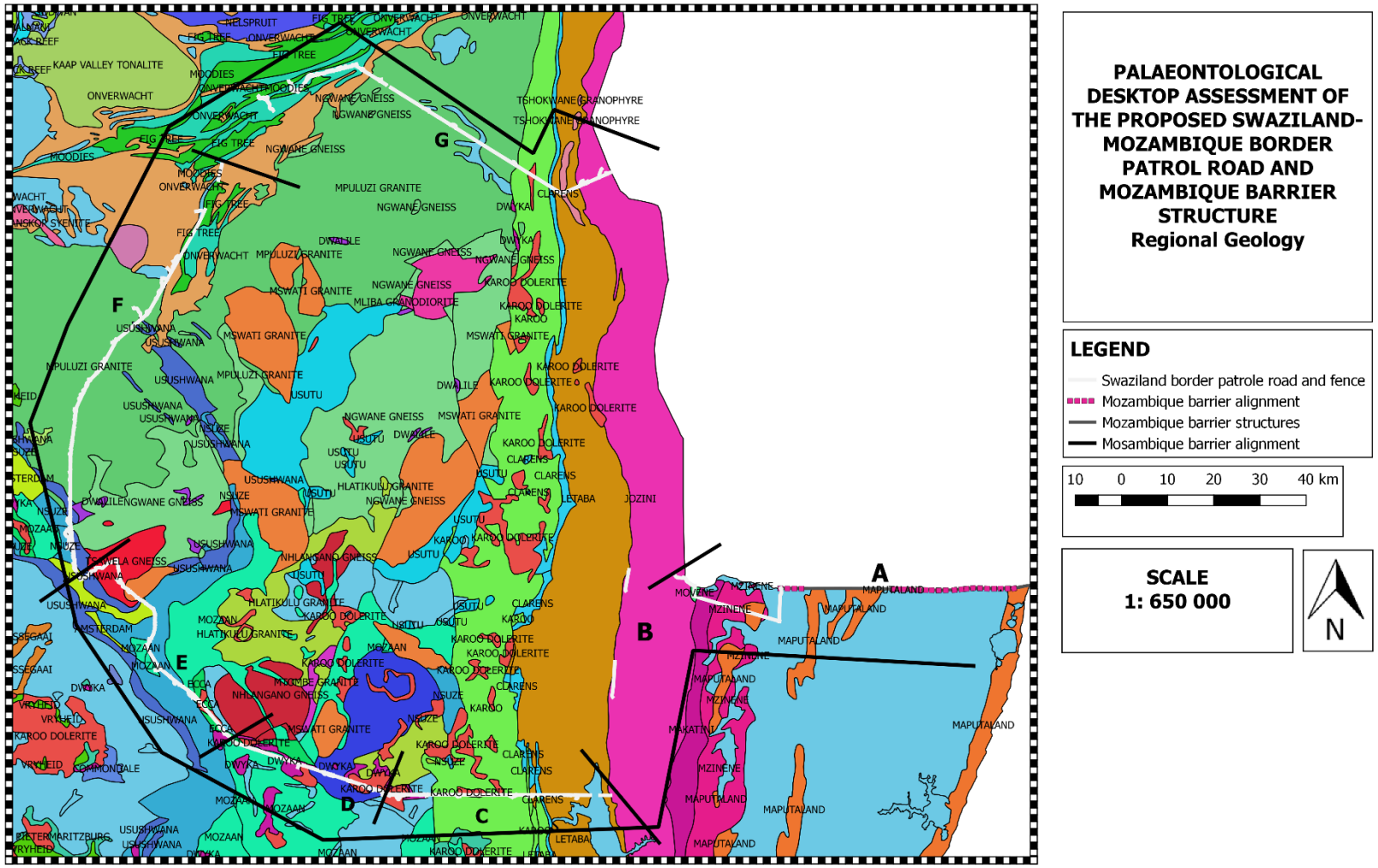


Figure 5: The surface geology of the proposed Swaziland-Mozambique Border Patrol Road and Mozambique Barrier Structure. The map is divided into different sections for discussion purposes. Section A and G has a High to very High Palaeontological Sensitivity. Map drawn by QGIS Desktop-version 2.18.12.

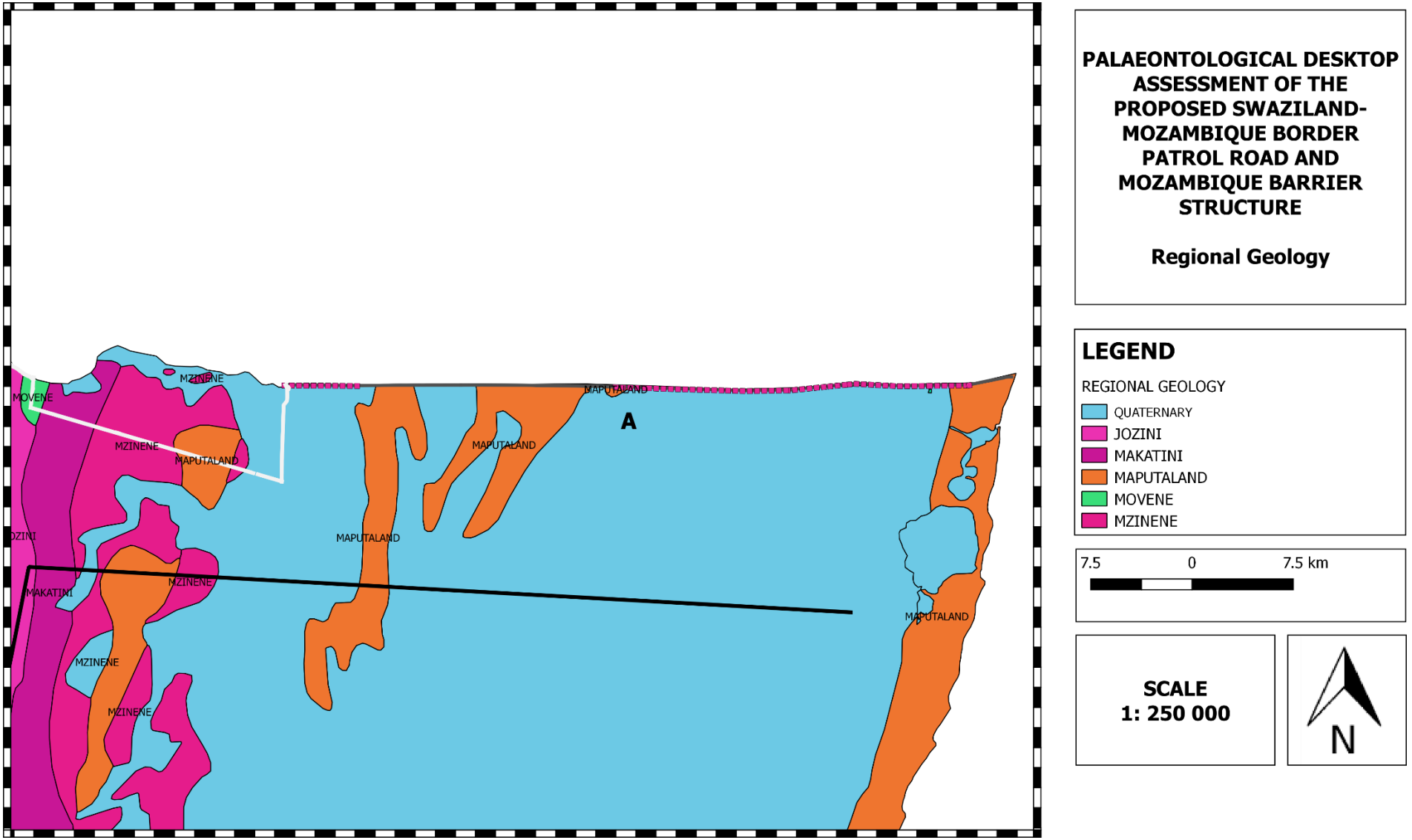


Figure 6: The surface geology of Section A of the proposed KZN-Mozambique border control barrier. The proposed development area is completely underlain by Quaternary superficial deposits of the Maputaland Group. These sediments have a high to very high Palaeontological Sensitivity. Map drawn by QGIS Desktop-version 2.14.20

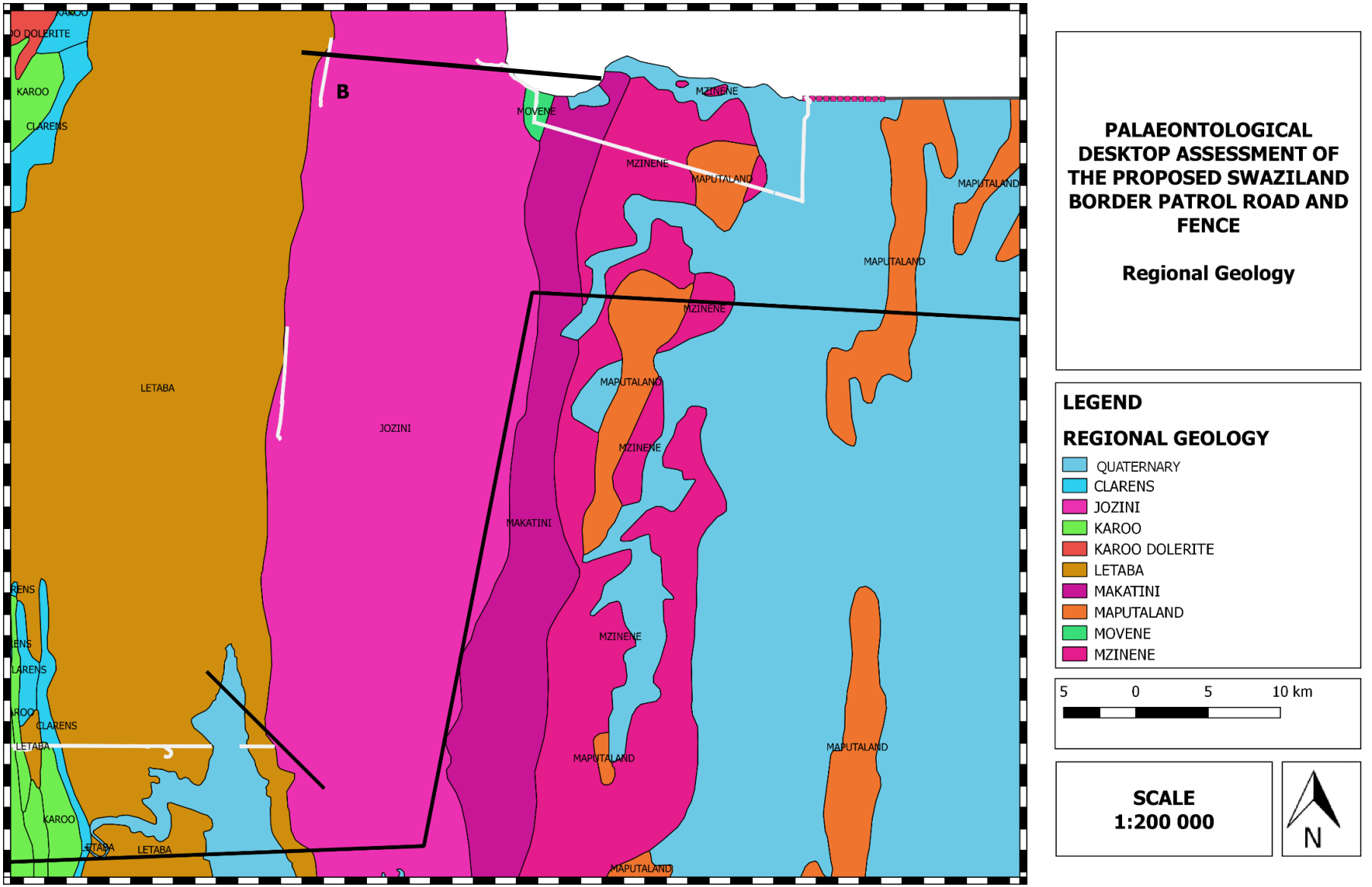


Figure 7: The surface geology of Section B of the proposed Swaziland Border Patrol Road and fence. The proposed development area is underlain by Quaternary deposits Josini and Letaba Formations, Movene and Makatini Formations. Map drawn by QGIS Desktop-version 2.14.20.

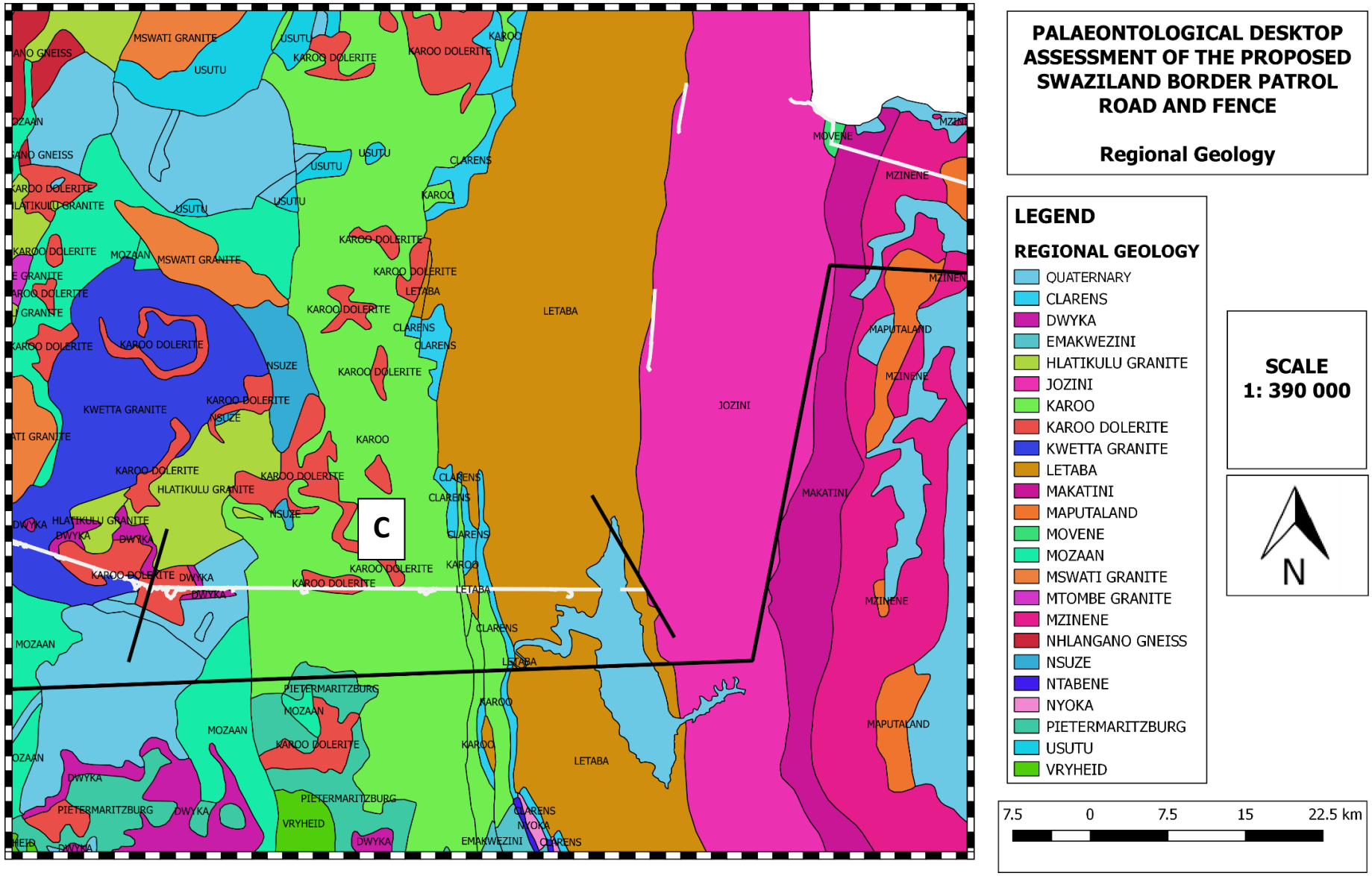


Figure 8: The surface geology of Section C of the proposed Swaziland-Mozambique Border Patrol Road and fence. The proposed development area is completely underlain by Josine Fm, Karoo Dolerite, Dwyka, the undifferentiated Karoo, Pietermaritzburg Fm, and Mozaan Fm. Map drawn by QGIS Desktop-version 2.14.20.

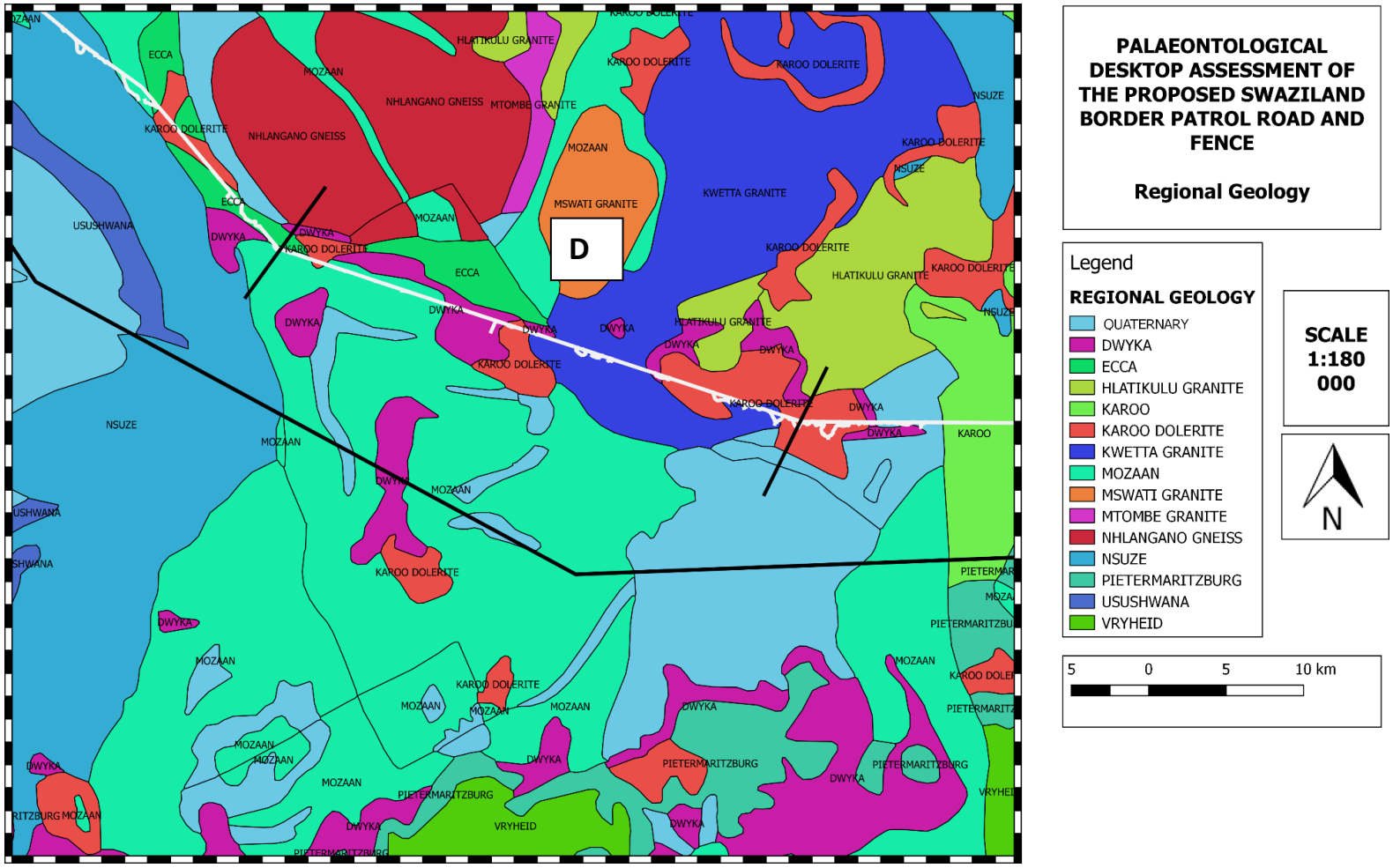


Figure 9: The surface geology of Section D of the proposed Swaziland Border Patrol Road and fence. The proposed development area is completely underlain by Quaternary, Karoo dolerite, the undifferentiated Karoo, the Dwyka and Ecca Groups. Map drawn by QGIS Desktop-version 2.14.20.

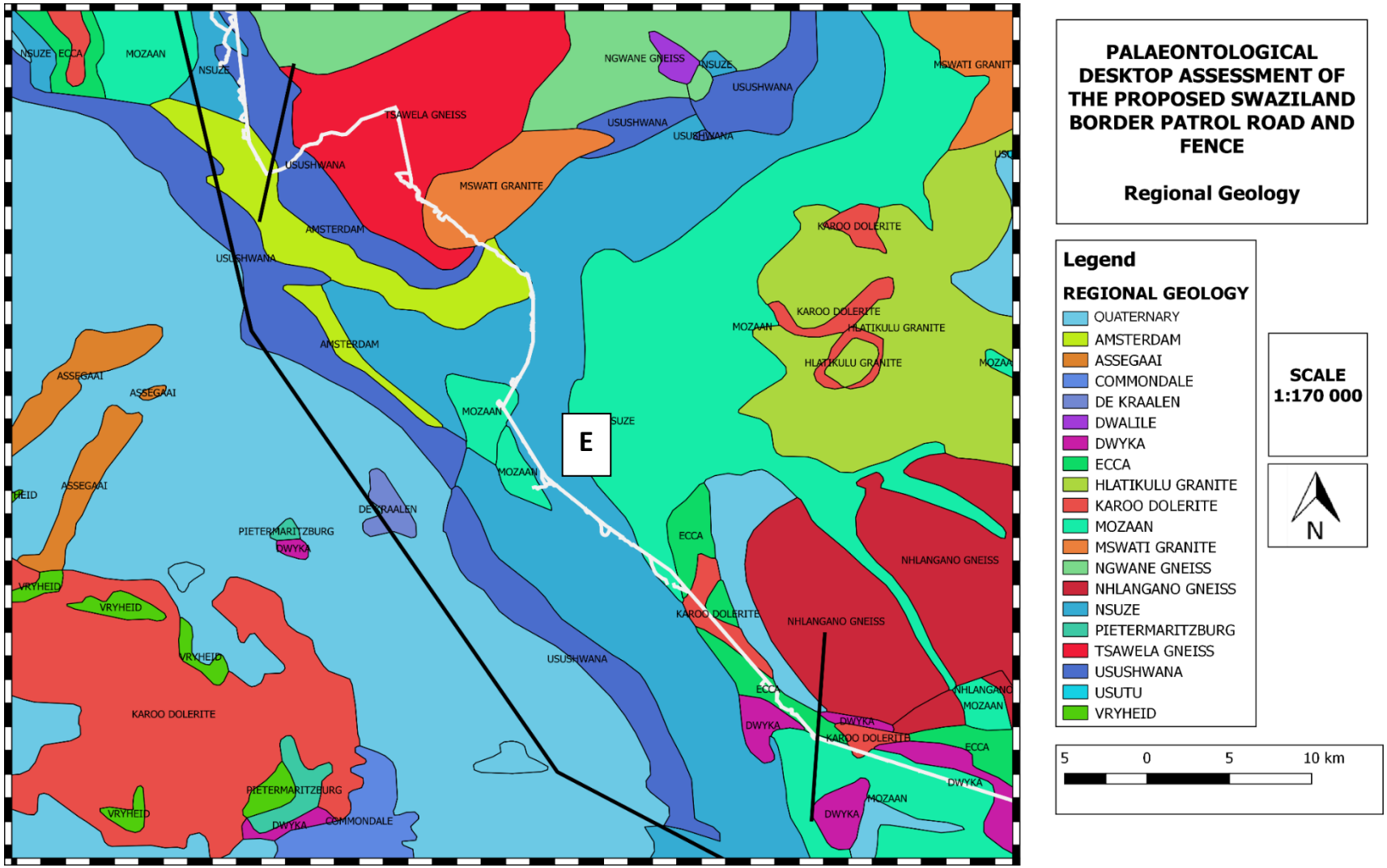


Figure 10: The surface geology of Section E of the proposed Swaziland Border Patrol Road and fence. The proposed development area is completely underlain by Nsuze and Mozaan Fm, Karoo dolerite, Ecca Group and Usushwana Fm. Map drawn by QGIS Desktop-version 2.14.20.

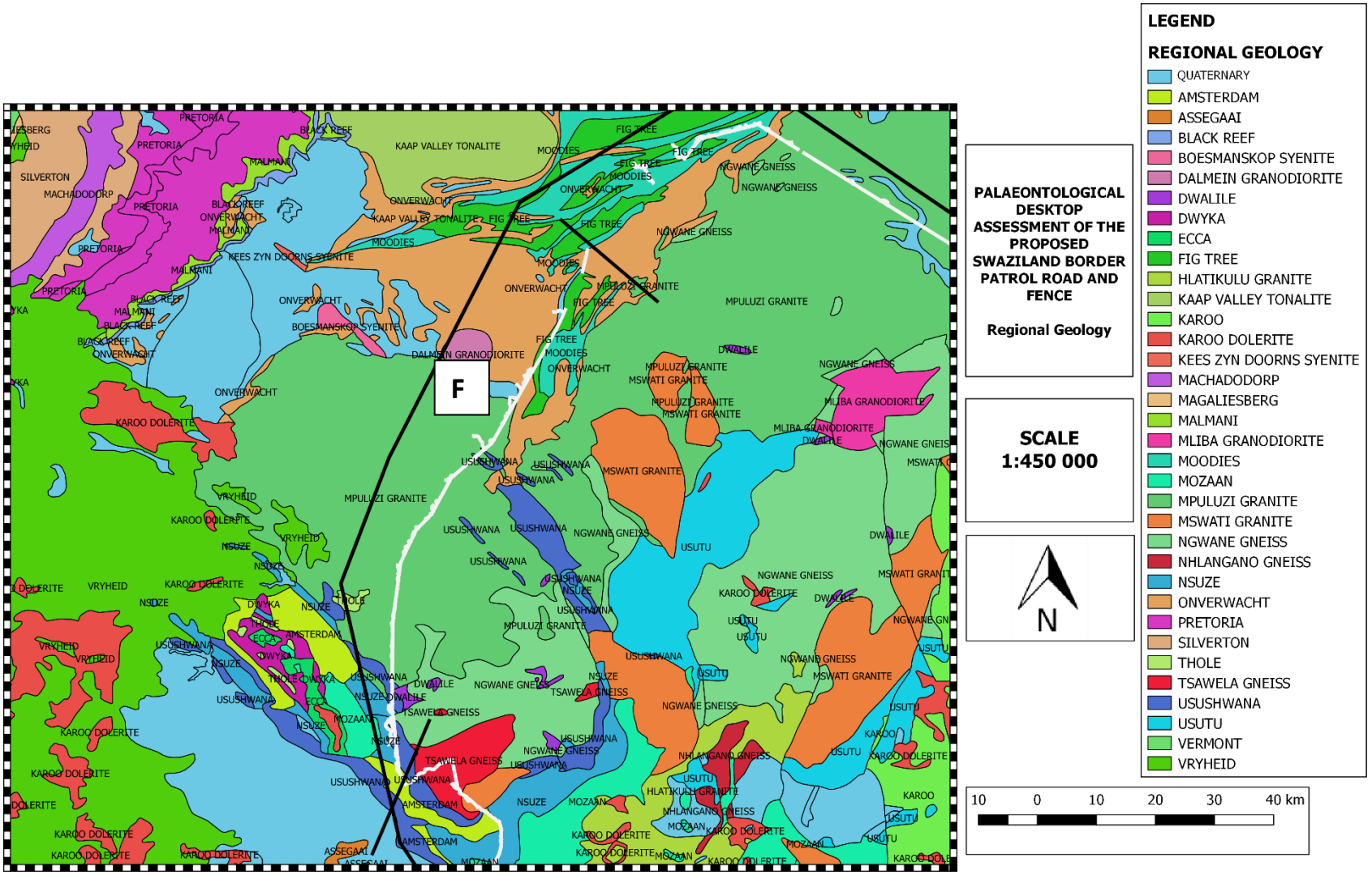


Figure 11: The surface geology of Section F of the proposed Swaziland Border Patrol Road and fence. The proposed development area is completely underlain by Quaternary, Barberton Sequence, Usushwana and Nsuze Fm. Map drawn QGIS Desktop-version 2.14.20 with GRASS 7.2.2

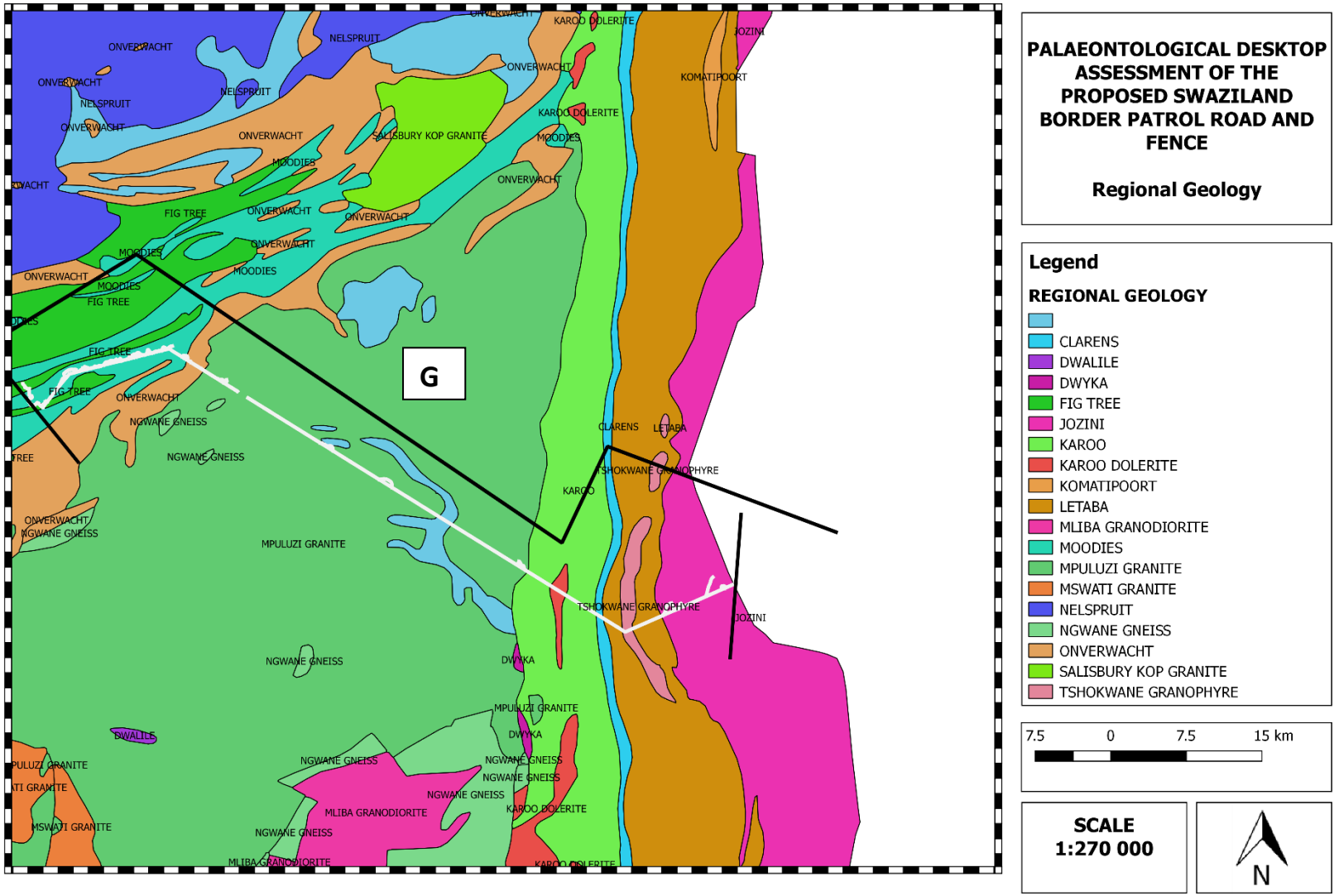


Figure 12: The surface geology of Section G of the proposed Swaziland Border Patrol Road and fence. The proposed development area is primary underlain by Mpuluzi Granite intrusive rocks, Barberton Sequence as well as the Undifferentiated Karoo. The Undifferentiated Karoo has a Very High Palaeontological Sensitivity. Map drawn by QGIS Desktop-version 2.14.20 with GRASS 7.2.2.

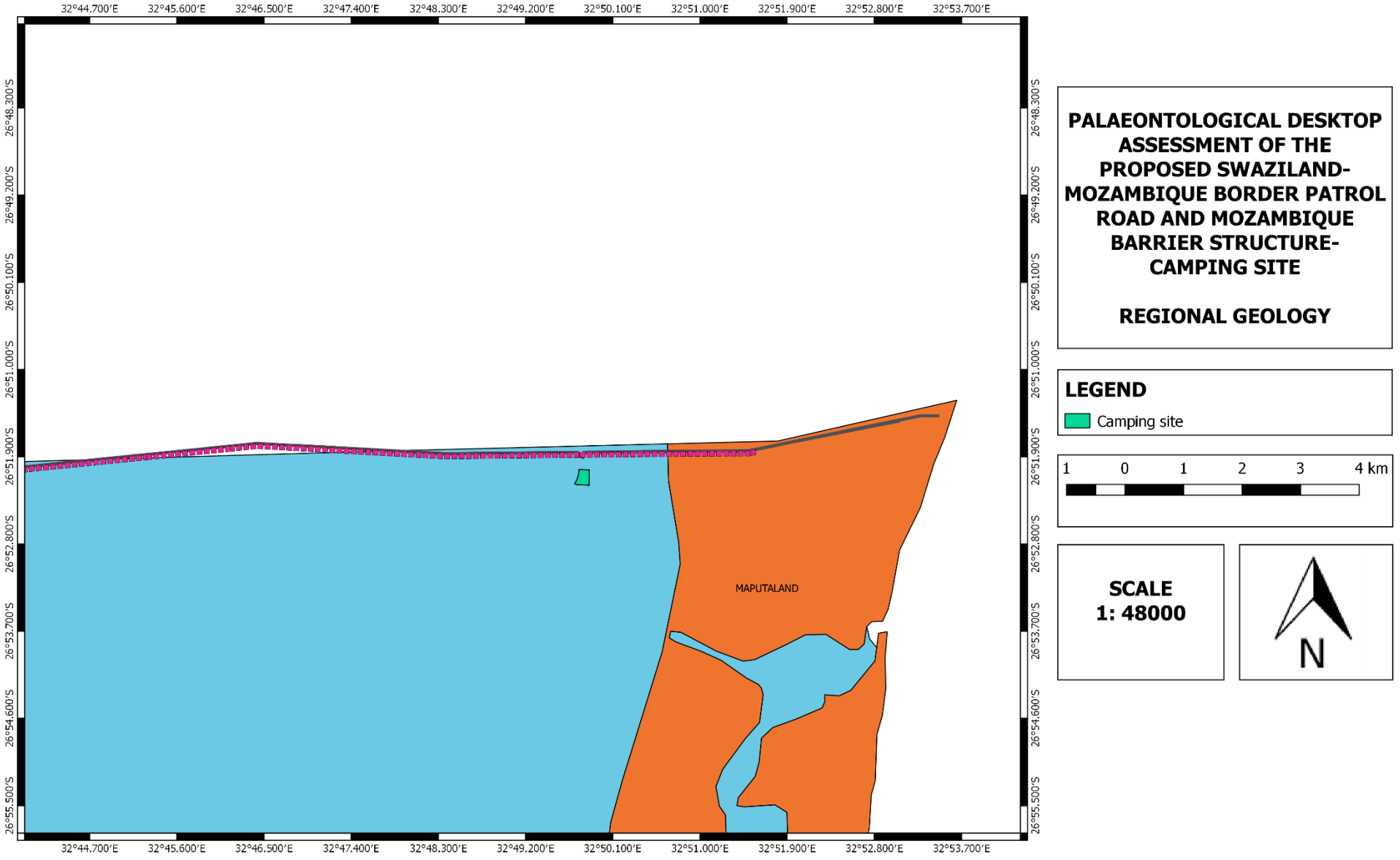


Figure 13: The surface geology of the camping site of the proposed project. The proposed development area is completely underlain Quaternary superficial deposits. Map drawn by QGIS Desktop-version 2.18.12.

The Geological and Palaeontological history of this report will be divided into 2 sections namely the geology and Palaeontology of the development in Kwazulu-Natal (2632 Kosi Bay 1:250 000 Geological Map) that will be followed by the geology and Palaeontology of Mpumalanga (3530 Barberton 1:250 000Geological Map). It is important to note that only sediments with a Very high, high and low Palaeontological Sensitivity in the proposed development area will be discussed. However, sediments with a Palaeontological Sensitivity of zero will be mentioned but not discussed.

5.1 KWAZULU-NATAL

Cenozoic fossils Assemblages of KwaZulu-Natal, Eastern and Western Cape coasts are restricted to the coastal areas and consists of very rich assemblages of marine fossils (MacRae, 1999; Johnson et al, 2006). These fossils include plant material like leaves, peats, wood, and pollens; diatoms and other microfossils, trace fossils which includes calcretised burrows, rhizoliths, termitaria, and vertebrate tracks; mammalian bones and teeth, tortoise remains, ostrich eggshells, non-marine mollusc shells, ostracods and freshwater stromatolites. The Kwazulu-Natal portion of the proposed development form part of the coastal Cenozoic deposits (Roberts, 2006). These sediments are of aeolian, estuarine, fluvial, lacustrine and littoral marine origin and is present along the coastal plains of southern Africa. The sediments are deposited very thinly. However, thick Cenozoic deposits are present offshore in rift basins and around major river mouths (Dingle, et al, 1983). The offshore Cenozoic sediments are unevenly distributed around the coastline and overlie a broad coastal plane in northern Kwazulu-Natal and southern Mozambique. The maximum width here is approximately 60 km which tapers southernly down the coast. The Palaeontological Sensitivity of sediments of the development area in Kwazulu-Natal is indicated in Table 2.

Maputaland Group

During the last glacial period the earth was much colder and sea levels approximately 100 meters below present. The coastline extended far out in the sea, while large rivers eroded deep valleys along the coast. 65 million years ago sea levels rose as the earth heated up and the valleys were infilled with shelly sands and estuarine muds which today forms the Maputaland Group.

During the Caenozoic the sea-levels dropped. The Tertiary calcrenite and limestone Uloa Formation overlies the St Lucia Formation. The Muzi Formation comprises of swamp deposits consisting of brown mottled clayey sand. This formation has only a few outcrops. The Muzi Formation is overlain by the Port Durnford Formation which comprise of lignite clay, sand and mudstone. In turn the Port Durnford Formation is overlain by the Bluff and Berea Formations. The coastal dune corridors are formed by the Bluff Formation which consists of a pale brown sandstone deposit. The Bluff Formation consists of orange, red and yellow aeolian sand.

The Maputaland Group forms a layer of Tertiary to Cretaceous deposits. The subdivision of Wolmarans and Du Preez (1986) of the Maputaland Group will be used for simplicity in this report, preferred to the more detailed subdivision of Johnson et al (2006).

A large portion of the Uloa Formation consist of approximately 5 metres of unbedded calcirudite, generally known as the "Pecten Bed" due to the quantity of the bivalve *Aeqipectenuloa*. Brachiopods, coralline algae, corals, echinoids, foraminifera and Gastropods are present in this formation, as well as isolated teeth of the extinct giant shark *Carcharodon megalodon* (Johnson et al, 2006). This Group has a high Palaeontological sensitivity. No fossils have been documented from the Muzi Formation. The Bluff Formation has local fossiliferous zones while the Berea and Masotcheni Formations consists of recent alluvial and sand deposits but do not contain significant fossil remains. The Port Durnford Formation consists a series of carbonaceous muds and sand, including fossils of terrestrial vertebrates (antelope, buffalo, elephant, hippopotamus, rhinoceros. Marine fossils comprise of crustaceans, fish, foraminifera, marine molluscs and fragments of crocodiles and turtles. This Group has a high Palaeontological sensitivity. Small deposits of coral limestone are present in the Bluff Formation which is a nearly unbroken outcrop with fossils. Significant fossil vertebrates are not known from the Berea Formation, but petrified wood has been described. The KwaZulu-Natal coastline are still shaped by fluctuations in sea-level. Recent deposits consist of alluvium, calcrete and sand.

Table 2: Explanation of symbols for the geological map and Period. SG = Supergroup; Gr-Group; Fm = Formation. Palaeontological sensitivity is indicated by colour codes: Very High=-Red; High = orange; Black-Zero. According to the SAHRIS PalaeoMap site visits is required for areas of High to Very High Palaeontological Sensitivity

Symbol	**Group/Formation**	**Lithology**	**Period**	**Paleo-Sensitivity**
2632 Kosi Bay Geological Map Published in 1986 Sheet Explanation by Du Preez and Wolmarans 1986				
Qs	Quaternary	Yellowish redistribute sand	Cenozoic	High
Qbe	Berea Fm	Red dune cordon sand	Cenozoic	Very High
Qb	Bluff Fm	Calcareous sandstone	Cenozoic	High
Qm	Muzi Fm	Argillaceous sandstone	Cenozoic	Zero
Kmz	Zululand Gr Mzinene Fm	Marine siltstone with shelly and concretionary horizons	Cenozoic	Very High

Zululand Group

The Zululand Groups is known for its ammonite fossils (snail-like animals up to one metre in size) which flourished in the warm ocean of the Cretaceous. Fossils of the Makatini Formation include large wooden fossil logs, which are significantly drilled by Teredo wood boring organism. A rich invertebrate fauna including ammonites, bivalves, echinoids, gastropods and nautiloids) are present in the overlying Mzinene Formation. Fine grained sediments comprise small fragments of plants, bored fossil tree trunks, as well as marine invertebrates. This formation has a High Palaeontological Sensitivity. Scientist is of the opinion that the palaeo-environment could be a shallow-marine environment. The upper St Lucia Formation includes various bivalve, echinoid, cephalopod, and gastropod remains as well as fossil wood and plant fragments and reptile bones. With a minimum of 62 ostracod species this Formation is much more fossiliferous than the underlying Mzinene Formation.

5.2 MPUMALANGA

The Quaternary superficial deposits and Undifferentiated Karoo in the Mpumalanga portion of the development has a very High Palaeontological Sensitivity, while the Barberton Supergroup has a low Palaeontological Sensitivity. The Karoo dolerite, Tshokwane Granophyre, Nelspruit Suite and Kaap Valley Granite are all unfossiliferous and have a Palaeontological Sensitivity of zero (Table 3).

Quaternary Cenozoic superficial deposits

The Tertiary to Quaternary Cenozoic superficial deposits consist of aeolian sand, alluvium (clay, silt and sand), colluvium (material collecting at the foot if a steep slope), spring tufa/tuff (a porous rock composed of calcium carbonate and formed by precipitation from water around mineral springs) and lake deposits, peats, pedocretes (calcrete), soils and gravels.

Quaternary fossil assemblages are very rare and low in diversity. These superficial deposits are spread out over a wide-ranging geographic area. In the past palaeontologists did not focus their research on Cenozoic deposits although they sometimes include important fossil biotas. Fossils assemblages may consist of ostrich egg fragments, bones, horn corns and mammalian teeth as well as reptile skeletons. Microfossils, non- marine mollusc shells and freshwater stromatolites have also been described. Plant material (foliage, pollens peats and wood) are recovered as well as trace fossils of vertebrate tracks, burrows, termite heaps/ mounds and root casts. This Group has a high Palaeontological sensitivity.

Table 3**:** Explanation of symbols for the geological map and Period. SG = Supergroup; Gr-Group; Fm = Formation. Palaeontological sensitivity is indicated by colour codes: Very High=-Red; High = orange, Blue=Low and Black= Zero. According to the SAHRIS PalaeoMap site visits is required for areas of High to Very High Palaeontological Sensitivity and a desktop is necessary for areas with a low Palaeontological Sensitivity.

3530 Barberton Geological maps Published in 1986 Sheet Explanation by F. Walraven and F.J. Hartzer			
Q	Quaternary	Superficial deposit, alluvium and scree	Cenozoic
Jd	Karoo dolerite		Jurassic
Jl	Lebombo Gr Letaba Fm	Green, fine-grained mafic lava, locally porphyritic, amygdaloidal interlayered rhyolite especially near top	Jurassic
Jt	Tshokwane Granophyre	Intrusive rocks Pink,,medium grained quartz feldspar granophyre, microgranite and syenite	Jurassic
Jj	Lebombo Gr Josini Fm	Red to light brown, fine grained rhyolitic lava, porphyritic rhyolite and tuf	Jurassic
P-T	Undifferentiated Karoo	Mudrock and sandstone	Permian to Triassic
Znm	Nelspruit Suite	Intrusive rocks	Swazian
Zu	Kaap Valley Granite		Swazian
Zm Zf Zgk Zt	Barberton Supergroup: Onverwacht Group Moodies Gr Fig Tree Gr Onverwach Gr Geluk Subgroup Kromberg Fm ……Tjakastad Subgroup	Predominantly volcanic igneous rocks, plus some igneous intrusions, minor sediments such as banded iron formation, chert, quartzite, conglomerate, schists	Swazian

Karoo Supergroup

In the development footprint the Karoo Supergroup is known as the undifferentiated Karoo.

Dwyka Group

The Natal Group is overlain by the Dwyka Group. The Permo-Carboniferous Dwyka Group is the oldest deposit in the Karoo Supergroup and spans the Late Carboniferous to Early Permian. The Dwyka Group overlies the glaciated Precambrian bedrocks in the north and unconformably and paraconfoformably

the Cape Supergroup in the south and in the east, it overlies the Natal Group and Msikaba Formation unconformably. Glacial pavements underlaying the Dwyka Group has well-developed striations (specifically in the north) (Johnson et al, 2006). The Dwyka Group is believed to be deposited in a marine basin (Visser, 1989).

South Africa was covered by an ice sheet during the Dwyka. These deposits were thus deposited in a cold, glacially dominated environment. This Group consists mainly of gravelly sediments with subordinate vorved shales and mudstones with facetted and scraped pebbles. The retreating glaciers deposited dark-grey tillite (Visser et al, 1987). The Dwyka is known for its rich assemblage of dropstones of various sizes.

The Permo-Carboniferous Dwyka Group is known for its track ways (trace fossils) which is also known as iIchnofacies that was formed by fish and arthropods, while fossilized faeces or coprolites have also been recovered. Body fossils consists of gastropods, invertebrates and marine fish. Fossil plants from this group include a rich diversity of conifers, cordaitaleans, glossopterids, ginkgoaleans, horsetails, lycopods, pollens and ferns spores (Almond and Pether, 2008).

Ecca Group

The Ecca Group comprises of thick clay and silt beds and were deposited in a large sea in the Karoo Basin. These sediments are now present as shales of the Pietermaritzburg Formation. The latter formation is overlain by the Vryheid Formation and is in turn overlain by the Volksrust Formation. The Ecca Group was deposited as Gondwana moved towards the equator. The Vryheid Formation consists mainly of light grey sandstones and was deposited along sandy shorelines alongside swamps. These swamps are the origin of the coal fields that are present today.

Generally, body fossils are absent from this Formations although some trace fossils have been recovered from the upper layers of the Pietermaritzburg Formation. The Vryheid Formation is known to contain a rich assemblage of Glossopteris flora which is the source vegetation for the Vryheid Formation. Gymnospermous glossopterids dominated the peat and non-peat accumulating of Permian wetlands after continental deglaciation took place (Falcon, 1986c, Greb et al., 2006).

Recent paleobotanical studies include that of Adenforff (2005), Bordy and Prefec (2008) and Prefec *et al.* (2008, 2009, 2010) and Prevec, (2011). Bamford (2011) described numerous plant fossils from this formation (e.g. *Azaniodendron fertile*, *Cyclodendron leslii, Sphenophyllum hammanskraalensis, Annularia sp., Raniganjia sp., Asterotheca spp., Liknopetalon enigmata, Hirsutum* sp., *Scutum* sp., *Ottokaria* sp., *Estcourtia* sp., *Arberia* sp., *Lidgetonnia* sp., *Noeggerathiopsis* sp., *Podocarpidites* sp as well as more than 20 Glossopteris species. In the past palynological studies have focused on the coal bearing successions of the Vryheid Formation and include articles by Aitken (1993, 1994, 1998), and Millsteed (1994, 1999), while recent studies were conducted by Götz and Ruckwied, 2014).

Bamford (2011) is of the opinion that only a small amount of data have been published on these potentially fossiliferous deposits and that most likely good material are present around coal mines and in other areas the exposures are poor and of little interest. When plant fossils do occur they are usually abundant. According to Bamford it is not feasible to preserve all the sites but in the interests of science these sites ought to be well documented, researched and the collected fossils must be housed in an accredited institution. Trace fossils as well as the bivalve *Megadesmus* have been described from the Volksrust Formation.

Beaufort Group

The Beaufort Group was deposited on the sediments of the Ecca Group. The Beaufort Group comprise of green, red and purple coloured mudstones which accumulated in a drying swampland. These rocks are approximately 250-million-year-old rocks and represents the record of the largest known extinction event to date, namely the end-Permian mass extinction, in which most of the known species died out.

The Beaufort Group comprises of the older Adelaide Subgroup and younger Tarkastad Subgroup. The Adelaide Subgroup overlies the Volksrust Formation (Ecca Group). The Beaufort Group is subdivided into a series of biostratigraphic units based on its faunal content. This Subgroup is divided into three Formations namely the oldest Kroonap formation, the Middleton Formation and the youngest Balfour formation. The latter formation is followed by the Katberg/Verkykerskop and Burgersdorp/Driekoppen Formations of the Tarkastad Subgroup. The flood plains of the Beaufort Group (Karoo Supergroup) are internationally renowned for the early diversification of land vertebrates and provide the worlds' most complete transition from early "reptiles" to mammals.

The Balfour Formation has an abundant assemblage of vertebrates. Fossils of the Balfour Formation includes vertebrates from the *Daptocecphalus* and *Lystrosaurus* Assemblage Zones (AZ) (Rubidge et al, 1995; MacRae, 1999; McCarthy and Rubidge, 2005; Johnson et al, 2009). Several important trace fossil assemblages, comprising casts of vertebrate burrows and vertebrate tracks have also been described from this Formation (Groenewald, 1996; Johnson *et al*., 2009).

The Middleton Formation is known for its Glossopteris fossils plant assemblages. During the Permian these plants inhabited a diversity of ecological niches, which includes riverine forests which was dominated by conifers, cycadeoids and ginkos while diverse assemblages of insects are also recorded from this Formation. This Formation is represented by rich assemblages of vertebrates found in the *Pristerognathus, Tropidostoma* and *Cistecephalus* Assemblage Zones of the Karoo Basin, (Rubidge, *et al*, 1995; MacRae, 1999; McCarthy, 2005).

The *Eodicynodon* and *Tapinocephalus* Assemblage Zones are present in the Kroonap Formation. The *Eodicynodon* AZ is characterised by *Eodicynodon* and *Tapinocaninus* fossils. The *Tapinocephaus* AZ has a rich diversity of Therapids, dinocephalia, while amphibia, fish and plant fossils are also present.

The *Lystrosaurus* AZ also includes the Palingkloof Member (*Daptocephalus* AZ, Adelaide Subgroup) (Groenewald, *et al,* 1995, Rubidge, 2005). The lower Palingkloof Member is palaeontologically

important as it precedes the Permo-Triassic Extinction Event which is to date the greatest Mass Extinction in history. This extinction killed off the diverse glossopterid plants and almost destroyed the vertebrate fauna. The fossil heritage of the Early Triassic Katberg Formation is also palaeontological noteworthy because they document the recovery of terrestrial biotas replacing the catastrophic end-Permian Mass Extinction event (approximately 251 million years ago).

The *Lystrosaurus* AZ (Katberg/ Verkykerskop Formations) is named after the dicynodont *Lystrosaurus* which consists of up to 95% of fossils found in this biozone (Botha & Smith 2007). The *Lystrosaurus* AZ is also known for *Procolophon* a small captorhinid parareptile and *Proterosuchus* which is a crocodile-like early archosaur. Small true reptile owenettids, therocephalians, and early cynodonts (*Galesaurus, Thrinaxodon*) and armour-plated "labyrinthodont" amphibians (*Lydekkerina*) are also present in this biozone. This biozone is also known by vertebrate and invertebrate burrows. Invertebrate burrows are represented by aquatic and land-living organisms while tetrapod burrows include various cynodonts, procolophonids and *Lystrosaurus* (Groenewald 1991, Groenewald and Kitching, 1995, Damiani, *et al.* 2003, Abdala, *et al.* 2006). Vascular plants are rare although arthrophyte ferns (*Schizoneura*, *Phyllotheca*), petrified wood ("*Dadoxylon*") and leaves of glossopterid progymnosperms are present.

The *Cynognathus* AZ (Burgersdorp/ Driekoppen Formations) is dominated by amphibians, therapsids and reptiles. The Burgersdorp biotas include fish groups, rich freshwater vertebrate fauna as well as large capitosaurid and trematosuchid amphibians. The reptile fauna includes primitive archosaurs lizard-like sphenodontids and rhynchosaurs. Therapsids include *Kannemeyeria and* numerous small to medium-sized carnivorous and herbivorous therocephalians and advanced cynodonts. Tetrapod trackways and burrows are also present.

The Stormberg Group

The Beaufort Group is followed by the Stormberg Group. The Stromberg Group consist of the youngest Clarens Formation, middle Elliot Formation and oldest Molteno Formation. The Molteno Formation is world renowned for its Mesozoic *Dicroidium* assemblages (plant fossils). The Elliot Formation is known for its early dinosaur and mammal remains while the Clarens Formation is known for dinosaur fossils and footprints. This Group has a high Palaeontological sensitivity.

Barberton Supergroup

The Onverwacht Group forms the basal unit of the Barberton Supergroup. The rocks are part of one of the oldest greenstone belts on Earth and represent a unique assemblage of some of the best-preserved, and most ancient rocks on Earth (Brandle et al., 2006). This Group comprise of six formations and include the stratigraphically younger Geluk Subgroup and the oldest Tjakastad Subgroup. The Tjakastad Subgroup consist of a thick series of igneous rocks. The Sandspruit Formation is approximately 2100m thick and consists of tectonic slices (megaxenoliths). Lithologically, it comprises of deformed and metamorphosed mafic and ultramafic rocks as well as subordinate metasedimentary beds.

The Geluk Subgroup are volcanic in origin (similar to the underlying Tjakastad Subgroup) but can be differenciated from the underlying subgroup by the occurrence of subordinate felsic lavas and visible banded chert (silicified pyroclastics) (Brandle. et al., 2006).

Scientist is of the opinion that the Onverwacht Group is an Achaeanage marine crust that was pushed alongside a volcanic arc. This caused deformation and metamorphism. The banded cherts and felsic lavas present within the Geluk Subgroup are thought to be the result of increasing proximity of the seafloor to the volcanoes of the volcanic arc (Brandle et al., 2006). Greenstone Belt is applied to the succession of volcanic rocks that have been exposed to low grade metamorphism. Green metamorphic minerals such as chlorite is thus present in the Greenstone Belt.

The Barberton Sequence of Mpumalanga consists of three Groups namely the youngest Moodies Group, middle Fig Tree Group and oldest Onverwacht Group. These groups comprise mainly of volcanic igneous rocks, and igneous intrusions, as well as minor sediments such as quartzite, schists, banded iron formation, chert and conglomerate. The oldest microfossils are found in the Onverwacht Group (Kromberg Formation). Microbial mats and stromatolites are present in cherts of this Greenstone Belt. Stromatolites are layered mounds, columns and sheet-like sedimentary rocks. These structures were originally formed by the growth of layer upon layer of cyanobacteria, a single-celled photosynthesizing microbe. Cyanobacteria are prokaryotic cells (simplest form of modern carbon-bases life). Stromatolites are first found in Precambrian rocks and are known as the earliest known fossils. The oxygen atmosphere that we depend on was generated by numerous cyanobacteria photosynthesizing during the Archaean and Proterozoic Era.

The following rock formations has a Palaeontological Sensitivity of zero and no fossils are present in these rocks.

Tshokwane Granophyre

The Tshokwane Granophyre intrusive rocks consists of Syenite and granophyre. No fossils are recorded from these rocks and thus have a zero Paleontological Sensitivity.

Nelspruit Suite

This Suite consist of two plutons, gneiss and porphyric granite. The rock is greyish to pink in colour. No fossils are recovered from this Suite.

Lebombo Group

The Jurassic Lebombo Group is Intrusive granites that consists of gabbro, gabbro-norite & granophyres This Group is up to 13 km thick

Karoo dolerite

The Karoo Igneous Province in southern Africa is a classic continental flood basalt province that was formed during the Early Jurassic Period. This province occurs over a comprehensive area in southern Africa and comprises a widespread system well developed igneous bodies (dykes, sills) that invaded the sediments of the Main Karoo Basin. Flood basalts do not typically form any visible volcanic structures, but with a series of outbursts form a suite of fissures of sub-horizontal lava flows that may vary in thickness. The Karoo is considered to be an old flood basalt province and is preserved today as erosional remnants of a more extensive lava cap that covered much of southern Africa in the geological past. This Suite is unfossiliferous According to the PalaeoMap of South African Heritage Resources Information System the Palaeontological Sensitivity of the Karoo Dolerite is zero

6 GEOGRAPHICAL LOCATION OF THE SITE

The proposed development follows the borders of South Africa and its neighbouring countries Mozambique and Swaziland (Fig 1).

7 METHODS

As part of the Palaeontological Impact Assessment, a field-survey of the development footprint was conducted in February 2018 to assess the potential risk to palaeontological material (fossil and trace fossils) in the proposed footprint of the development. A physical field-survey was conducted on foot and by vehicle within the proposed development footprint. The results of the field-survey, the author's experience, aerial photos (using Google Earth, 2018), topographical and geological maps were used to assess the proposed development footprint. No consultations were undertaken for this Impact Assessment.

The National Defence Force is thanked for their support and escort throughout the KZN development footprint as the chance of a car hijack was eminent. It is much appreciated.

7.1 Assumptions and limitations

The accuracy of Desktop Palaeontological Assessment is reduced by several factors which may include: the databases of institutions are not always up to date and relevant locality and in the past geological information were not accurately documented. Various remote areas of South Africa have not been evaluated by palaeontologists and data is based on aerial photographs alone. Geological maps focusses on the geology of an area and the sheet explanations were never intended to focus on palaeontological heritage.

Similar Assemblage Zones, but in different areas is used to provide information on the presence of fossil heritage in an unmapped area. Desktop studies of similar geological formations and Assemblage Zones generally **assume** that exposed fossil heritage is present within the development area. The accuracy of the Palaeontological Impact Assessment is thus improved considerably by conducting a field-assessment.

8 FIELD OBSERVATIONS

The following photographs were taken on a site visit to the proposed development footprint. Only the areas in the development footprint with a High to very High Palaeontological Sensitivity (according to the SAHRIS Sensitivity Map) were evaluated. No fossils were found in the proposed development footprint although several gastropod fossils are known to the author from the Ndumo Game reserve.

High and very Palaeontological Sensitive areas at the KZN –Mozambique Border

26° 52'02"S 32°49'44"E Border	
26° 52'02"S 32°49'44"E Proposed Camp Site	
26° 51'51"S 32°51'04"E Border fence and road next to the fence	

26° 50’28”S 32°52’44”E Border fence and road next to the fence	
26° 51’48”S 32°45’60”E Border fence	

26° 51’49”S 32°47’29”E Vegetation next to the border fence	
26° 52’05”S 32°41’38”E Thick unfossiliferous topsoil without outcrops	
Lush vegetation without fossiliferous outcrops	

Border fence at Tembe National Elephant Park	

Very High Palaeontological Sensitive areas at the Swaziland Border

25° 55’57”S 32°45’38”E	
25° 55’53.73”S 32°45’38.06”E	

25° 55’58”S 32°45’03.52”E	
25° 56’11.03”S 32°46’02.14”E	

9 FINDINGS AND RECOMMENDATIONS

The proposed project and base camp are underlain by various sedimentary rocks of which the **Quaternary** and the **Undifferentiated Karoo** has a **high Palaeontological sensitivity** and **the Zululand Group** which has a **very high palaeontological sensitivity**. The various intrusive rocks have an igneous origin and is thus unfossiliferous and has a zero palaeontological sensitivity. As part of the Palaeontological Impact Assessment, a field-survey of the development footprint was conducted in February 2018 to assess the potential risk to palaeontological material in the proposed footprint of the development. A physical field-survey of the proposed development and camping site was conducted on foot and by vehicle and during this field survey, **no fossiliferous outcrops** were found in the development footprint. For this reason, a **low palaeontological sensitivity** is allocated to the development footprint. Although fossils are uncommon and only occur periodically a single fossil may be scientifically valuable as many fossil taxa are known from a single fossil. The recording of fossils will expand our knowledge of the Palaeontological Heritage of the development area.

The scarcity of fossil heritage at the proposed development footprint indicate that the impact of the proposed development will be of a low significance in palaeontological terms. It is therefore considered that the proposed Swaziland-Mozambique Border Patrol Road and Mozambique Barrier Structure 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 facility may be authorised as the

whole extent of the development footprint is not considered sensitive in terms of palaeontological resources.

However, if fossil remains are discovered during any phase of construction, either on the surface or exposed by new excavations the **Chance Find Protocol** must be implemented by the ECO in charge of these developments. These discoveries ought to be protected (*in situ* if possible) and the ECO must report to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) so that suitable mitigation (recording and collection) can be carry out by a paleontologist.

Preceding any collection of fossil material, the specialist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an accredited collection (museum or university collection), while all fieldwork and reports should meet the minimum standards for palaeontological impact studies suggested by SAHRA.

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9.1 INTRODUCTION: IMPACT ASSESSMENT METHODOLOGY

Impact assessment must take account of the nature, scale and duration of effects on the environment, whether such effects are positive (beneficial) or negative (detrimental). Each issue / impact is also assessed according to the project stages from planning, through construction and operation to the decommissioning phase. Where necessary, the proposal for mitigation or optimisation of an impact is noted. A brief discussion of the impact and the rationale behind the assessment of its significance is provided in this Section.

The EIA of the project activities is determined by identifying the environmental aspects and then undertaking an environmental risk assessment to determine the significant environmental aspects. The environmental impact assessment is focussed on the following phases of the project namely:

- Planning Phase;
- Construction Phase; and
- Operational Phase.

As the project entails rehabilitation of existing infrastructure which will be permanent, decommissioning is not applicable to this project, however, impacts associated with post construction clean-up are considered.

9.2 IMPACT ASSESSMENT METHODOLOGY

The potential environmental impacts associated with the project will be evaluated according to its nature, extent, duration, intensity, probability and significance of the impacts, whereby:

- ***Nature:*** A brief written statement of the environmental aspect being impacted upon by a particular action or activity;
- ***Extent:*** The area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales. This is often useful during the detailed assessment phase of a project in terms of further defining the determined significance or intensity of an impact. For example, high at a local scale, but low at a regional scale;
- ***Duration:*** Indicates what the lifetime of the impact will be;
- ***Intensity:*** Describes whether an impact is destructive or benign;
- ***Probability:*** Describes the likelihood of an impact actually occurring; and
- ***Cumulative:*** In relation to an activity, means the impact of an activity that in itself may not be significant but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area.

The criteria to be used for the rating of impacts are provided in **Table 8-1**.

Table 9-1: Criteria to be used for the rating of impacts

Criteria	Description			
EXTENT	**National (4)** The whole of South Africa	**Regional (3)** Provincial and parts of neighbouring provinces	**Local (2)** Within a radius of 2 km of the construction site	**Site (1)** Within the construction site
DURATION	**Permanent (4)** Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact can be considered transient	**Long-term (3)** The impact will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter. The only class of impact which will be non-transitory	**Medium-term (2)** The impact will last for the period of the construction phase, where after it will be entirely negated	**Short-term (1)** The impact will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase
INTENSITY	**Very High (4)** Natural, cultural and social functions and processes are altered to extent that they permanently cease	**High (3)** Natural, cultural and social functions and processes are altered to extent that they temporarily cease	**Moderate (2)** Affected environment is altered, but natural, cultural and social functions and processes continue albeit in a modified way	**Low (1)** Impact affects the environment in such a way that natural, cultural and social functions and processes are not affected
PROBABILITY OF OCCURRENCE	**Definite (4)** Impact will certainly occur	**Highly Probable (3)** Most likely that the impact will occur	**Possible (2)** The impact may occur	**Improbable (1)** Likelihood of the impact materialising is very low

Significance is determined through a synthesis of impact characteristics. Significance is also an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of significance of the impact.

Table 9-2: Criteria for the rating of classified impacts

	Class	Description
+	**Any value**	Any positive / beneficial 'impact', i.e. where no harm will occur due to the activity being undertaken.
–	**Low impact (4 -6 points)**	A low impact has no permanent impact of significance. Mitigation measures are feasible and are readily instituted as part of a standing design, construction or operating procedure.
	Medium impact (7 -9 points)	Mitigation is possible with additional design and construction inputs.
	High impact (10 -12 points)	The design of the site may be affected. Mitigation and possible remediation are needed during the construction and/or operational phases. The effects of the impact may affect the broader environment.
	Very high impact (12 - 14 points)	Permanent and important impacts. The design of the site may be affected. Intensive remediation is needed during construction and/or operational phases. Any activity which results in a "very high impact" is likely to be a fatal flaw.
Status		Denotes the perceived effect of the impact on the affected area.
Positive (+)		Beneficial impact.
Negative (-)		Deleterious or adverse impact.
Neutral (*I*)		Impact is neither beneficial nor adverse.
It is important to note that the status of an impact is assigned based on the *status quo* – i.e. should the project not proceed. Therefore, not all negative impacts are equally significant.		

The suitability and feasibility of all proposed mitigation measures will be included in the assessment of significant impacts. This will be achieved through the comparison of the significance of the impact before and after the proposed mitigation measure is implemented. Mitigation measures identified as necessary will be included in an EMPr.

9.3 POTENTIAL IMPACTS AND SIGNIFICANCE

The following sections will provide a description of the potential impacts as identified by the specialist assessment, EAP and through the PPP as well as the assessment according to the criteria described in **Table 8-1** and **8-2**.

All potential impacts associated by the proposed development through the construction and operation of the development life-cycle have been considered and assessed in the following sections. As the infrastructure is expected to be permanent, the decommissioning phase impacts have not been considered.

It must be noted that any impact on the Palaeontological Heritage will only be during the CONSTRUCTION phase and that only the Areas of High and Very High Palaeontological Sensitivity will be impacted upon.

9.3.1 Construction Phase Impacts

Table 9-3: Construction phase impacts

Phase	Potential Aspect and/or Impact	Mitigation	Extent (E)	Duration (D)	Intensity (I)	Probability (P)	Significance (E+D+I+P)	
Construction	**Aspect:** ***T***he excavations and clearing of vegetation during the construction phase will consist of digging into the superficial sediment cover as well as underlying deeper bedrock. These excavations will change the existing topography and may possibly disturb, destroy or permanently close-in fossils at or below the ground surface. These fossils will then be lost for research. **Impact:** Destruction of fossil Heritage Damaging impacts on palaeontological heritage occur during the **construction** phase which will modify the existing topography	**Without**	1	4	1	2	-8	**Medium Negative**
		With	1	4	1	1	-7	Medium Negative
		Key mitigation measures: ***Not necessary*** In the event that fossil remains are discovered during any phase of construction, either on the surface or unearthed by fresh excavations, the ECO in charge of these developments ought to be alerted immediately. These discoveries ought to be protected (preferably *in situ*) and the ECO must report to SAHRA so that appropriate mitigation (*e.g.* recording, collection) can be carry out by a professional paleontologist. Preceding any collection of fossil material, the specialist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an approved collection which comprises a museum or university collection, while all fieldwork and reports should meet the minimum standards for palaeontological impact studies proposed by SAHRA. The lack of appropriate exposure at the proposed development footprint indicates that the impact of the development is of low significance in palaeontological terms						

The numbering included in the above tables came as a result of Table 9-4

CONTENT OF SPECIALIST REPORTS ACCORDING TO APPENDIX 6 OF THE EIA REGULATIONS 2014 AS AMENDED IN 2017

(1) A specialist report prepared in terms of these Regulations must contain-

a) details of-
   (i) the specialist who prepared the report; and

   (ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;

b) a declaration that the specialist is independent in a form as may be specified by the competent authority;
c) an indication of the scope of, and the purpose for which, the report was prepared;
d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;
e) a description of the methodology adopted in preparing the report or carrying out the specialised process;
f) the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;
g) an identification of any areas to be avoided, including buffers;
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;
i) a description of any assumptions made and any uncertainties or gaps in knowledge;
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;
k) any mitigation measures for inclusion in the Environmental Management Programme (EMPr);
l) any conditions for inclusion in the environmental authorisation;
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;
n) a reasoned opinion- (i) as to whether the proposed activity or portions thereof should be authorised; and (ii) 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;
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and
q) any other information requested by the competent authority.
r) Original signed specialist declaration.

10 CHANCE FINDS PROTOCOL

A following procedure will only be followed if fossils are uncovered during excavation.

10.1 LEGISLATION

Cultural Heritage in South Africa (includes all heritage resources) is protected by the **National Heritage Resources Act (Act 25 of 1999) (NHRA).** According to Section 3 of the Act, all Heritage resources include **"all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens**".

Palaeontological heritage is unique and non-renewable and is protected by the NHRA and are the property of the State. It is thus the responsibility of the State to manage and conserve fossils on behalf of the citizens of South Africa. Palaeontological resources may not be excavated, broken, moved, or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority as per section 35 of the NHRA.

10.2 BACKGROUND

A fossil is the naturally preserved remains (or traces) of plants or animals embedded in rock. These plants and animals lived in the geologic past millions of years ago. Fossils are extremely rare and irreplaceable. By studying fossils it is possible to determine the environmental conditions that existed in a specific geographical area millions of years ago.

10.3 INTRODUCTION

This informational document is intended for workmen and foremen on construction sites. It describes the actions to be taken when mining or construction activities accidentally uncovers fossil material.

It is the responsibility of the Environmental Control Officer (ECO) of the project to train the workmen and foremen in the procedure to follow when a fossil is accidentally uncovered. In the absence of the ECO, a member of the staff must be appointed to be responsible for the proper implementation of the chance find protocol as not to compromise the conservation of fossil material.

10.4 CHANCE FIND PROCEDURE

- If a chance find is made the person responsible for the find must immediately **stop working** and all work must cease in the immediate vicinity of the find.
- The person who made the find must immediately **report** the find to his/her direct supervisor which in turn must report the find to his/her manager and the ECO or site manager. The ECO must report the find to the relevant Heritage Agency (South African Heritage Research Agency, SAHRA). (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). The information to the Heritage Agency must include photographs of the find, from various angles, as well as the GPS co-ordinates.

- A preliminary report must be submitted to the Heritage Agency within **24 hours** of the find and must include the following: 1) date of the find; 2) a description of the discovery and a 3) description of the fossil and its context (depth and position of the fossil), GPS co-ordinates.
- Photographs (as many as you can) of the discovery must be of high quality, in focus, accompanied by a scale. It is also important to have photographs of the vertical section (side) where the fossil was found.

Upon receipt of the preliminary report, the Heritage Agency will inform the ECO (site manager) whether a rescue excavation or rescue collection by a palaeontologist is necessary.

- The site must be secured to protect it from any further damage. **No attempt** should be made to remove material from their environment. The exposed finds must be stabilized and covered by a plastic sheet or sand bags. The Heritage agency will also be able to advise on the most suitable method of protection of the find.
- In the event that the fossil cannot be stabilized the fossil may be collected with extreme care by the ECO (site manager). Fossils finds must be stored in tissue paper and in an appropriate box while due care must be taken to remove all fossil material from the rescue site.
- Once Heritage Agency has issued the written authorization, the developer may continue with the development.

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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 experience in locating, collecting and curating fossils, including exploration field trips in search of new localities in the Karoo Basin. She has been a member of the Palaeontological Society of South Africa for 10 years and have been been conducting Palaeontological Impact Assessments since 2014. 80 Technical reports on palaeontology (scoping reports have been written

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;

PALAEONTOLOGICAL CONSULTANT: Banzai Environmental (Pty) Ltd

CONTACT PERSON: Elize Butler

Tel: +27 844478759

Email: elizebutler002@gmail.com

SIGNATURE: