DESKTOP PALAEONTOLOGICAL HERITAGE IMPACT ASSESSMENT REPORT IN RESPECT OF A PROSPECTING RIGHT APPLICATION FOR LITHIUM ON THE FARMS OCEAAN 064 REM, OCEAAN 099 REM, KRONENBLOEM 051 REM, BROODKOP 304 PTN 1 AND HOOGE BULT 542 REM AND VARIOUS EXTENTS OF THE FARMS FELIX 380 REM, GOEDGUNST 315 REM, VENSTERBLOEM 163 REM, BROODKOP 304 REM, ONGEGUND 007 REM, GOUDLAAGTE 238 REM, VERDEEL 278 REM, GELUK 237 REM, ENKELBOSCH 031 PTN 7, ENKELBOSH 031 REM AND ENKELBOSH 031 PTN 1 LOCATED APPROXIMATELY 7.5 KM WEST OF DOVER AND 12 KM NORTH OF KOPPIES, FREE STATE PROVINCE

14 November 2019

Prepared for:

Heritage Contracts and Archaeological Consulting CC

On behalf of:

Lengana Health SA(Pty) Ltd

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Prepared for:

Heritage Contracts and Archaeological Consulting CC

On Behalf of:

Lengana Health SA (Pty) Ltd

Prepared By:

Dr B.D. Millsteed

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EXECUTIVE SUMMARY

A desktop study has been conducted on the site of a Prospecting Right application to explore for lithium on various farms that form one application area. The site is located approximately 7.5 km west of Dover and 12 km north of Koppies, in the Koppies Magisterial Districts, Fezile Dabi District Municipality and Ngwathe Local Municipality, Free State Province. The Prospecting Right application area can be located within the confines of 1:50 000 topographic map 2727BA. The aerial extent of the Prospecting Right application area is 2 195 ha.

The expected duration of the proposed exploration activities triggering this report is <4 months. However, the maximum allowable term for the life of a Prospecting Right is 5 years (with a possibility for renewal for a further 3 years).

Heritage Contracts and Archaeological Consulting CC has been appointed, as independent consultants, to conduct the Heritage Impact Assessment component of the reporting process for this Prospecting Right application. Heritage Contracts and Archaeological Consulting CC has retained BM Geological Services to provide a desktop Palaeontological Heritage Impact Assessment Report in respect of the proposed project that will form part of the final Heritage Impact Assessment Report.

The aerial extent of the Prospecting Right application area is underlain by a lithologically diverse assemblage of stratigraphic units consisting of Swazian (Archaean) greenstones of the Greenlands Formation (of the Johannesburg Dome), sandstone, mudstones and coals of the Vryheid and Volksrust Formations, and intrusive dolerite of the Karoo Dolerite Suite. It is interpreted that Cainozoic regolith forms the land surface over the majority of the Prospecting Right application area.

Most of the exploration activities to be undertaken are non-invasive and will result in disturbance of the immediate land surface (<0.5 m in depth). The invasive phase of exploration will consist of the drilling of eight (8) diamond borehole. The excavation of eight (8) sumps to house drilling muds for the diamond drilling program will require excavation of small voids < 1.5 m deep and < 4 m^2 in area. These activities will impact predominantly upon the regolith cover; although in the case of the northern-most six (6) of the holes there may also be some impact upon the Greenlands Formation. The southern-most two (2) of the boreholes may impact upon the Volksrust Formation. The boreholes will impact upon the regolith, Greenlands Formation, and the Volksrust Formation (and there is a low possibility of the Vryheid Formation being impacted).

The rocks comprising the Greenlands Formation, and the Karoo Dolerite Suite are unfossiliferous. It is also interpreted that the Cainozoic regolith is unfossiliferous. Any impacts upon these units caused by the progression of the prospecting operations will have **negligible to nil** probability of resulting in a negative impact upon their

palaeontological heritage. The sediments of the Volksrust and Vryheid Formations are known to contain plant macrofossil assemblages of the *Glossopteris* flora (the former also containing trace fossil assemblages). The significance of the fossil assemblages contained in these two units was assessed as **high**, but the probability of any negative impact is **moderate to good** for the Volksrust Formation and **low** for the Vryheid Formation.

Almost the entire extent of the project area appears to bear a significant Cainozoic regolith cover. The regolith itself is unfossiliferous. It is also the case that almost all of the area which is the subject of the Prospecting Right application area has been cultivated (ploughed). The implication of the heavily disturbed nature of the land surface is that any fossils that may have been existed it (either as syndepositional or inherited from the bedrock) and which would have been observable at surface will have been destroyed as a result of the historical ploughing. In addition, six (6) of the eight boreholes are planned to be collared upon the non-fossiliferous Greenlands Formation. So even if regolith is not present, the bedrock that will be impacted contains no fossils. Only the southern-most two (2) boreholes will be collared in potentially fossiliferous bedrock (the Volksrust Formation). However, as discussed above, it is most likely that the land surface will be the regolith. As almost all of the prospecting activities will only impact the land surface to a depth of < 1.5 m it will only be the regolith that will be affected. The boreholes will impact upon the Volksrust Formation (and possibly the Vryheid Formation) at depth, but as discussed above this impact of the boreholes upon the fossil heritage of the units will be unimportant.

The following damage mitigation protocols are suggested: -

- Given the above discussion, a site visit and thorough field investigation as part of a Full Impact Assessment it is not recommended as there will be little to no opportunity to observe fossils at surface.
- No damage mitigation protocols are required to be enacted for this prospecting phase of the project.
- The only opportunity for this project to meaningfully impact upon the palaeontological heritage of the area will be if the project proceeds to a mining phase.
- Should the project wish to proceed to a mining phase a Palaeontological Heritage Impact Assessment report should be prepared and submitted to SAHRA prior to commencement of the mining (during the authorisation process).

This desktop study has not identified any palaeontological reason to prejudice the progression of this exploration project provided it operates within the parameters described herein.

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TABLE OF FIGURES

1 INTRODUCTION

Lengana Health SA (Pty) Ltd has applied for a Prospecting Right in respect of lithium on the farms: -

- Oceaan 064 Rem
- Oceaan 099 Rem
- Kronenbloem 051 Rem
- Broodkop 304 Ptn 1
- Hooge Bult 542 Rem

and various extents of the farms:

- Felix 380 Rem
- Goedgunst 315 Rem
- Vensterbloem 163 Rem
- Broodkop 304 Rem
- Ongegund 007 Rem
- Goudlaagte 238 Rem
- Verdeel 278 Rem
- Geluk 237 Rem
- Enkelbosch 031 Ptn 7
- Enkelbosh 031 Rem
- Enkelbosh 031 Ptn 1

The site is located approximately 7.5 km west of Dover and 12 km north of Koppies, in the Koppies Magisterial District, Fezile Dabi District Municipality and Ngwathe Local Municipality, Free State Province (Figure 1). The application area lies between the N1 highway and the R82 road (Figure 1). Access to the project area is gained from the N1 via the R723 gravel road. The Prospecting Right area can be located within the confines of 1:50 000 topographic map 2727BA. The aerial extent of the Prospecting Right application area is 2 195 ha. The co-ordinates of the corner points defining the perimeter of the Prospecting Right application area and its composite farm portions is provided in Figure 2.

The expected duration of the proposed exploration activities triggering this report is <4 months. However, the maximum allowable term for the life of a Prospecting Right is 5 years (with a possibility for renewal for a further 3 years).

Heritage Contracts and Archaeological Consulting CC has been appointed, as independent consultants, to conduct the Heritage Impact Assessment component of the reporting process for this Prospecting Right application. Heritage Contracts and Archaeological Consulting CC has retained BM Geological Services to provide a desktop Palaeontological Heritage Impact Assessment Report in respect of the proposed project that will form part of the final Heritage Impact Assessment Report.

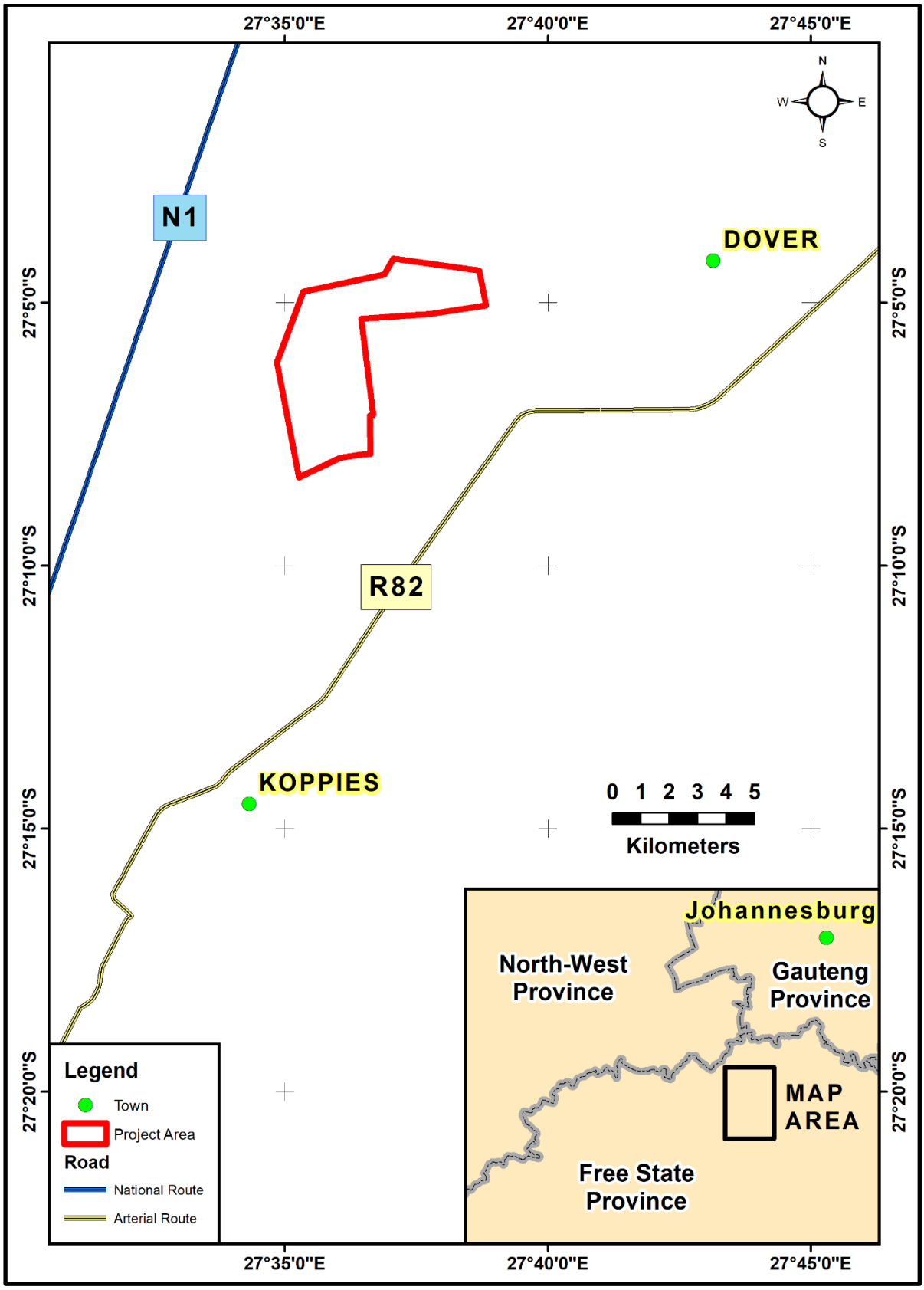
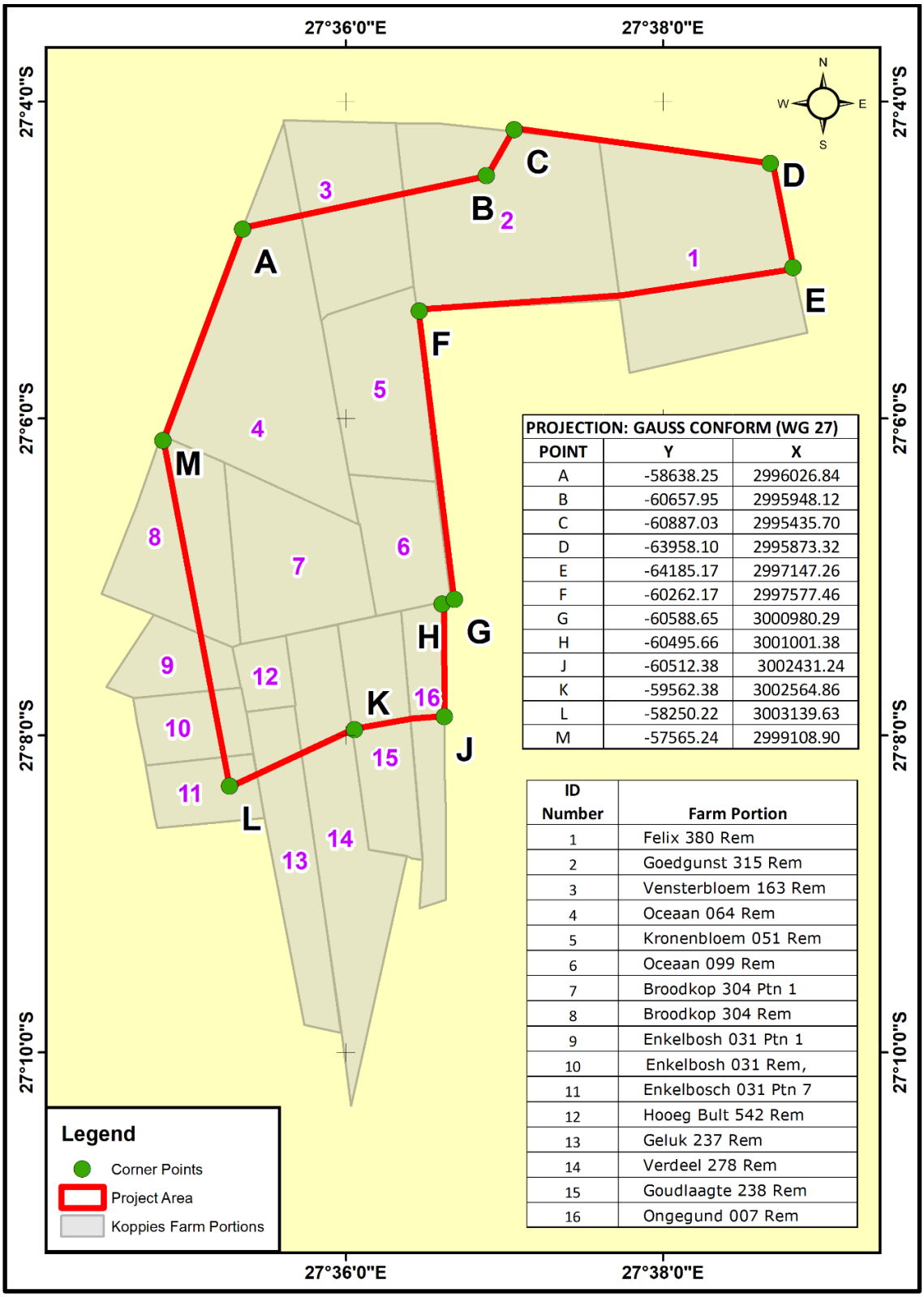


Figure 1: Location of the Prospecting Right application area.



PROJECTION: GAUSS CONFORM (WG 27)		
POINT	Y	X
A	-58638.25	2996026.84
B	-60657.95	2995948.12
C	-60887.03	2995435.70
D	-63958.10	2995873.32
E	-64185.17	2997147.26
F	-60262.17	2997577.46
G	-60588.65	3000980.29
H	-60495.66	3001001.38
J	-60512.38	3002431.24
K	-59562.38	3002564.86
L	-58250.22	3003139.63
M	-57565.24	2999108.90

ID Number	Farm Portion
1	Felix 380 Rem
2	Goedgunst 315 Rem
3	Vensterbloem 163 Rem
4	Oceaan 064 Rem
5	Kronenbloem 051 Rem
6	Oceaan 099 Rem
7	Broodkop 304 Ptn 1
8	Broodkop 304 Rem
9	Enkelbosh 031 Ptn 1
10	Enkelbosh 031 Rem,
11	Enkelbosch 031 Ptn 7
12	Hooeg Bult 542 Rem
13	Geluk 237 Rem
14	Verdeel 278 Rem
15	Goudlaagte 238 Rem
16	Ongegund 007 Rem

Figure 2: Map of the various farm potions that comprise the Prospecting Right area. Shown also are the corner points that define the Prospecting Right's boundary and the co- ordinates of those corner points.

2 TERMS OF REFERENCE AND SCOPE OF THE STUDY

The terms of reference for this study were as follow: -

- Conduct a desktop assessment of the potential impact of the proposed project on the palaeontological heritage of the project area.
- Describe the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions.
- Quantify the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions.
- Provide an overview of the applicable legislative framework.
- Make recommendations concerning future work programs as, and if, necessary.

3 LEGISLATIVE REQUIREMENTS

South Africa's cultural resources are primarily dealt with in two Acts. These are the National Heritage Resources Act (Act 25 of 1999) and the National Environmental Management Act (Act 107 of 1998).

3.1 The National Heritage Resources Act

The following are protected as cultural heritage resources by the National Heritage Resources Act:

- Archaeological artefacts, structures and sites older than 100 years.
- Ethnographic art objects (e.g. prehistoric rock art) and ethnography.
- Objects of decorative and visual arts.
- Military objects, structures and sites older than 75 years.
- Historical objects, structures and sites older than 60 years.
- Proclaimed heritage sites.
- Grave yards and graves older than 60 years.
- Meteorites and fossils.
- Objects, structures and sites or scientific or technological value

The Act also states that those heritage resources of South Africa which are of cultural significance or other special value for the present community and for future generations must be considered part of the national estate and fall within the sphere of operations of heritage resources authorities. The national estate includes the following:

- Places, buildings, structures and equipment of cultural significance.
- Places to which oral traditions are attached or which are associated with living heritage.
- Historical settlements and townscapes.
- Landscapes and features of cultural significance.
- Geological sites of scientific or cultural importance.

- Sites of Archaeological and palaeontological importance.
- Graves and burial grounds.
- Sites of significance relating to the history of slavery.
- Movable objects (e.g. archaeological, palaeontological, meteorites, geological specimens, military, ethnographic, books etc.).

3.2 Need for Impact Assessment Reports

Section 38 of the Act stipulates that any person who intends to undertake an activity that falls within the following:

- The construction of a linear development (road, wall, power line, canal etc.) exceeding 300 m in length.
- The construction of a bridge or similar structure exceeding 50 m in length.
- Any development or other activity that will change the character of a site and exceed 5 000 m^2 or involve three or more existing erven or subdivisions thereof.
- Re-zoning of a site exceeding 10 000 $m^{2.}$
- Any other category provided for in the regulations of SAHRA or a provincial heritage authority.

must at the very earliest stages of initiating such a development, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development. If there is reason to believe that heritage resources will be affected by such development, the developer may be notified to submit an impact assessment report. A Palaeontological Impact Assessment (PIA) only looks at the potential impact of the development palaeontological resources of the proposed area to be affected.

3.3 Legislation Specifically Pertinent to Palaeontology*

*****Note: Section 2 of the Act defines "palaeontological" material as "any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains".

Section 35(4) of this Act specifically deals with archaeology, palaeontology and meteorites. The Act states that no person may, without a permit issued by the responsible heritage resources authority (national or provincial):

- Destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite.

- Destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite.
- Trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or
- Bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment that assists in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.
- Alter or demolish any structure or part of a structure which is older than 60 years as protected.

The above-mentioned palaeontological objects may only be disturbed or moved by a palaeontologist, after receiving a permit from the South African Heritage Resources Agency (SAHRA). In order to demolish such a site or structure, a destruction permit from SAHRA will also be needed.

Further to the above point, Section 35(3) of this Act indicates that "any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority". Thus, regardless of the granting of any official clearance to proceed with any development based on an earlier assessment of its impact on the Palaeontological Heritage of an area, the development should be halted and the relevant authorities informed should fossil objects be uncovered during the progress of the development.

3.4 The National Environmental Management Act [as amended]

The National Environmental Management Act does not provide the detailed protections and administrative procedures for the protection and management of the nation's Palaeontological Heritage as are detailed in the National Heritage Resources Act, but this act is more general in is application. In particular Section 2(2) of the Act states that environmental management must place people and their needs at the forefront of its concerns and, amongst other issues, serve their cultural interests equitably. Further to this point section 2(4)(a)(iii) states that disturbances of sites that constitute the nation's cultural heritage should be avoided, and where it cannot be avoided should be minimised and remedied.

Section 23(1) indicates that a general objective of integrated environmental management is to identify, predict and evaluate the actual and potential impact of activities upon the cultural heritage. This section also highlights the need to identify options for mitigating of negative effects of activities with a view to minimising negative impacts.

In order to give effect to the general objectives of integrated environmental management outlined in the Act the potential impact on cultural heritage of activities that require authorisation or permission by law must be investigated and assessed prior to their implementation and reported to the relevant organ of state. Thus, a survey and evaluation of cultural resources must be done in areas where development projects that will potentially negatively affect the cultural heritage will be performed. During this process the impact on the cultural heritage will be determined and proposals for the mitigation of the negative effects made.

4 RELEVENT EXPERIENCE

Dr Millsteed holds a PhD in palaeontology and has previously been employed as a professional palaeontologist with the Council for Geoscience in South Africa. He is currently the principle of BM Geological Services and has sufficient knowledge of palaeontology and the relevant legislation required to produce this Palaeontological Impact Assessment Report. Dr Millsteed is registered with the South African Council for Natural Scientific Professions (SACNASP; Reg. No. 400332/07), is a member of the Palaeontological Society of South African and the Association of Australasian Palaeontologists and is also a Fellow of the Geological Society of South Africa.

5 INDEPENDENCE

Dr Millsteed was contracted as an independent consultant to conduct this desktop Palaeontological Heritage Impact Assessment study and shall receive fair remuneration for these professional services. Neither Dr Millsteed nor BM Geological Services has any financial interest in either Lengana Health SA (Pty) Ltd, the proposed prospecting operations, nor any companies or individuals associated with the exploration project.

6 GEOLOGY AND FOSSIL POTENTIAL

The Prospecting Right application area is underlain by Mesoarchaean (Swazian) greenstone rocks of the Greenlands Formation within the Johannesburg Dome (Figures 3 and 4). The greenstones form an inlier that crops in the southern portion of the project area (where they extend to the east outside of project area). The Greenlands Formation forms the basement to the Early Permian, coal-bearing strata of the Vryheid Formation (Karoo Supergroup) and the stratigraphically overlying Volksrust Formation (Karoo Supergroup). Jurassic basalts of the Karoo Dolerite Suite crop out in the north-eastern and north-

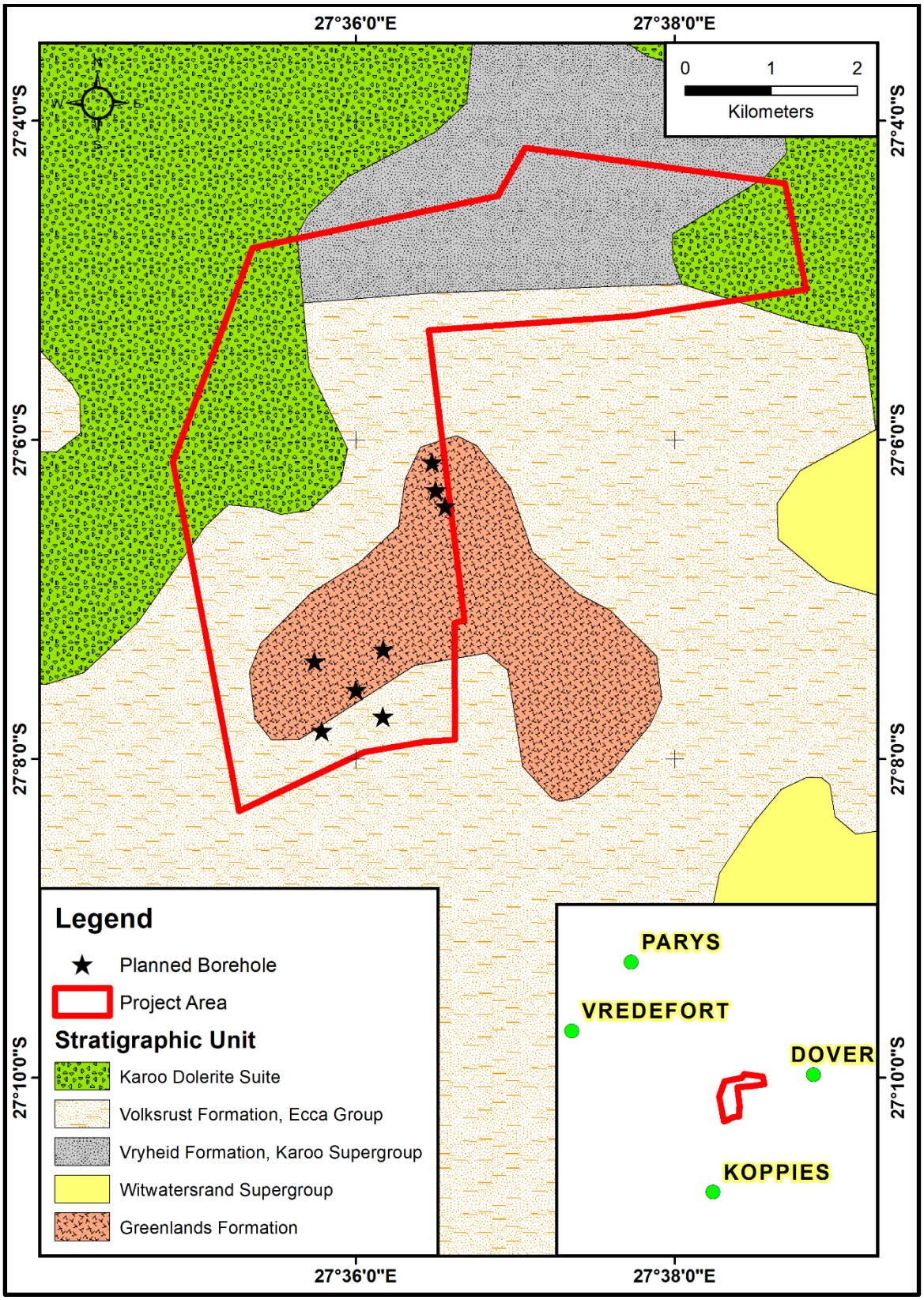


Figure 3: Map of the bed rock geology of the Prospecting Right application area and its surrounding environs.

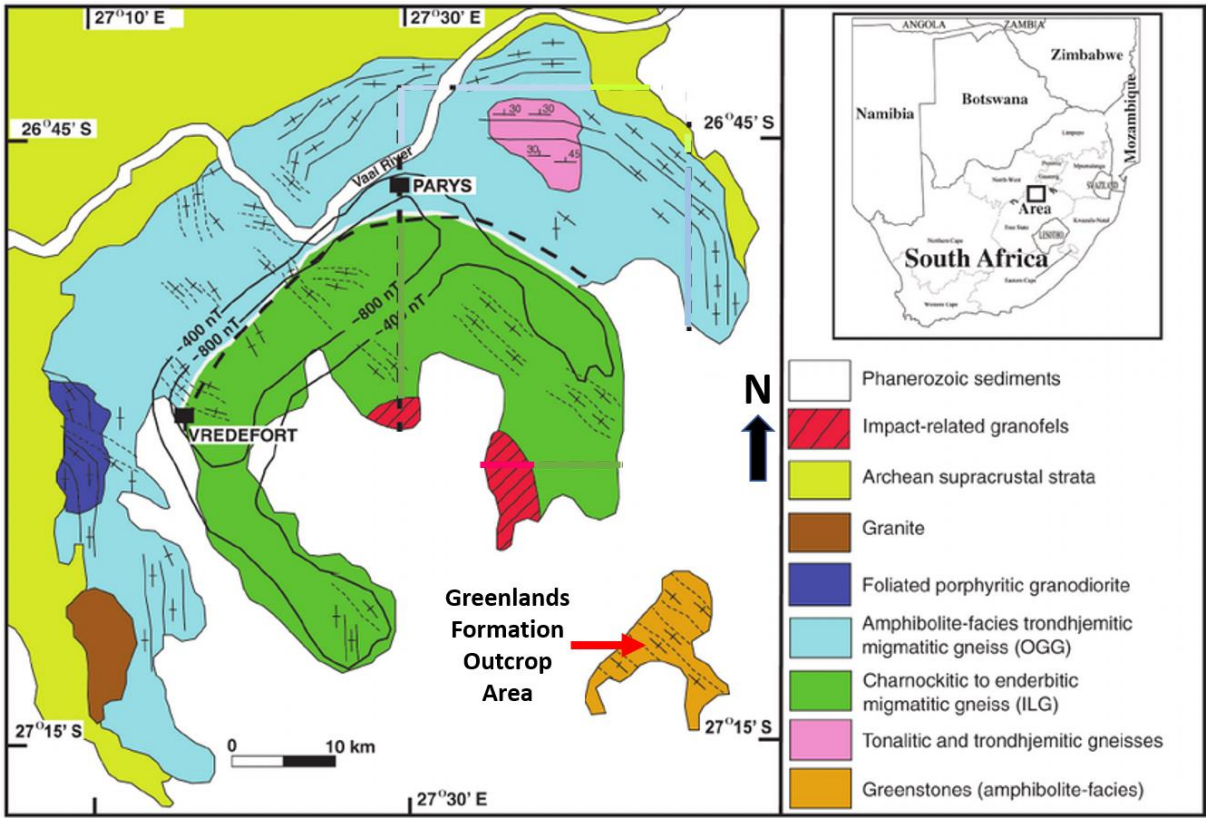


Figure 4: Simplified geological map of the Vredefort Dome area. The location of the Greenlands Formation outcrop area is shown relative to the towns of Vredefort and Parys. For the location of Vredefort and Parys relative to the project area see Figure 3 (modified from Beiki and Pedersen (2011).

western corners of the project area. A pervasive Cainozoic regolith horizon is interpreted to form the land surface over most of the Prospecting Right area. A brief description of the geology of the Prospecting Right application area and the palaeontological potential of those geological units is provided below.

6.1 Greenlands Formation

6.1.1 Geology

The Swazian-age (Mesoarchaean) rocks of the Greenlands Formation (formerly termed the Greenlands Greenstone Belt) form a megaxenolith within the older granite-gneisses of the Johannesburg Dome succession, Kaapvaal Craton (Figure 4). The greenstones are comprised of a meta-volcanic sequence primarily composed of tholeiitic to komatitic

basalts, with minor components of banded iron-formation and quartz-serecite-biotite schists occurring interleaved within the mafic-ultramafic rocks (Brandle, *et al*., 2006).

6.1.2 Palaeontological potential

The rocks of the Greenlands Formation represent a metamorphosed volcano-sedimentary succession, which is predominantly composed of meta-volcanic rocks (metamorphosed lavas). The rocks of this succession are not known to be fossiliferous. Portions of the older Barberton Greenstone Belt located in the northeast corner of South Africa and Swaziland (i.e., the Kromberg and Hoogenoeg Formations) are known to contain fossils of some of the oldest microbial mats (stromatolites) on Earth (Walsh, 1991). These fossils occur within cherts that are thought to be derived from metamorphosed sediments. However, the meta-lavas of the Greenlands Formation cannot be fossiliferous, and metamorphosed sedimentary cherts are not reported from the succession. The potential for these rocks to contain palaeontological materials is low.

6.2 Ecca Group, Karoo Supergroup

6.2.1 Vryheid and Volksrust Formations, Ecca Group

6.2.1.1 Geology

The Main Karoo Basin consists of a retro-arc foreland basin filled with a lithological succession ranging in age from the Late Carboniferous to the Middle Jurassic (Johnson *et al*., 2006). The basin-fill sequence wedges out northwards over the adjacent Kaapvaal Craton.

In the Main Karoo Basin of South Africa, the Vryheid Formation is a sandstone and coal-rich stratigraphic unit that interfingers with (i.e., is transitional with and partially time equivalent to) the overlying Volksrust and underlying Pietermaritzburg Formations; both of which are both are predominantly argillaceous (Figure 5). Genetically the Vryheid Formation can be divided into lower fluvial-dominated deltaic interval, a middle fluvial interval (the coal-bearing zone) and an upper fluvial-dominated deltaic interval (Johnson *et al*., 2006). The thickness and frequency of sandstone units increases upwards from the base of the formation, reaching their maximum in the middle fluvial interval and then decrease again towards the overlying Volksrust Formation. To the south and south-east the Vryheid Formation grades laterally into undifferentiated, deep-water argillites of the Ecca Group (Figure 5).

The Vryheid Formation is one of sixteen (16) recognised stratigraphic units that constitute the Permian Ecca Group. During the deposition of the Ecca Group the Karoo Basin was dominated by a large sea (the salinity levels of this water body remain unresolved). The exception to this model was the deposition of the coal-bearing strata of the Vryheid

Formation along the northern margin during an episode of deltaic progradation into the basin.

Deposition of the Vryheid Formation was terminated by a basin-wide transgression that drowned the Vryheid deltas and their coal swamps resulting in the deposition of the deep-water sediments of the Volksrust Formation.

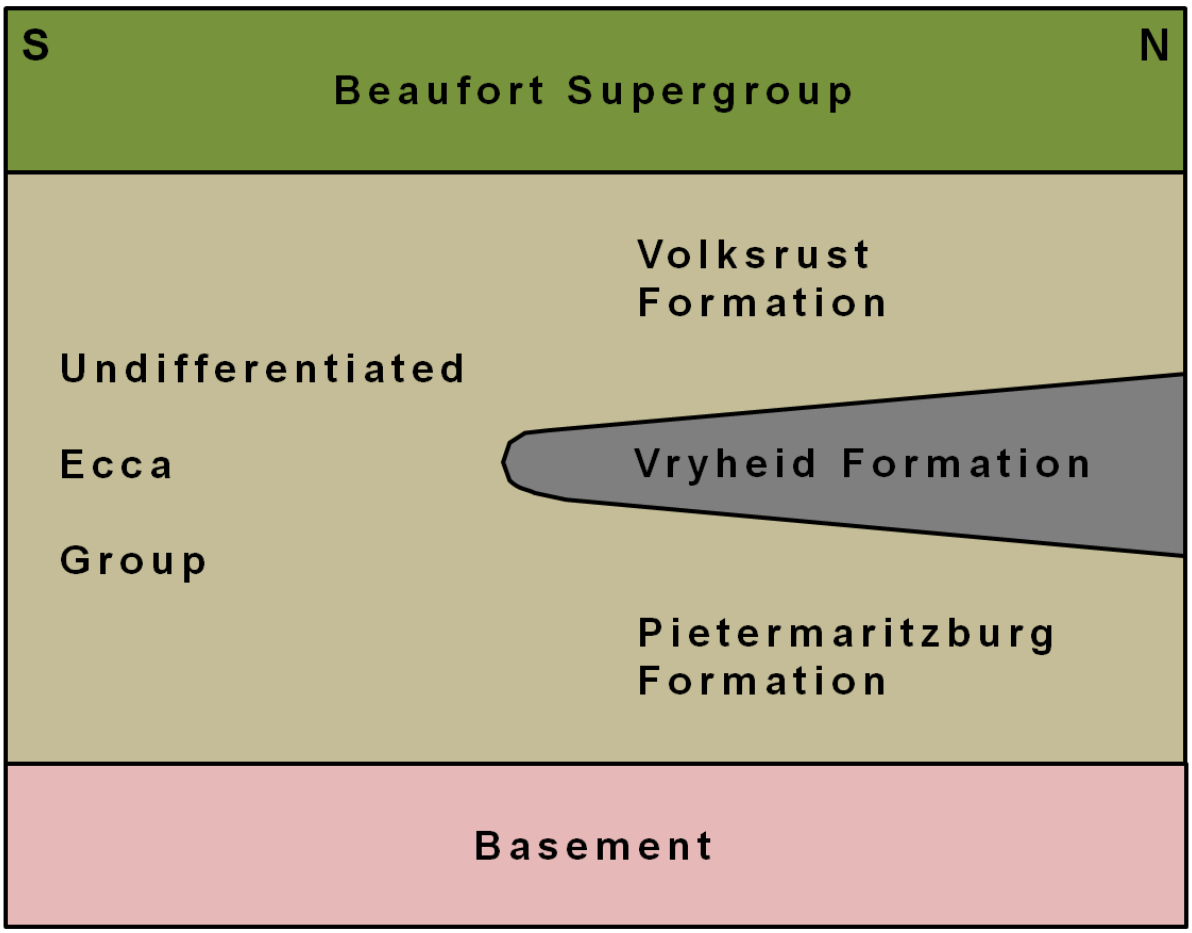


Figure 5: Schematic north-south oriented stratigraphic section of the Ecca Group in the north-east corner of the Karoo Basin. The Volksrust and Pietermaritzburg Formations can only be recognised when the Vryheid Formation forms part of the vertical sequence. In the north and north-western portions of the basin the Pietermaritzburg Formation was not deposited and the coal-bearing strata of the Vryheid Formation rest directly upon the basement.

6.2.1.2 Vryheid Formation Palaeontological Potential

The most conspicuous and common components of the palaeontological record of the Ecca Group, in general, are the plant macrofossils of the *Glossopteris* flora. Two large and conspicuous leaf form taxa dominate the *Glossopteris* flora; these being *Glossopteris* and *Gangamopteris*. Within the upper Ecca (containing the Vryheid Formation) *Gangamopteris* has ceased to occur with only *Glossopteris* present (Anderson and McLauchlan, 1976). The palaeobotanical record of the Ecca Group is diverse and the literature describing it is voluminous (numerous papers having been published by Drs E. Plumstead, H. Anderson, J. Anderson, E. Kovaks-Endrődy and M. Bamford amongst others). A comprehensive review of the flora in the Karoo Basin literature is, accordingly, beyond the scope of this study, but a thorough review of the palaeobotanical content of the Ecca Group in general and the Vryheid Formation in particular is presented in Bamford (2004). In that summary it was indicated that the Vryheid Formation can be expected to contain the plant macrofossils *Buthelezia*, *Sphenophyllum*, *Rangia*, *Phyllotheca*, *Schizoneura*, *Sphenopteris*, *Noeggerathiopsis*, *Taeniopteris*, *Pagiophyllum* and *Benlightfootia* and the wood taxa *Australoxylon* and *Prototaxoxylon*. In addition to the above records can be added the observations of Tavener-Smith *et al*., (1988) where it was noted that both *Glossopteris* and *Vertebraria* occur within the palaeontological record of the formation.

In portions of the Vryheid Formation that are typified by low thermal alteration abundant assemblages of palynomorph plant microfossils (including acritarchs) can be expected (Anderson, 1977).

Jubb and Gardiner (1975) report the presence of fragmentary fish fossils within the Ecca sequence of southern Africa; these being *Coelacanthus dendrites* from the Somkele coal-field of northern Natal and *Namaicthys digitata* from correlative strata in the Senge Coal-fields of Zimbabwe. Fossil fish faunas are obviously rare and none have been reported from the Vryheid Formation the possibility remains that they may be present.

Animal body fossils are rare within the Ecca Group in general (excepting the time equivalent faunas of the Whitehill Formation). However, no reptile fossils have been identified within the Vryheid Formation.

Hobday and Tavener-Smith (1975) reviewed trace fossil assemblages identified within the Vryheid Formation. Within that fossil assemblage they identified two forms (*Helminthiopsis* and *Taphrelminthopsis* within horizontally laminated siltstones and mudstones that represent part of the deep-water *Nerites* community.

No fossil materials were identified within the Vryheid Formation sandstone outcrops located within the study area. However, the possibility that the formation contains fossils remains. Similarly, it is possible that argillaceous strata (that have a higher fossil-bearing potential than the sandstone facies) may be present in the area. The possibility exists,

therefore, that fossils, particularly those of the *Glossopteris* flora may be present within the project area.

6.2.1.3 Volksrust Formation Palaeontological Potential

The most conspicuous and common components of the palaeontological record of the Ecca Group in general are the plant macrofossils of the *Glossopteris* flora. Two large and conspicuous leaf form taxa dominate the *Glossopteris* flora; these being *Glossopteris* and *Gangamopteris*. Within the upper Ecca (containing the Volksrust Formation) *Gangamopteris* has ceased to be present with only *Glossopteris* present (Anderson and McLauchlan, 1976). The palaeobotanical record of the Ecca Group is diverse and the literature describing it is voluminous (numerous papers having been published by E. Plumstead, H. Anderson, J. Anderson, E. Kovaks-Endrődy, R. Prevec and M. Bamford amongst many others). A comprehensive review of the fossil flora in the Karoo Basin literature is, accordingly, beyond the scope of this study, but a thorough review of the palaeobotanical content of the Ecca Group in general and the Volksrust Formation in particular is presented in Bamford (2004). In that summary it is indicated that the Volksrust Formation can be expected to contain the macroplant fossils *Buthelezia*, *Sphenophyllum*, *Rangia*, *Phyllotheca*, *Schizoneura*, *Sphenopteris*, *Noeggerathiopsis*, *Taeniopteris*, *Pagiophyllum* and *Benlightfootia* and the wood tax *Australoxylon* and *Prototaxoxylon*. To these records can be added those of Tavener-Smith *et al*., (1988) who recorded the presence of *Glossopteris* and *Vertebraria* to the palaeontological record of the formation.

In portions of the Volksrust Formation that are typified by low thermal alteration abundant assemblages of palynomorph plant microfossils (including acritarchs) can be expected (Anderson, 1977).

Animal body fossils are rare within the Ecca Group in general (excepting the faunas of the Whitehill Formation). Within the Volksrust Formation the large pelycopod bivalve *Megadesmus* has been recorded near the boundary with the Beaufort Group (Cairncross *et al*., 2005). A locality containing beetles (Coleoptera) have been recorded from the formation in Kwazulu-Natal (Ponomarenko & Mostovski, 2005).

Jubb and Gardiner (1975) report the presence of fragmentary fish fossils within the Ecca sequence of southern Africa; these being *Coelacanthus dendrites* from the Somkele coal-field of northern Natal and *Namaicthys digitata* from the Senge coal-fields of Zimbabwe elsewhere. While fish faunas are obviously rare and none have been reported from the Volksrust Formation the possibility remains that they may be present. No reptile fossils have been identified within this formation.

Tavener-Smith *et a*l., (1988) document the presence of trace fossils they ascribed to *Planolites* type, *Skolithus*, *Scolicia*-like trails, burrows similar to *Teichichnus* and

Palaeophycus burrows present in the formation in Zululand. Hobday and Tavener-Smith (1975) reviewed trace fossil assemblages identified within the underlying Vryheid Formation. Within that fossil assemblage they identified two forms (*Helminthiopsis* and *Taphrelminthopsis* within horizontally laminated siltstones and mudstones that represent part of the deep-water *Nerites* community. While these taxa were not found within the Volksrust Formation that stratigraphic unit was also deposited within deep water and, as such, similar deep-water trace fossil forms may also be expected to be present within the unit.

6.3 Karoo Dolerite Suite

6.3.1 Geology

The intrusive dolerite rocks of the Karoo Dolerite Suite are present throughout the Main Karoo Basin as a series of dykes and sills. These Jurassic dolerites (emplaced approximately 183 ± 2 Ma) represent the remnants of the feeder system to the flood basalt eruptions that forms the lavas of the Drakensberg Group that cap the Drakensberg Mountains (Duncan and Marsh, 2006).

6.3.2 Palaeontological potential

Dolerite is a hypabyssal, intrusive igneous rock type; as such there is nil potential for any fossil material to be located within this rock unit.

6.4 Cainozoic Regolith

6.1.1 Geology

Examination of Google earth imagery (Figure 6) reveals that the land surface overlying the project area is utilised for cultivation across almost its entire extent. The presence of the almost uniform utilisation of the project area by cultivation (i.e., ploughing) implies an equally uniform coverage of Cainozoic regolith horizon. The thickness of the regolith coverage is unknown to the author, but it may be realistically expected to differ according to the underlying bedrock lithology and the slope of the land surface.

The genesis of the regolith cover is not known to the author with any certainty. However, Rietspruit traverses the central portions of the project area, where it drains to the west, and its smaller, ephemeral tributaries traverse the northern portions (Figure 6). No potentially fossiliferous levee banks or fluvial terraces are evident in the satellite imagery on the margins of Rietspruit or is tributaries. The land surface to both the north and south of Rietspruit is significantly topographically higher than Rietspruit. It is, accordingly, highly unlikely that those areas would have either accumulated or preserved fluvial overbank

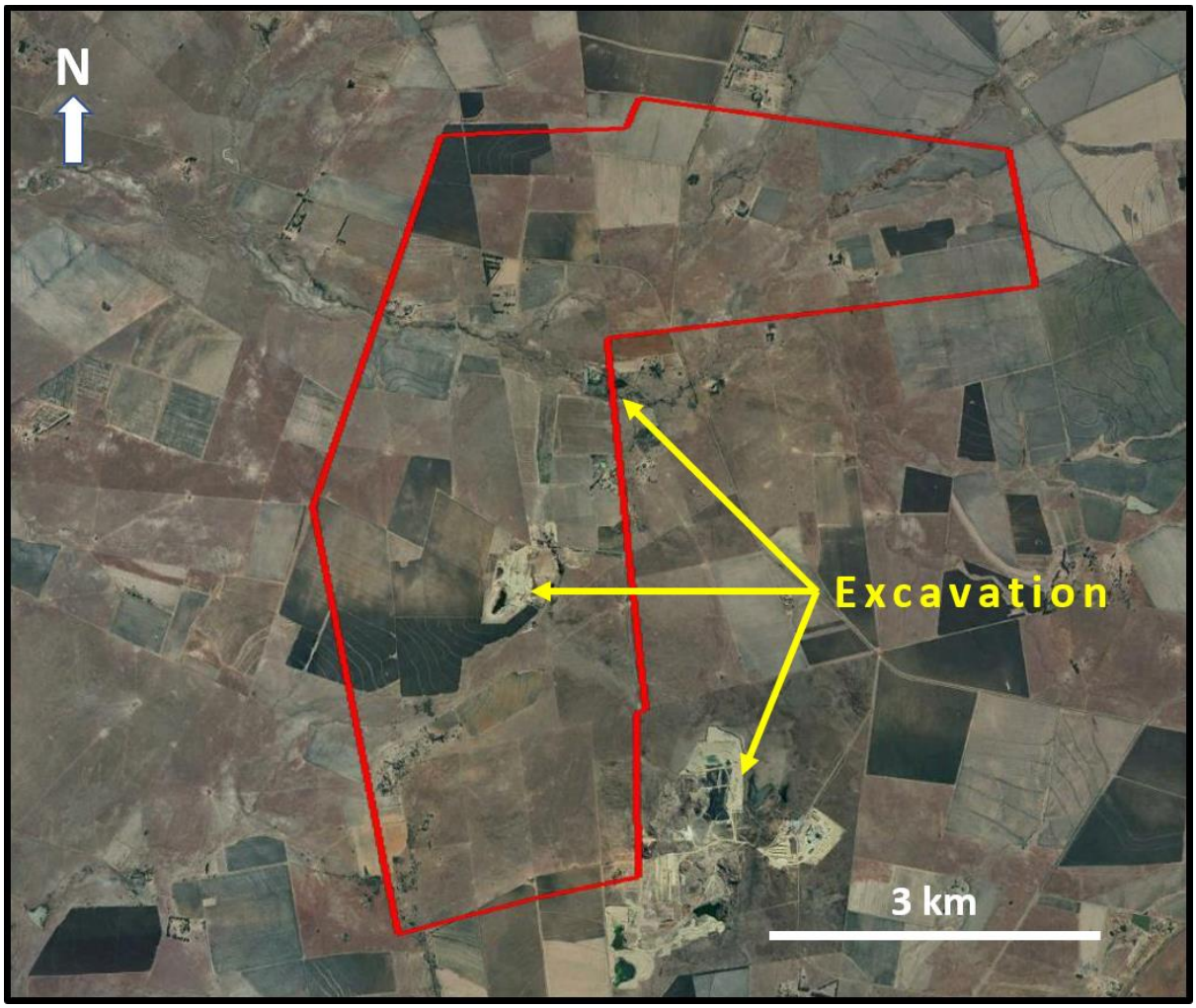


Figure 6: Google earth image of the Prospecting Right application area (red polygon). Shown is the location of the three historic mining excavations present within the project area and in the immediately adjacent environs. It is evident from the image that almost the entire expanse of the project area is utilised for cultivation.

deposits. With cognisance to these observations, it is considered most likely herein, that the regolith was derived from *in situ* decomposition of the underlying bedrock sequences.

6.1.2 Palaeontological potential

As discussed above in Section 6.1.1 it is more likely that the genesis of the regolith cover is the result of *in situ* decomposition of the immediately underlying bedrock. Of the various lithological units underlying the Prospecting Right application area only the Vryheid Formation and the Vryheid Formation strata (to a lower degree of probability) are potentially fossiliferous. No fossil materials could be inherited from the underlying unfossiliferous units by the regolith. Where the bedrock is either the Vryheid or Volksrust Formations any fossil material would potentially have been destroyed by the weathering

processes. Taking all the preceding discussion into account the probability of the regolith horizon being fossiliferous is considered negligible.

7 ENVIRONMENT OF THE PROPOSED PROJECT SITE

The environment of the Prospecting Right application area and the surrounding environs is shown in Figure 7. It is evident in Figure 7 that the Prospecting Right application area is topographically undulatory with the lowest lying ground in the centre of the project area where it is associated with the Rietspruit. Away from Rietspruit, the land surface gains

elevation to the south where it forms the crest of a rounded hill (>1480 m a.m.s.l high). To the north of the project area the land surface gains elevation to forms a part of the broad, gently south-westerly sloping toe a large hill and attains a maximum altitude of >1460 m a.m.s.l.

Three large mining excavations (and associated disturbed areas) are located along the eastern margins of the southern portions of the project area (Figures 6 and 7). The northern-most (approx. 600 m long) and central (approx. 700 m long) excavations are the smallest and are wholly located within the project area. The southern-most excavation is the largest by far, being over 2 500 m in length. However, most of the excavation lies external to the project area, with an area of only approx. 350 m x 250 m being located within the project area.

Figure 8 indicates that the entire land surface of the Prospecting Right application area is vegetated by plants of the Central Free State Grassland biome. Mucina and Rutherford (2006) describe the conservation status of the Central Free State Grassland biome as vulnerable. However, it is apparent from Figure 6 that almost none of the original Central Free State Grassland biome remains extant within the Prospecting Right application area as the area has been historically extensively utilised for cultivation and the area has been almost completely ploughed. Any of the original vegetation remaining within the project area appears to be located along the immediate margins of the fluvial drainage channels that traverse the area.

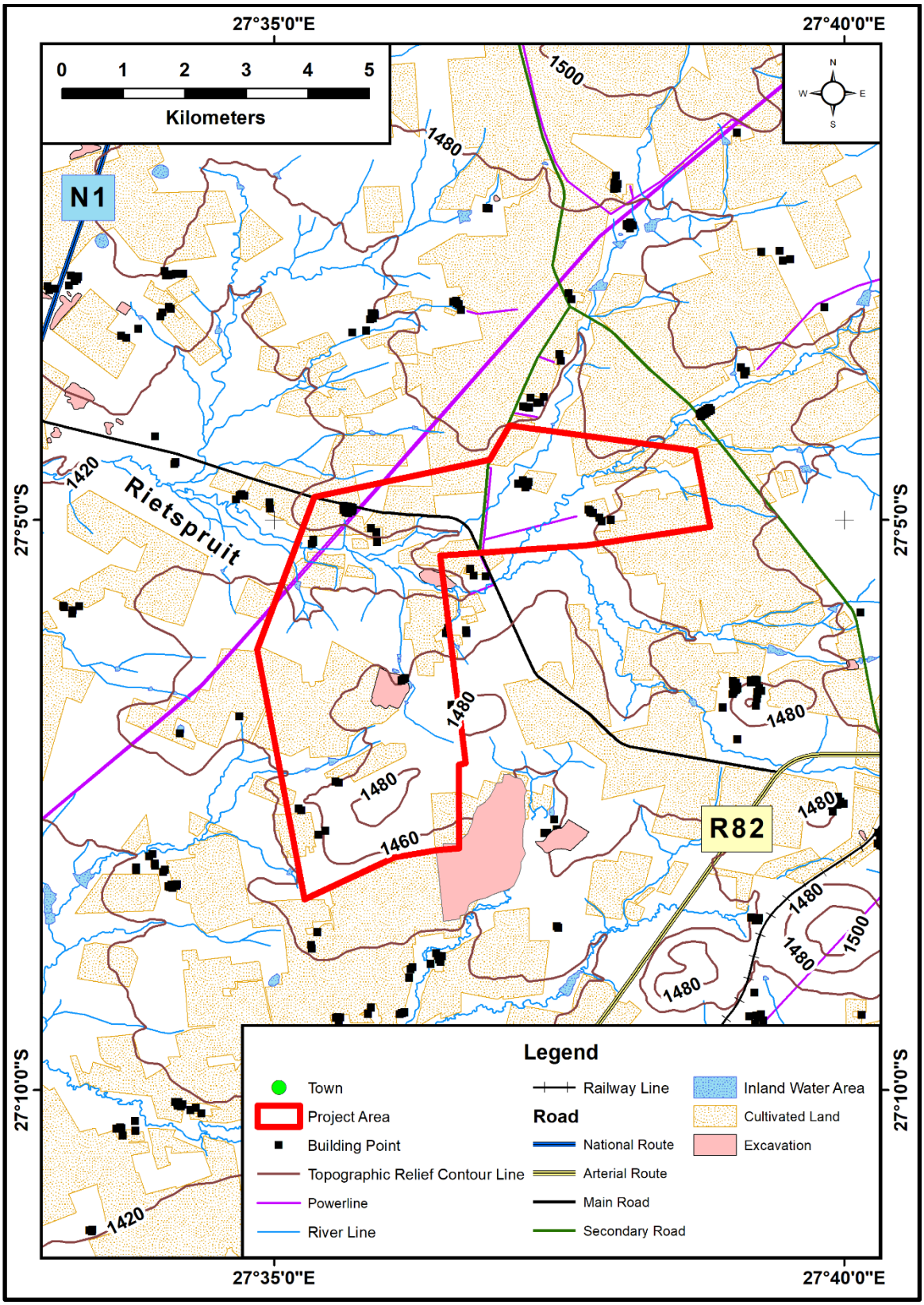


Figure 7: The environment of the Prospecting Right area (red polygon) as well as the immediate environs. The topographic relief contour interval is 20 m.

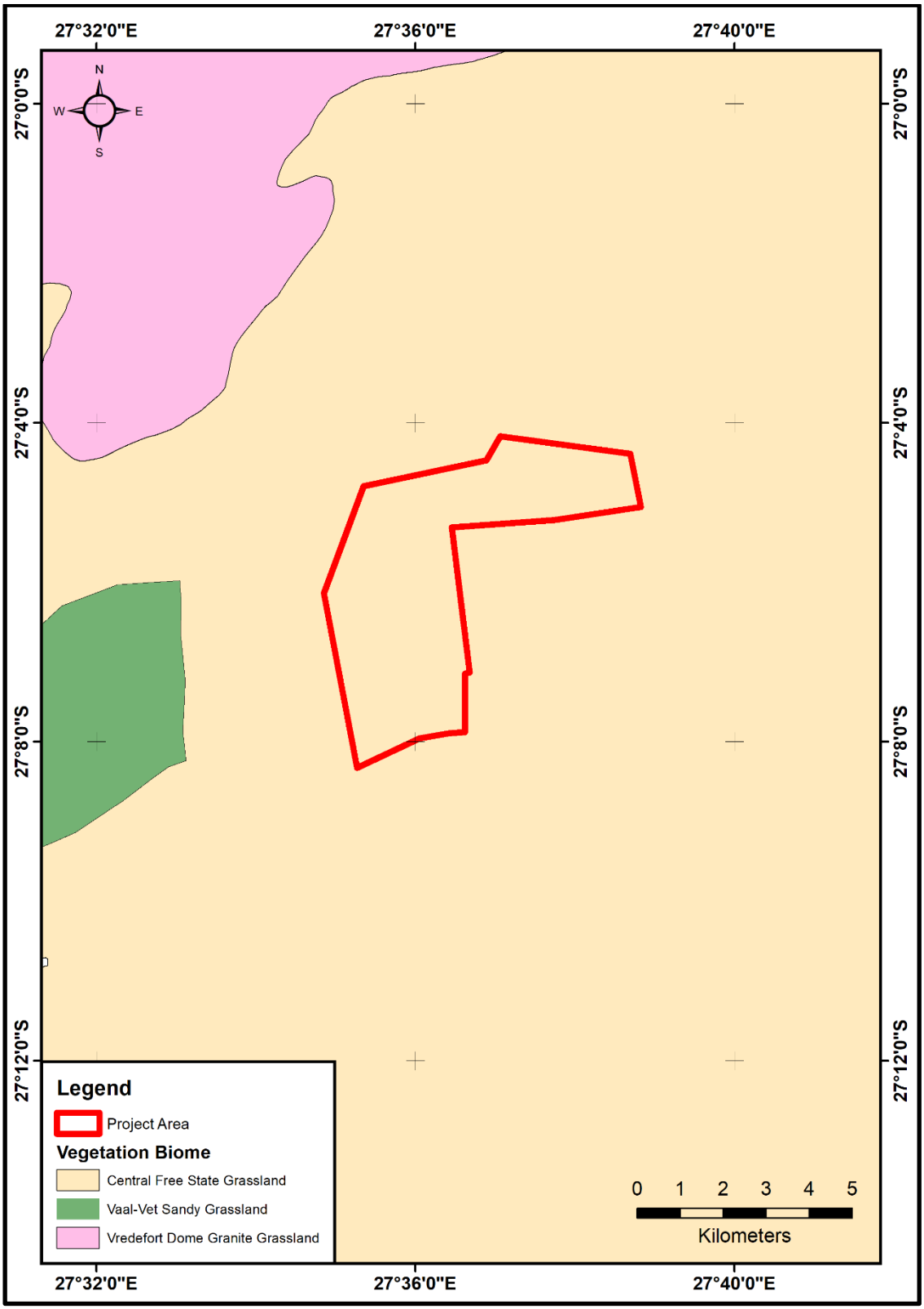


Figure 8: Map of the distribution of vegetation biomes occurring within the Prospecting Right project area and within the immediate environs (modified from Mucina and Rutherford, 2006).

8 OVERVIEW OF SCOPE OF THE PROJECT

The invasive prospecting phase of the exploration program will involve a diamond drilling program. At present the drilling of eight boreholes is planned. They are distributed within two separate areas, one in the southern-most extent of the project area and the second in its south-eastern portion (Figure 3). Should exploration prove positive it is possible that more boreholes will be required and the drilling program expanded. The drill holes are expected to be approx. 50 m apart and are expected to reach ca. 40 m in depth. Each exploration site is expected to disturb a minimum area of 40 m^2 in total and 5 m^2 per borehole. A sump for holding drilling muds may be required to be excavated at the site of each borehole; if so, the sump will probably be shallow (<1 m) deep. The boreholes themselves, will result in the development of a void with a diameter < 20 cm. The proposed duration of the invasive prospecting activities is three-four months and any negative impacts resulting from the activities will be restricted to the duration of the activities.

As far as is possible access to the drill sites will utilise existing farm tracks. A mobile drill rig will be utilised, minimising both the need for site preparation, and the disruption of the site's land surface. No site (e.g., drillers or exploration camps) will be established in the project area. While no infrastructure development will occur on site measures will be put in place to implement erosion control (i.e., after the prospecting ceases the area will be rehabilitated where necessary). This rehabilitation will include the re-use of topsoil and the erosion control measures. The aerial extent of the Prospecting Right application area is 2 195 ha.

8.1 Impact upon the geology

It was indicated in Section 6, above, that the bedrock geology of the project area consists of the Vryheid Formation in the northern portions, the Volksrust Formation in the majority of the central and southern sections. An inlier of granite-gneiss and greenstone rocks of Swazian-age basement occurs in the southern portion of the project area (where they extend out of the project area). It was also indicated in Section 6.4 that almost the entire extent of the project area bears Cainozoic regolith cover. Basalts of the Karoo Dolerite Suite crop out in the north-eastern and north-western corners of the project area and will not be impacted upon by the project as it is currently planned.

As the majority of the project area appears to bear a Cainozoic regolith cover this unit will be penetrated by the majority of the drilling activities. Where present the regolith will also be negatively impacted by the surficial (i.e., non-penetrative) drilling activities. Accordingly, this unit will be subject to most of the non-penetrative exploration activities. It is assumed that the maximum depth of the negative impact they will cause upon the underlying geology will be < 1 m.

The exploration project will target pegmatites within the Greenlands Formation (a meta-volcanic greenstone sequence primarily composed of tholeiitic to komatitic basalts). The Greenland Formation greenstones formsa megaxenolith within the Swazian-age granite-gneiss basement complex. The strata of this unit will, by necessity, be penetrated by the drilling activities as they constitute the exploration target. Indeed, it is apparent from (Figure 3) that six (6) of the planned boreholes will be collared upon the greenstone.

Rocks of the Vryheid Formation surround the Swazian greenstone basement inlier. It appears from Figure 3 that these rocks may also be penetrated by the drilling activities; these boreholes being located immediately adjacent to the southern margin of the greenstone outcrop. Where the Vryheid Formation crops out the unit may be directly negatively impacted upon by the surface surface-impacting activities.

It is uncertain if the stratigraphically older rocks of the Vryheid Formation underly the Volksrust Formation in the southern drilling target. Clearly, the Vryheid Formation occurs to the north of the planned drilling activities, and would normally stratigraphically underly the Volksrust Formation. However, it is geologically feasible that the sedimentary units thin and pinch out against the topographically raised basement inlier. In this scenario, the Vryheid Formation may pinch out against the basement complex and be absent in the drilling areas. Both scenarios are possible and it is considered safest, herein, to assume that the Vryheid Formation is also present beneath the southern drilling area. In this case, the unit will only be present at depth and, as such, will only be negatively impacted by the penetration of the boreholes.

The following impact assessment (Section 9) is made in the light of these assumptions.

9 IMPACT ASSESSMENT

The potential impact of Lengana Health SA (Pty) Ltd's exploration project is categorised below according to the following criteria: -

9.1 Nature of Impact

The potential negative impacts of the proposed project on the palaeontological heritage of the area are:

- Damage or destruction of fossil materials during the construction of project infrastructural elements to a maximum depth of those excavations. Many fossil taxa (particularly vertebrate taxa) are known from only a single fossil and, thus, any fossil material is potentially highly significant. Accordingly, the loss or damage to any single fossil can be potentially significant to the understanding of the fossil heritage of South Africa and to the understanding of the evolution of life on Earth in general. Where fossil material is present, and will be directly affected by the building or construction

of the projects infrastructural elements, the result will potentially be the irreversible damage or destruction of the fossil(s).

- Movement of fossil materials during the construction phase, such that they are no longer *in situ* when discovered. The fact that the fossils are not *in situ* would either significantly reduce or completely destroy their scientific significance.
- The loss of access for scientific study to any fossil materials present beneath infrastructural elements for the life span of the existence of those constructions and facilities.

9.2 Extent of impact

The possible extent of the impact of the proposed project on the palaeontological heritage of South Africa is restricted to the damage, destruction or accidental relocation of fossil material caused by the excavations and construction of the necessary infrastructure elements forming part of the project. The extent of the area of potential impact is, accordingly, categorised as **local** (i.e., restricted to the project site).

9.3 Duration of impact

The anticipated duration of the identified impact is assessed as potentially **long term to permanent**. This is assessment is made because, in the absence of mitigation procedures, the damage or destruction of any palaeontological materials that may be present will be permanent. This long-term assessment is thus not in conflict with the fact that the invasive exploration phase itself is short term (<4 months).

9.4 Probability of impact

It is pertinent to realise that fossils are generally scarce and sporadic in their occurrence and, as such, the probability of any development affecting a fossil at any point on the land surface in relatively low.

The sediments of the Volksrust Formation are known to contain an important palaeontological heritage particularly in respect of plant macrofossils of the *Glossopteris* flora as well as trace fossil assemblages. However, the occurrence of fossils within the geological record is erratic in general and the chance of impacting upon most macrofossil types at any point within the Volksrust Formation is low. It must be noted that where plant macrofossils or trace fossils are present within a sequence (as they are elsewhere in the Volksrust Formation) they are often in dense accumulations. The probability of a negative impact is accordingly assessed as being **moderate**.

The sediments of the Vryheid Formation are noted for containing an important palaeontological heritage particularly in respect of plant macrofossils of the *Glossopteris* flora as well as trace fossil assemblages. However, the occurrence of fossils within the

geological record is erratic in general and the chance of impacting upon most macrofossil types at any point within the Vryheid Formation is low. In addition, it is salient to recognise that the Vryheid Formation is unlikely to be impacted by the planned exploration and, even if it is, it will only be affected as a very thin, attenuated sequence. The attenuation of the unit resulting from pinching out of the unit against the topographically heightened greenstone inlier. Where plant macrofossils or trace fossils are present within a sequence (as they are elsewhere in the Vryheid Formation) they are often in dense accumulations. The probability of a negative impact upon the palaeontological heritage of the unit that may arise from the prospecting operations is assessed as moderate to good, but the probability of impacting upon the unit is low. Accordingly, the probability of the fossil heritage of the Vryheid Formation being negatively impacted upon is categorised as **low**.

The presence of a Cainozoic regolith cover sequence overlying the project area is interpreted herein (see Section 6.4 above). It is interpreted, herein, that this regolith is derived from *in situ* decomposition of the underlying bedrock. The probability of any fossil materials having been originally present within the regolith is assessed as **negligible** as fossils present in the bed rock will have been destroyed by the weathering process. It is also evident in Figure 6 that the entire extent of the Prospecting Right application area has been cultivated (ploughed) and the land surface has accordingly been overturned (multiple times) to the depth of a plough blade. Additionally, should any fossil materials have originally existed in the regolith at surface prior to cultivation, they will now have been destroyed or moved.

Strata of the Swazian Greenlands Formation are not known to be fossiliferous, and the probability of fossils being discovered/impacted upon is very low. Thus, the probability of any negative impact resulting upon the palaeontological heritage of this unit caused by the prospecting project is assessed as being **negligible**.

The rocks of the Karoo Dolerite Suite are unfossiliferous and will not be impacted upon by the project. The probability of any negative impact resulting upon the palaeontological heritage of these units caused by the prospecting project is assessed as **nil**.

It should be noted that the boreholes themselves will be of narrow diameter and the statistical chances of them impacting upon fossils is extremely small. Further to this point it is also pertinent to note that even if the drill holes do intersect fossils, they will be deep within the earth and would not have been available to inspection by science for an unreasonably long period.

9.5 Significance

Should the project progress without due care to the possibility of fossils being present within either the bedrock or regolith the resultant damage, destruction or inadvertent relocation any affected fossils will be permanent and irreversible. The rocks of the Vryheid and Volksrust Formations are well known to contain highly scientifically significant plant

macrofossil assemblages of the *Glossopteris* flora as well as trace fossil assemblages. Thus, the sediments of both formations provide an important window into the evolution the of plant life that constitutes the famous *Glossopteris* flora during this poorly understood interval in the Early Permian within the Main Karoo Basin. Their significance is due to the uniqueness of their terrestrial environments within the basin fill of the Main Karoo Basin at that time. Thus, any fossil materials occurring within the project areas are potentially extremely scientifically and culturally significant and any negative impact on them would be of **high significance**. The trace fossil assemblages contained within the units are not as scientifically significant as the plant macrofossils assemblages. While the trace fossils may be present in large numbers they tend to be taxonomically depauperate. They do however provide important palaeoenvironmental data.

The rocks of the Swazian Greenlands Formation, the Karoo Dolerite Suite and the regolith cover are unfossiliferous. The significance of any negative impact resulting upon the palaeontological heritage of these units is assessed as **nil**.

10 DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSABLE LOSS

The degree to which the possible negative effects of the proposed project can be mitigated, reversed, or reversed can be determined as discussed below.

10.1 Mitigation

Almost the entire extent of the project area appears to bear a significant Cainozoic regolith cover. The regolith itself is unfossiliferous. It is also the case that almost all of the area which is the subject of the Prospecting Right application area has been cultivated (ploughed). The implication of the heavily disturbed nature of the land surface is that any fossils that may have been existed it (either as syndepositional or inherited from the bedrock) and which would have been observable at surface will have been destroyed as a result of the historical ploughing. In addition, six (6) of the eight boreholes are planned to be collared upon the non-fossiliferous Greenlands Formation. So even if regolith is not present, the bedrock that will be impacted contains no fossils. Only the southern-most two (2) boreholes will be collared in potentially fossiliferous bedrock (the Volksrust Formation). However, as discussed above, it is most likely that the land surface will actually be the regolith. As almost all of the prospecting activities will only impact the land surface to a depth of < 1.5 m it will only be the regolith that will be affected. The boreholes will impact upon the Volksrust Formation (and possibly the Vryheid Formation) at depth, but as discussed above this impact of the boreholes upon the fossil heritage of the units will be unimportant.

The following damage mitigation protocols are suggested: -

- Given the above discussion, a site visit and thorough field investigation as part of a Full Impact Assessment it is not recommended as there will be little to no opportunity to observe fossils at surface.
- No damage mitigation protocols are required to be enacted for this prospecting phase of the project.
- The only opportunity for this project to meaningfully impact upon the palaeontological heritage of the area will be if the project proceeds to a mining phase.
- Should the project wish to proceed to a mining phase a Palaeontological Heritage Impact Assessment report should be prepared and submitted to SAHRA prior to commencement of the mining (during the authorisation process).

10.2 Reversal of damage

Any damage to, or the destruction of, palaeontological materials or the reduction of their scientific value due to a loss of their original location is **irreversible**.

10.3 Degree of irreversible loss

Once a fossil is damaged, destroyed or moved from its original position without its geographical position and stratigraphic location being recorded the **damage is irreversible**.

By their nature fossils are usually scarce and sporadic in their occurrence and the chances of negatively impacting on a fossil in any particular area are low. However, any fossil material may be of the greatest scientific importance; this is particularly true of vertebrate fossils in which many taxa are known from only one fossil. Thus, the potential always exists during construction and excavation within potentially fossiliferous rocks for the permanent and irreversible loss of extremely significant or irreplaceable fossil material. This said, many fossils are incomplete in their state of preservation or are examples of relatively common taxa. As such, just because a fossil is present it is not necessarily of great scientific value. Accordingly, not all fossils are necessary significant culturally of scientifically significant and the potential degree of irreversible loss will vary from case to case. The judgement on the significance of the fossil must be made by an experienced palaeontologist.

11 ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE

The information provided within this report was derived from a desktop study of available maps and scientific literature; no direct observation was made of the area as the result of a site visit. In particular, the discussion of the geological units occurring beneath the

project area infrastructure (and as such the basis of understanding the fossiliferous potential of the area and the extent of any negative impact upon the palaeontological heritage of the area) was derived from the published 1:250 000 geological maps of the area. The accuracy of 1:250 000 geological maps is often variable; some areas being compiled from air photo interpretation or remote sensing procedures. The possibility of the presence of additional geological units being present within the project area cannot be disregarded.

The presence and mode of formation of the Cainozoic regolith interpreted to be underlying the project area has been hypothesised from available evidence and the author's knowledge of the area and not by direct observation.

12 ENVIRONMENTAL IMPACT STATEMENT

A desktop study has been conducted on the site of a Prospecting Right application to explore for lithium on the farms: -

- Oceaan 064 Rem
- Oceaan 099 Rem
- Kronenbloem 051 Rem
- Broodkop 304 Ptn 1
- Hooge Bult 542 Rem

and various extents of the farms:

- Felix 380 Rem
- Goedgunst 315 Rem
- Vensterbloem 163 Rem
- Broodkop 304 Rem
- Ongegund 007 Rem
- Goudlaagte 238 Rem
- Verdeel 278 Rem
- Geluk 237 Rem
- Enkelbosch 031 Ptn 7
- Enkelbosh 031 Rem
- Enkelbosh 031 Ptn 1

The site is located approximately 7.5 km west of Dover and 12 km north of Koppies, in the Koppies Magisterial Districts, Fezile Dabi District Municipality and Ngwathe Local Municipality, Free State Province. The Prospecting Right application area can be located within the confines of 1:50 000 topographic map 2727BA. The aerial extent of the Prospecting Right application area is 2 195 ha.

The aerial extent of the Prospecting Right application area is underlain by a lithologically diverse assemblage of stratigraphic units consisting of Swazian (Archaean) greenstones of the Greenlands Formation (of the Johannesburg Dome), sandstone, mudstones and coals of the Vryheid and Volksrust Formations, and intrusive dolerite of the Karoo Dolerite Suite. It is interpreted that Cainozoic regolith forms the land surface over the majority of the Prospecting Right application area.

Most of the exploration activities to be undertaken are non-invasive and will result in disturbance of the immediate land surface (<0.5 m in depth). The excavation of eight (8) sumps to house drilling muds for the diamond drilling program will require excavation of small voids < 1.5 m deep and < 4 m^2 in area. These activities will impact predominantly upon the regolith cover; although in the case of the northern-most six (6) of the holes there may also be some impact upon the Greenlands Formation. The southern-most two (2) of the boreholes may impact upon the Volksrust Formation. The boreholes will impact upon the regolith, Greenlands Formation, and the Volksrust Formation (and there is a low possibility of the Vryheid Formation being impacted).

The rocks comprising the Greenlands Formation, and the Karoo Dolerite Suite are unfossiliferous. It is also interpreted that the Cainozoic regolith is unfossiliferous. Any impacts upon these units caused by the progression of the prospecting operations will have **negligible to nil** probability of resulting in a negative impact upon their palaeontological heritage. The sediments of the Volksrust and Vryheid Formations are known to contain plant macrofossil assemblages of the *Glossopteris* flora (the former also containing trace fossil assemblages). The significance of the fossil assemblages contained in these two units was assessed as **high**, but the probability of any negative impact is **moderate to good** for the Volksrust Formation and **low** for the Vryheid Formation.

Almost the entire extent of the project area appears to bear a significant Cainozoic regolith cover. The regolith itself is unfossiliferous. It is also the case that almost all of the area which is the subject of the Prospecting Right application area has been cultivated (ploughed). The implication of the heavily disturbed nature of the land surface is that any fossils that may have been existed it (either as syndepositional or inherited from the bedrock) and which would have been observable at surface will have been destroyed as a result of the historical ploughing. In addition, six (6) of the eight boreholes are planned to be collared upon the non-fossiliferous Greenlands Formation. So even if regolith is not present, the bedrock that will be impacted contains no fossils. Only the southern-most two (2) boreholes will be collared in potentially fossiliferous bedrock (the Volksrust Formation). However, as discussed above, it is most likely that the land surface will actually be the regolith. As almost all of the prospecting activities will only impact the land surface to a depth of < 1.5 m it will only be the regolith that will be affected. The boreholes will impact upon the Volksrust Formation (and possibly the Vryheif Formation) at depth, but as discussed above this impact of the boreholes upon the fossil heritage of the units will be unimportant.

The following damage mitigation protocols are suggested: -

- Given the above discussion, a site visit and thorough field investigation as part of a Full Impact Assessment it is not recommended as there will be little to no opportunity to observe fossils at surface.
- No damage mitigation protocols are required to be enacted for this prospecting phase of the project.
- The only opportunity for this project to meaningfully impact upon the palaeontological heritage of the area will be if the project proceeds to a mining phase.
- Should the project wish to proceed to a mining phase a Palaeontological Heritage Impact Assessment report should be prepared and submitted to SAHRA prior to commencement of the mining (during the authorisation process).

13 Considered Opinion

This desktop study has not identified any palaeontological reason to prejudice the progression of this exploration project provided it operates within the parameters described herein.

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