DESKTOP PALAEONTOLOGICAL ASSESSMENT AND FOR THE PROPOSED RIETKOL MINING OPERATION - NHLABATHI MINERALS (PTY) LTD APPLICATION IN THE DELMAS LOCAL MUNICIPALITY, NKANGALA DISTRICT MUNICIPALITY, MPUMALANGA PROVINCE.

FOR

Jacana Environmentals cc

DATE: 26 April 2018

By

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INTRODUCTION

Gideon Groenewald was appointed to undertake a Desktop Palaeontological Assessment Survey for the proposed Rietkol Mining Operation (Rietkol Project) - Nhlabathi Minerals (Pty) Ltd in the Victor Khanye Local Municipality, Nkangala District Municipality, Mpumalanga Province.

Dr Gideon Groenewald has a PhD in Geology from the University of Port Elizabeth (Nelson Mandela Metropolitan University) (1996) and a National Diploma in Nature Conservation from Technicon RSA (the University of South Africa) (1989). He specialises in research on South African Permian and Triassic sedimentology and macrofossils with an interest in biostratigraphy, and palaeo-ecological aspects. He has extensive experience in the locating of fossil material in the Karoo Supergroup and has more than 20 years of experience in locating, collecting and curating fossils, including exploration field trips in search of new localities in the southern, western, eastern and north-eastern parts of the country. His publication record includes multiple articles in internationally recognized journals. Dr Groenewald is accredited by the Palaeontological Society of Southern Africa (society member for 25 years).

DECLARATION OF INDEPENDENCE

I, Gideon Groenewald, declare that I am an independent specialist consultant and have no financial, personal or other interest in the proposed development, nor the developers or any of their subsidiaries, apart from fair remuneration for work performed in the delivery of palaeontological heritage assessment services. There are no circumstances that compromise the objectivity of my performing such work.

Legal Requirements

This Palaeontological Assessment forms part of the Heritage Impact Assessment (HIA) and complies with the requirements of the South African National Heritage Resource Act No 25 of 1999 (revised 2017). In accordance with Section 38 of the National Resources Act No 25 of 1999 (Heritage Resources Management), a HIA is required to assess any potential impacts to palaeontological heritage within the development footprint.

Categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act, and which therefore fall under its protection, include:

- geological sites of scientific or cultural importance;
- objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens; and
- objects with the potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage.

Aims and Methodology

A Desktop investigation is often the only opportunity to record the fossil heritage within the development footprint. These records are very important to understand the past and form an important part of South Africa's National Estate.

Following the "*SAHRA APM Guidelines: Minimum Standards for the Archaeological & Palaeontological Components of Impact Assessment Reports*" the aims of the palaeontological impact assessment are:

- to identifying exposed and subsurface rock formations that are considered to be palaeontologically significant;
- to assessing the level of palaeontological significance of these formations;
- to comment on the impact of the development on these exposed and/or potential fossil resources; and
- to make recommendations as to how the developer should conserve or mitigate damage to these resources.

Prior to a field investigation, a preliminary assessment (desktop study) of the topography and geology of the study area is made, using appropriate 1:250 000 geological information (2830 Dundee) in conjunction with Google Earth. Potential fossiliferous rock units (groups, formations etc) are identified within the study area and the known fossil heritage within each rock unit is inventoried from the published scientific literature, previous palaeontological impact studies in the same region and the author's field experience.

Priority palaeontological areas are identified within the development footprint to focus the field investigator's time and resources. The aim of the desktop survey is to document any exposed fossil material and to

assess the palaeontological potential of the region in terms of the type and extent of rock outcrop in the area.

The likely impact of the proposed development on local fossil heritage is determined on the basis of the palaeontological sensitivity of the rock units concerned and the nature and scale of the development itself, most notably the minimal extent of fresh bedrock excavation envisaged. The different sensitivity classes used are explained in Table 1 below.

Table 1 Palaeontological sensitivity analysis outcome classification

PALAEONTOLOGICAL SIGNIFICANCE/VULNERABILITY OF ROCK UNITS	
The following colour scheme is proposed for the indication of palaeontological sensitivity classes. This classification of sensitivity is adapted from that of Almond *et al* (2008) and Groenewald *et al* (2014).	
RED	Very High Palaeontological sensitivity/vulnerability. Development will most likely have a very significant impact on the Palaeontological Heritage of the region. Very high possibility that significant fossil assemblages will be present in all outcrops of the unit. Appointment of professional palaeontologist, desktop survey, Phase I Palaeontological Impact Assessment (PIA) (field survey and recording of fossils) and Phase II PIA (rescue of fossils during construction) as well as application for collection and destruction permit compulsory.
ORANGE	High Palaeontological sensitivity/vulnerability. High possibility that significant fossil assemblages will be present in most of the outcrop areas of the unit. Fossils most likely to occur in associated sediments or underlying units, for example in the areas underlain by Transvaal Supergroup dolomite where Cenozoic cave deposits are likely to occur. Appointment of professional palaeontologist, desktop survey and Phase I Palaeontological Impact Assessment (field survey and collection of fossils) compulsory. Early application for collection permit recommended. Highly likely that a Phase II PIA will be applicable during the construction phase of projects.

GREEN	Moderate Palaeontological sensitivity/vulnerability. High possibility that fossils will be present in the outcrop areas of the unit or in associated sediments that underlie the unit. For example areas underlain by the Gordonia Formation or undifferentiated soils and alluvium. Fossils described in the literature are visible with the naked eye and development can have a significant impact on the Palaeontological Heritage of the area. Recording of fossils will contribute significantly to the present knowledge of the development of life in the geological record of the region. Appointment of a professional palaeontologist, desktop survey and Phase I PIA (ground proofing of desktop survey) compulsory.
BLUE	Low Palaeontological sensitivity/vulnerability. Low possibility that fossils that are described in the literature will be visible to the naked eye or be recognized as fossils by untrained persons. Fossils of for example small domal Stromatolites as well as micro-bacteria are associated with these rock units. Fossils of micro-bacteria are extremely important for our understanding of the development of Life, but are only visible under large magnification. Recording of the fossils will contribute significantly to the present knowledge and understanding of the development of Life in the region. Where geological units are allocated a blue colour of significance, and the geological unit is surrounded by highly significant geological units (red or orange coloured units), a palaeontologist must be appointed to do a desktop survey and to make professional recommendations on the impact of development on significant palaeontological finds that might occur in the unit that is allocated a blue colour. An example of this scenario will be where the scale of mapping on the 1:250 000 scale maps excludes small outcrops of highly significant sedimentary rock units occurring in dolerite sill outcrops. Collection of a representative sample of potential fossiliferous material recommended. At least a Desktop Survey and “Chance Find Protocol” is compulsory. The Chance Find Protocol must be included in the EMPr for the project.

GREY	Very Low Palaeontological sensitivity/vulnerability. Very low possibility that significant fossils will be present in the bedrock of these geological units. The rock units are associated with intrusive igneous activities and no life would have been possible during implacement of the rocks. It is however essential to note that the geological units mapped out on the geological maps are invariably overlain by Cenozoic aged sediments that might contain significant fossil assemblages and archaeological material. Examples of significant finds occur in areas underlain by granite, just to the west of Hoedspruit in the Limpopo Province, where significant assemblages of fossils and clay-pot fragments are associated with large termite mounds. Where geological units are allocated a grey colour of significance, and the geological unit is surrounded by very high and highly significant geological units (red or orange coloured units), a palaeontologist must be appointed to do a desktop survey and to make professional recommendations on the impact of development on significant palaeontological finds that might occur in the unit that is allocated a grey colour. An example of this scenario will be where the scale of mapping on the 1:250 000 scale maps excludes small outcrops of highly significant sedimentary rock units occurring in dolerite sill outcrops. It is important that the report should also refer to archaeological reports and possible descriptions of palaeontological finds in Cenozoic aged surface deposits. At least a Desktop Survey and "Chance Find Protocol" document is compulsory. The Chance Find Protocol must be included in the EMPr of the project.

When rock units of Moderate to Very High Palaeontological sensitivity are present within the development footprint, palaeontological mitigation measures must be incorporated into the Environmental Management Programme (EMPr). A suitably qualified Palaeontologist must clear all projects falling on Low to Very Low Palaeontological sensitive geology.

Scope and Limitations of the Desktop Study

The study will include: i) an analysis of the area's stratigraphy, age and depositional setting of fossil-bearing units; ii) a review of all relevant palaeontological and geological literature, including geological maps, and previous palaeontological impact reports; iii) data on the proposed development provided by the developer (e.g. location of footprint, depth and volume of bedrock excavation envisaged); and iv) where feasible,

location and examination of any fossil collections from the study area (e.g. museums).

The key assumption for this scoping study is that the existing geological maps and datasets used to assess site sensitivity are correct and reliable. However, the geological maps used were not intended for fine scale planning work and are largely based on aerial photographs alone, without ground-truthing. There is also an inadequate database for fossil heritage for much of the RSA, due to the small number of professional palaeontologists carrying out fieldwork in RSA and the Kingdom of Lesotho. Most development study areas have never been surveyed by a palaeontologist.

These factors may have a major influence on the assessment of the fossil heritage significance of a given development and without supporting field assessments may lead to either:

- an underestimation of the palaeontological significance of a given study area due to ignorance of significant recorded or unrecorded fossils preserved there; or
- an overestimation of the palaeontological sensitivity of a study area, for example when originally rich fossil assemblages inferred from geological maps have in fact been destroyed by weathering or are buried beneath a thick mantle of unfossiliferous “drift” (soil, alluvium etc.).

LOCALITY OF THE RIETKOL MINING ACTIVITY (GENERAL SITE LAYOUT)

The proposed Rietkol Project falls in rural disturbed terrain underlain by sandy and clayey soils of mainly weathered rocks of several structurally fault bound parts of the Transvaal and Karoo Supergroups that cuts into Pre-Karoo rock sequences in the central part of the study area, deep sand of alluvium and sand associated with the younger formations near Delmas in the Mpumalanga Province.

The locality map for the Project was simplified from the existing Scoping Report Data (2018) to ensure proper discussion of the potential for Palaeontological Heritage sensitivity of the underlying geological formations (Figure 1).

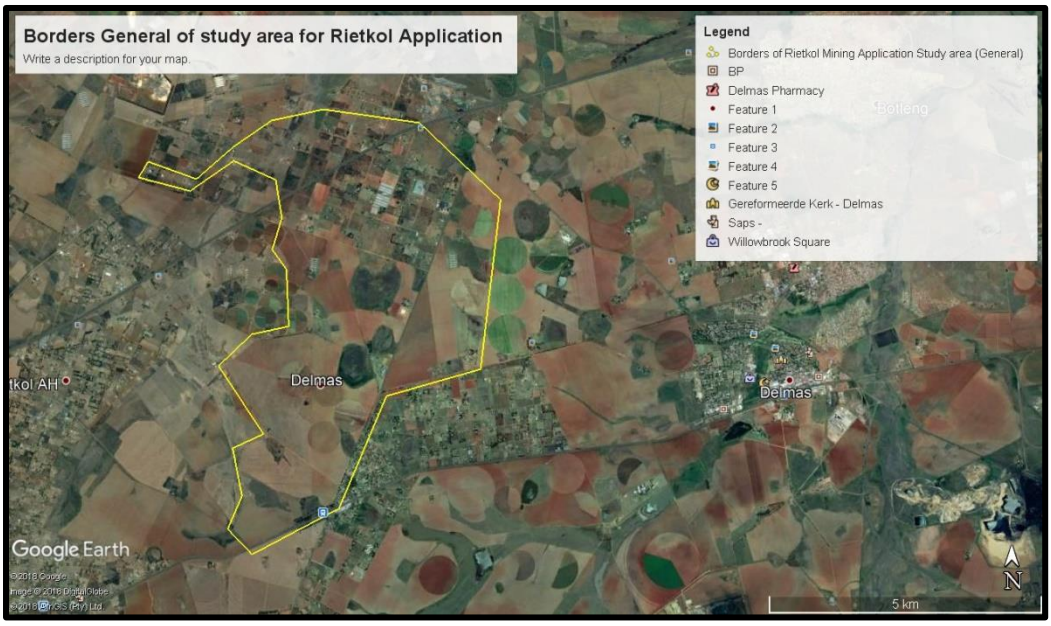

Figure 1 Locality of the area of application for the Rietkol Mining Application

A comprehensive description of the Rietkol Project is supplied in a recently completed Scoping Report for the Project and the details will not be repeated in this report. Basically the application is for the mining of several grades of sand and clays that resulted from millions years of Earth evolution in the study area.

The mining process will entail the physical crushing of quartzite and chert layers into very specific sandy materials that will be used for specific applications. Clay deposits will be mined for specific clay products and will be separated from the sandy component for unique applications.

GEOLOGY

The site of the development falls on very deep sand and clay from either weathered rocks of very old Pre-Karoo Witwatersrand and Transvaal Supergroup rocks or deeply weathered clayey soils of the Permian aged rocks of the Vryheid Formation of the Ecca Group, Karoo Supergroup. Following drilling inspections a prominent and extensive Jurassic aged dolerite sill underlies the entire mining area (Johnson et al, 2009; Groenewald, 2012).

The project spans a very gentle structural terrain, and is dominated by large areas underlain by dolomitic rocks of the Hospital Hill Formation, Witwatersrand Supergroup, the Malmani Subgroup of the Chuniespoort Group, Transvaal Supergroup as well as a cover of

Permian aged Vryheid Formation of the Ecca Group, Karoo Supergroup (Figure 2).

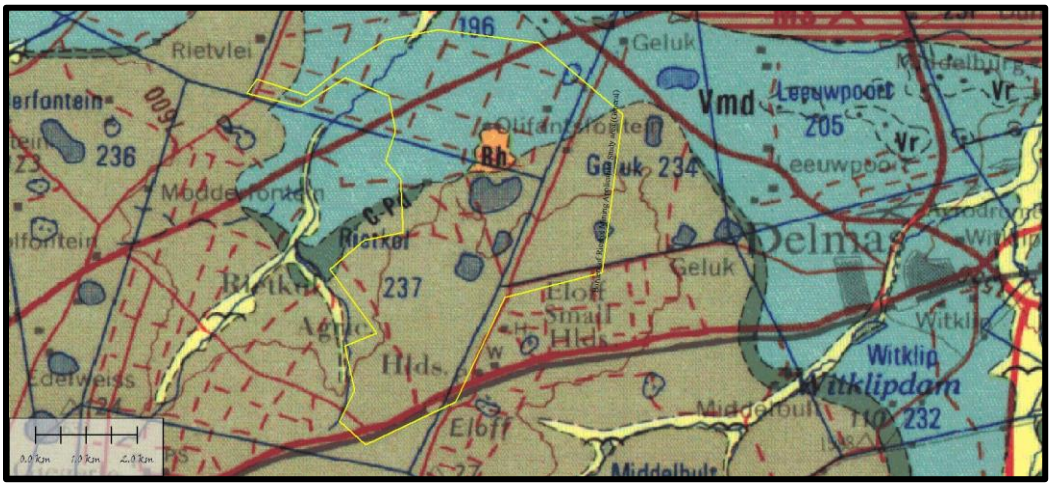

Figure 2 Geology underlying the application area for the Rietkol Mining Application

Witwatersrand Supergroup

Hospital Hill Formation (Rh)

The Randian aged Hospital Hill Formation consists mainly of subordinate shale, quartzite and minor conglomerate. This unit is most likely the target rock group for the production of the various grades of silica sand that will be produced from this Project.

Transvaal Supergroup

Chuniespoort Group

Malmani Subgroup (Vma)

The Malmani Subgroup consists primarily of a sequence of stromatolitic dolomite, subordinate chert, quartzite and carbonaceous shale (Johnson et al, 2009). The dolomite is known for very significant cast formations and it is highly likely that caves, that could exist over the past 1000 million years have been eroded and only the floors of the carst-related caves are now present as local zones of highly brecciated and silica enriched deposits. These silica enriched floors of the collapsed caves contain significant information of Palaeontological Heritage value (Groenewald *et al*, 2014).

Karoo Supergroup

Dwyka Group (C-Pd)

The Dwyka Group is very thin in the study area but it might be part of the target rock for the mining operation. It contains mainly glacial moraine remains of brecciated quartzites and interbedded, poorly defined shales.

Ecca Group

Vryheid Formation (Pv)

The Permian aged Vryheid Formation consists primarily of dark green mudstone and sandstone with prominent layers of carbonaceous shale and coal beds (Johnson et al, 2009; Groenewald et al, 2014). The formation is overlying and underlying a prominent dolerite sill in the study area (Scoping Report, 2018).

PALAEONTOLOGY

Witwatersrand Supergroup

Hospital Hill Formation (Rh)

Although highly significant micro-fossils of algae have been recorded from the conglomerates in these Radian aged sediments (MacRae, 1999), and the fossils are significant in the Palaeontological Heritage record, the mining of silica sand will not include any elemental removal of silica minerals and the fossils will not necessarily form part of the Geological studies related to the Project. The “Chance Find” of these micro-fossils is too low to warrant further recommendations for mitigation regarding Palaeontological Heritage.

Transvaal Supergroup, Chuniespoort Group

Malmani Subgroup (Vma)

The Malmani Subgroup is very well known for the significant stromatolites discovered in this group with the appropriate designation of “Stromatolitic dolomite”. The Subgroup can contain very significant information regarding the Palaeo-environment of the site during the Vaalian age and it is recommended that the mine must inform the HIA specialist and Palaeontological specialist for proper collection of a representative sample of these structures if uncovered during construction and/or mining.

The more important potential fossil finds are associated with the main chert breccia on site. This silica-enriched unit of rock most probably represents the brecciated infill of a karst landscape where the only remains on site are the floors of the karsts that represents collapsed roofs of significant caves as is found in the Cradle of Humankind near Krugersdorp towards the west (MacRae, 1999; McCarthy and Rubidge, 2005). For this reason, the area on the site underlain by Malmani Dolomite is Very High Palaeontological significance and a "Chance Find Protocol" (CFP) is needed, must be included into the EMPr for the Project with a very specific budget allocation for the appointment of a suitably qualified Palaeontologist to visit the site on a regular basis in close collaboration with the Mine Management teams and ECO. The Palaeontologist must apply for a collection and destruction permit on behalf of the mine to record any finds and clear the site for destruction on a regular basis.

Karoo Supergroup

Dwyka Group

The Dwyka Group is poorly defined in outcrop. The group contains significant fossils in other parts of the Karoo Basin but it is only moderately significant for fossils in this Project. If any plant or trace fossils are recorded during the site visits of the Palaeontologist as described in the CFP, the fossils must be collected and sent to the appropriate Institute for curation.

Ecca Group

Vryheid Formation

The Vryheid Formation underlies the southern part of the study area and any excavation that exceeds 1.5m into this Very Highly significant rock type must be inspected for possible presence of significant plant remains of the Glossopteris Assemblage (Groenewald et al, 2014).

The Vryheid Formation is well-known for the occurrence of coal beds that resulted from the accumulation of plant material over long periods of time. Plant fossils described by Bamford (2011) from the Vryheid Formation are; *Azaniodendron fertile, Cyclodendron leslii, Sphenophyllum hammanskraalensis, Annularia sp., Raniganjia sp.,*

Asterotheca spp., Liknopetalon enigmata, Glossopteris > 20 species, Hirsutum 4 spp., Scutum 4 spp., Ottokaria 3 spp., Estcourtia sp., Arberia 4 spp., Lidgetonnia sp., Noeggerathiopsis sp. and Podocarpidites sp.

According to Bamford (2011) "*Little data have been published on these potentially fossiliferous deposits*." Around the coalmines there is most likely to be good material and yet in other areas the exposures may be too poor to be of interest. When they do occur fossil plants are usually abundant and it would not be feasible to preserve and maintain all the sites, however, in the interests of heritage and science such sites should be well recorded, sampled and the fossils kept in a suitable institution.

Although no vertebrate fossils have been recorded from the Vryheid Formation, invertebrate trace fossils have been described in some detail by Mason and Christie (1985). It should be noted, however, that the aquatic reptile, *Mesosaurus*, which is the earliest known reptile from the Karoo Basin, as well as fish (*Palaeoniscus capensis*), have been recorded in equivalent-aged strata in the Whitehill Formation in the southern part of the basin (MacRae, 1999; Modesto, 2006). Indications are that the Whitehill Formation in the main basin might be correlated with the mid-Vryheid Formation. If this assumption proves correct, there is a possibility that Mesosaurus could be found in the Vryheid Formation (Catuneanu et al 2005).

The late Carboniferous to early Jurassic Karoo Supergroup of South Africa includes economically important coal deposits within the Vryheid Formation of Natal. The Karoo sediments are almost entirely lacking in body fossils but ichnofossils (trace fossils) are locally abundant. Modern sedimentological and ichnofaunal studies suggest that the north-eastern part of the Karoo basin was marine. In KwaZulu-Natal a shallow basin margin accommodated a prograding fluviodeltaic complex forming a broad sandy platform on which coal-bearing sediments were deposited. Ichnofossils include U-burrows (formerly *Corophioides*) which are assigned to ichnogenus *Diplocraterion* (Mason and Christie, 1985).

Dolerite interbedded with the Vryheid Formation will not contain any fossils.

PALAEONTOLOGICAL IMPACT AND MITIGATION

The predicted palaeontological impact of the development is based on the initial mapping assessment and literature reviews as well as information gathered during the desktop investigation. The desktop investigation confirms that the study area is underlain by relatively deep (>2m) sandy, loamy and clay soil associated with the large range of geological formations from Randian aged quartzites to Vaalian aged Stromatolitic dolomites and most recent Permian aged sandstone and shale of the Vryheid Formation (Figure 3).

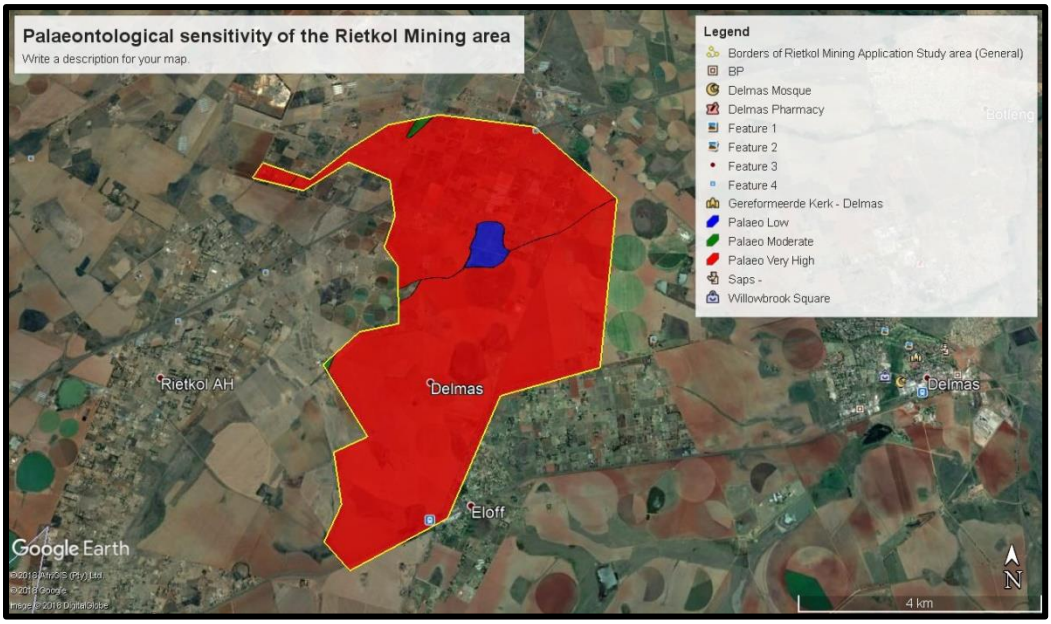

Figure 3 Palaeontological sensitivity of the area affected by the Rietkol Mining Application

The areas underlain by Vaalian aged rocks of the Hospital Hill Formation, will have a Low Palaeontological significance and underlies the entire central part of the development. The overlying Malmani Subgroup is Very Highly sensitive for Palaeontological Heritage and a suitably qualified palaeontologist must visit the site during the first excavations that exceeds 1.5m in this part of the development that is indicated with a red colour on the sensitivity map (Figure 4).

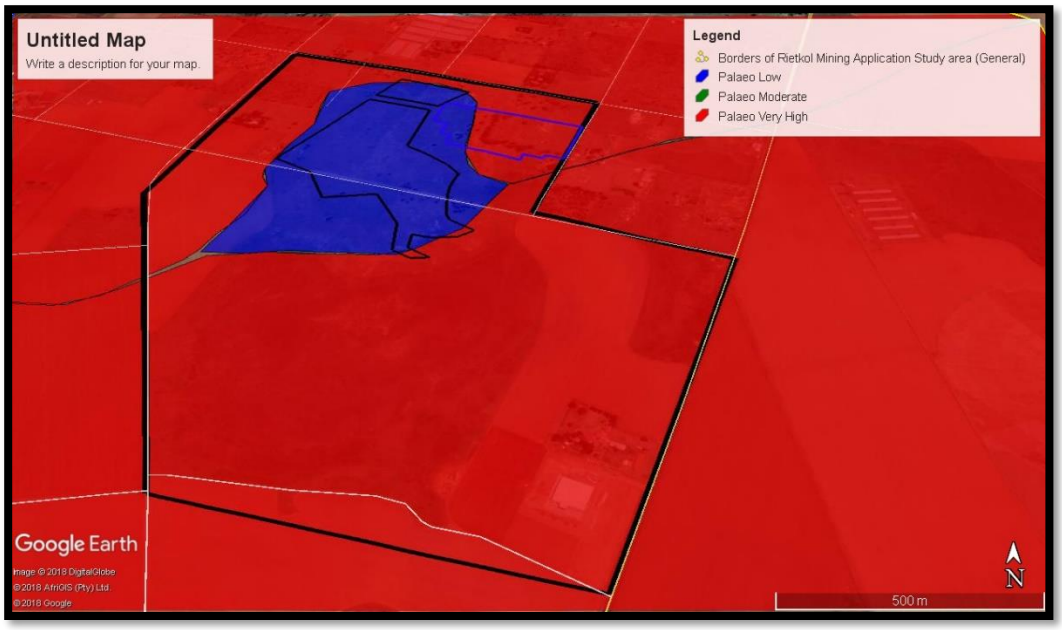

Figure 4 Palaeontological sensitivity of the area affected by the Rietkol Project mining and infrastructure footprints (zoomed)

It is important to stress that the Malmani Subgroup contains significant karst formations and caves over it entire outcrop area. The "Chance Find Protocol" (CFP) must specifically refer to the methodologies needed for chance find of Very Highly significant fossils of Homonin origin in this operation. A suitably qualified Palaeontologist must be appointed for regular site inspections and training of the Environmental personnel to be on the lookout for cave breccia in this mining area, or any excavation deeper than 1.5m on the site.

The Dwyka Group will have a moderate sensitivity and it is likely that the mining will expose more of the Group. A Moderate sensitivity is allocated to these areas.

The Vryheid Formation is very well known for the presence of plant fossils and if fossils are recorded the CPF must be clearly indicating the processes needed to record a representative sample and then apply for a destruction permit for the remainder of the area that will be mined.

The fact that the development entails extremely high impact excavation for the mining and local excavation for infrastructure, most of the development will result in deep (>1.5m) excavations for foundations or trenching for infrastructure into the sandy substrate. It is not recommended that a Phase 1 PIA be done before excavation exposed

significant trenching deeper than 1.5m. It is important that the Environmental personnel report any suspicious looking material for inspection by a suitably qualified PIA specialist.

No further mitigation for Palaeontological Heritage is recommended at this stage for this project. If however, any fossils are unexpectedly recorded during excavations of more than 1.5m depth, and specifically in sections allocated a red Very High sensitivity (Figure 4) a suitably qualified palaeontologist must be appointed to prepare a "Chance Find Protocol" (CFP). This CFP report must be included into the EMPr of the project and upgraded continuously during the mining phase when excavations of deeper than 1.5m are planned for this project.

CONCLUSION

The development site applicable to the application for the proposed Rietkol Project is underlain by Radian aged quartzitic rocks with a Low sensitivity for Palaeontological Heritage. The area is also underlain by Vaalian aged dolomite with a Very High sensitivity in terms of possible Quaternary aged deposits of cave breccias that might contain Very Significant Homonin remains. A very small outcrop of Dwyka Group tillite is recorded, but it can be expected that more sediments will be exposed during mining. A group is allocated a Moderate sensitivity. The southern part of the area is underlain by Very Highly sensitive Permian to Triassic aged sandstone and mudstones with a Very High to High Palaeontological sensitivity.

No significant fossils are expected in any formation at this stage of the development and it is very important to note that a suitably qualified palaeontologist must visit all the sites indicated as High and Very Highly significant during the first week of excavations.

If excavations expose fossils, it will be very important that a suitably qualified Palaeontological Specialist be appointed to do a Phase 1 PIA and to develop a "Chance Find Protocol" document. The CFP document must then be included as part of the EMPr of this project, to record all unexpected fossils associated with the geological formations on site.

It is recommended that:

- The EAP and ECO must be informed of the fact that a Very High Palaeontological Sensitivity is allocated to the part of study area underlain by the Malmani Subgroup and the Karoo

Supergroup sedimentary rocks and a Low sensitivity over the central part of the site underlain by quartzite.

- No further mitigation for Palaeontological Heritage is recommended for this project before excavation of deeper than 1.5m is done.
- A suitably qualified palaeontologist must do a Phase 1 PIA and develop a “Chance Find Protocol” (CFP) if fossils are recorded from any formation in this area during the **first week** of excavations into areas with a Very High and High Palaeontological significance.
- Recommendations contained in the resultant Phase 1 PIA and “Chance Find Protocol” must be approved by AMAFA and SAHRA for inclusion in the EMPr of the project.
- These recommendations must be included in the EMPr of this project.

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QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

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Dr Gideon Groenewald
Geologist