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# PALAEONTOLOGICAL ASSESSMENT (DESKTOP) REQUESTED IN TERMS OF SECTION 38 OF THE NATIONAL HERITAGE RESOURCES ACT NO 25/1999 FOR A MINING RIGHT ON A PORTION OF PORTION 1 & PORTION OF PORTION 351 OF FARM VOORUITZIGT 81 KIMBERLEY DISTRICT, NORTHERN CAPE PROVINCE


Prepared by

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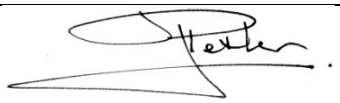
| **REVIEW** | **Mr John Pether** |  | **30/07/2017** |

**DECLARATION OF INDEPENDENCE**

AHSA is an independent consultancy: I hereby declare that I have no interest, be it business, financial, personal or other vested interest in the undertaking of the proposed activity, other than fair remuneration for work performed, in terms the National Heritage Resources Act (No 25 of 1999).

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## EXECUTIVE SUMMARY

This desktop palaeontological assessment (PIA) has been conducted in the context of an application by Kimcrush (Pty Ltd) for a Mining Right on a Portion of Portion 1 & Portion of Portion 351 of the Farm Vooruitzigt 81, Kimberley District, Northern Cape Province.

The proposed mining will be undertaken by open-cast methods. The target mineral is dolerite which will be crushed at the site to obtain various grades of stone for civil works: ballast stone, crusher sand, crusher dust, paving gravel, building concrete stone, and other grades of concrete stone for roadworks and rail installation. As the footprint of the mine will be extended new service roads will be opened and other support infrastructure developed. These physical works may result in the disturbance or destruction of heritage resources if they exist. For this reason an HIA is necessary to prepare a heritage impact statement showing what is present or what is likely to occur at the site.

In this desk study, the underlying rock units in the area of the proposed development have been identified from the 1: 250 000 geology map 2824 Kimberley (Council for Geosciences, Pretoria), scientific literature and previous palaeontological impact assessments that have been conducted in the broader area by various scholars.

The following is a summary of the findings:
The proposed mining intends to exploit the unfossiliferous Karoo dolerite rock which underlies the project area under a cover of Gordonia Formation sandy red soils. It is unlikely that fossiliferous Dwyka or Ecca formations will be affected. The affected Gordonia Formation is of low palaeontological sensitivity.

Overall, the impact of the proposed development on fossil resources is expected to be minimal. However, it is still recommended that the Environmental Control Officer (Eco) puts in place a contingency plan to rescue chance finds and where possible preserve them *in situ*. A standard Fossil Finds Procedure (FFP) has been drafted by Heritage Western Cape and is attached to this report to provide field guidance to the ECO. The recommendations made here should also be incorporated into the Environmental Management Plan for the proposed mining operations.

# 1. INTRODUCTION

This desktop palaeontological assessment (PIA) has been conducted in the context of an application by Kimcrush (Pty Ltd) for a Mining Right on a Portion of Portion 1 & Portion of Portion 351 of the Farm Vooruitzigt 81, Kimberley District, Northern Cape Province. The palaeontological assessment is a requirement in a Heritage Impact Assessment (HIA) as prescribed under Section 38 of the National African Heritage Resources Act (Act No. 25 of 1999).

## 1.1. Nature of development and expected impacts

The proposed mining will be undertaken by open-cast methods. The target rock is dolerite which will be crushed at the site to obtain various grades of stone for civil works: ballast stone, crusher sand, crusher dust, paving gravel, building concrete stone, and other grades of concrete stone for roadworks and rail installation. As the footprint of the mine will be extended, new service roads will be opened and other support infrastructure developed. These physical works may result in the disturbance or destruction of heritage resources where they exist. For this reason an HIA is to prepare a heritage impact statement which shows what is present and what is likely to occur at the site.

## 1.2. Research value of the fossils

The National Heritage Resources Act no. 25 of 1999 defines palaeontological resources as fossilised remains or traces of animals or plants which lived in geological times other than fossil fuels or fossiliferous rocks intended for industrial use. Palaeontological fossils therefore have scientific research value whereby scientists identify and reconstruct different types of plants and animals that no longer exist and put together a "tree of life" to describe the evolutionary relationships between them and also extant organisms. Thus in the geological provenance in which fossils are found there lies natural libraries or archives in which a few ancient organisms (plants and animals) have been preserved. Fossilization is a relatively rare process, yet it nevertheless provides a surprisingly important window into the past and has allowed scientists to put together a picture of the history of life on earth.

The fossil record is better understood if it is placed in a geologic timeframe. The oldest fossils are approximately 3.8 billion years old. But in this long timeline multicellular organisms with skeletons appeared only 580 million years ago.[1]

The breadth of palaeontological research has been expanding to also determine long-term physical changes in paleogeography and paleoclimatology and how they that affected the history of life today's patterns of biodiversity. Palaeontologists help identify key moments that led to current patterns of biodiversity, and understand humanity's role in the story of life. Fossils provide irrefutable empirical scientific data relevant to how and why biodiversity has changed in the past. This brings to the fore the subject of extinctions and how best humans can deal with them.

## 2. LOCATION AND PHYSICAL SETTING

The property is located 2km from the western limits of Kimberley along the N8 highway from the city to Griekwastad. The highway forms the southern boundary of the property. While a small eastern portion of the property has been used as a quarry or borrow pit, a large portion to the west is undisturbed and exhibits the natural vegetation and soil characteristics of this part of the highveld. The terrain is flat, an open grassland with scattered acacia trees (dominated by *Acacia erioloba*).

[1] http://sciencing.com/importance-fossils-2470.html (Consulted 25 April 2016); https://www.msnucleus.org/membership/html/k-6/rc/pastlife/6/rcpl6_1a.html (Consulted 25 April 2016)


Fig. 1. Google-Earth map shows the location of Kimberley between the Vaal and Orange Rivers.

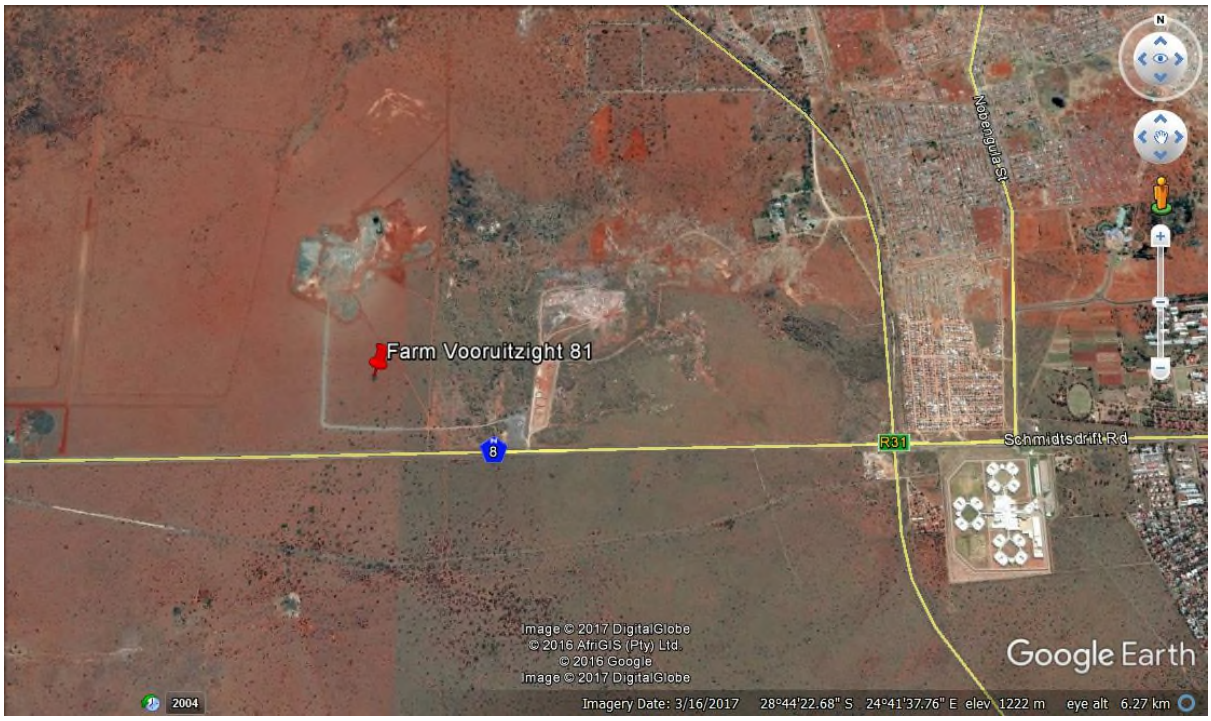


Fig. 2. Google-Earth view of the location of Portion of Portion 1 and Portion 351 of Farm Vooruitzigt 81 (Kimcrush Pty Ltd), on the western outskirts of Kimberley.

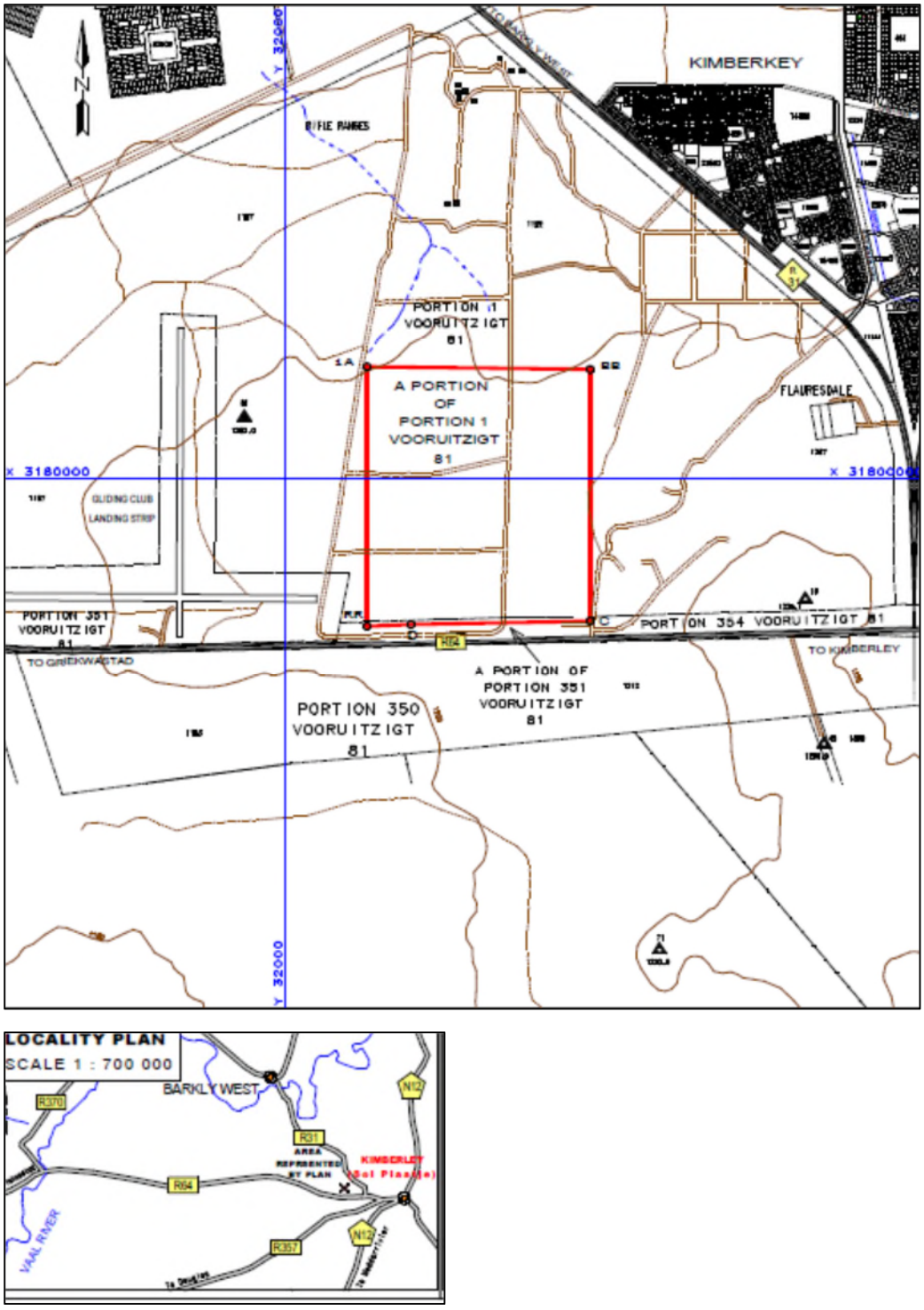


Fig. 3. Layout map of the property (courtesy of Kimcrush (Pty) Ltd).

## 3. RELEVANT LEGISLATION

Various categories of heritage resources are recognised as part of the National Estate in Section 3 of the National Heritage Resources Act (25/1999) (NHRA) including:

- geological sites of scientific or cultural importance palaeontological sites

- palaeontological objects and material, meteorites and rare geological specimens

The National Heritage Resources Act (25/1999) (NHRA) treats fossils as a palaeontological heritage - and are regarded as part of the National Estate (section 32.1(a)). Sections 35 and 38 of the same Act form the legal context in which Heritage Impact Assessments are prescribed. Sections 35 and 38 guided fieldwork and preparation of this report as a statutory reference. The PIA has been conducted at the same time with a Heritage Impact Assessment (HIA) to locate sites of heritage significance and assess potential adverse impacts of the proposed mining.

Section 38 of the NHRA states the nature and scale of development which triggers a HIA:

*38. (1) Subject to the provisions of subsections (7), (8) and (9), any person who intends to undertake a development categorised as—*

*(a) the construction of a road, wall, powerline, pipeline, canal or other similar form of linear development or barrier exceeding 300m in length;*

*(b) the construction of a bridge or similar structure exceeding 50 m in length;*

*(c) any development or other activity which will change the character of a site— exceeding 5 000 $m^2$ in extent; or*

*(ii) involving three or more existing erven or subdivisions thereof; or*

*(iii) involving three or more erven or divisions thereof which have been consolidated within the past five years; or*

(*iv) the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority;*

*(d) the re-zoning of a site exceeding 10 000 $m^2$ in extent; or*

*(e) any other category of development provided for in the regulations by SAHRA or a provincial heritage resources 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.*

Section 35 (4) of the NHRA prohibits the destruction of archaeological, palaeontological and meteorite sites:

*No person may, without a permit issued by the responsible heritage resources authority—*
*(a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;*
*b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;*
*(c) trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or*
*(d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.*

It is important to highlight that other pieces of legislation apply as well as this palaeontological impact assessment (PIA) is part of an Environmental Impact Assessment (EIA) required in terms of the National Environmental Management Act (Act 107 of 1998) and Mineral and Petroleum Resources Development Act (Act 28 of 2002 as amended).

## 4. APPROACHES AND METHODOLOGY

### 4.1. Overview

The geological map of the study area was used to determine potentially fossiliferous formations represented within the study area. The fossil heritage within each formation is recorded in the published scientific literature. Previous palaeontological impact reports in the same region are a valuable resource as these may include observations based on the report author's field experience. The likely impact of the proposed development on local fossil heritage is determined on the basis of:

1. The palaeontological sensitivity of the formations concerned.
2. The extent the development, most notably the extent to which palaeontologically-sensitive formations are planned to be excavated.

If formations of moderate to high palaeontological sensitivity occur within a proposed development, a field survey by a professional palaeontologist is usually advised in order to identify possible fossil hotspots requiring specialist mitigation.

### 4.2. Assumptions and limitations

It was assumed in this PIA study that palaeontological sensitivity of formations underlying the study area is similar to that noted for the formations in the wider region. outside the study area is fairly uniformly distributed. It is not possible to predict the buried fossil content of an area other than in general terms, based on the fossils that have been found and the depositional environments of the formations. There are factors such as lateral variations in the depositional settings of a formation, the local variations in the intensities of tectonic deformation and metamorphism, and the weathering undergone by a given formation, which influence the local palaeontological sensitivities. Thus on the basis of reading other surveys in the broader area one may fail to predict variations present within a sedimentary rock unit so that there might be highly fossiliferous localities where the rating has been determined to be low, or low sensitivity localities where the rating has been determined to be high.

## 5. GEOLOGY AND PALAEONTOLOGICAL PROFILE OF THE STUDY AREA

As discussed in Section 4.1 the geology and palaeontological sensitivity of the area has been informed by geological maps, scientific literature as well as previous impact assessments in the region. The Big Hole located in the centre of Kimberley, 5km east of the study area has provided significantly valuable profiles that have been considered as a useful reference.

### 5.1. Geology map of Kimberley (2824)

The geological map (Fig 5) shows that the area is covered by Gordonia Formation (Kalahari Group) aeolian sands (Qs)and below them a calcrete horizon (Qc) dating to the Plio-Pleistocene. The Gordonia Formations sands are closely underlain by a thick Karoo dolerite sill (Jd). Beneath the sill are Dwyka Group shales which do not crop out and are not depicted on the map.


Fig. 4. Extract from the 1:250 000 geology map 2824 (Kimberley) which shows the development area with underlying intrusive dolerites (Jd) of the Jurassic age and overlying Gordonia Formation (Kalahari Group) aeolian sands (QS) dating to the Plio-Pleistocene and Calcretes (Qc) of the same age. In the wider area are outcrops of the Allanridge Formation (Ra) and the Prince Albert Formation (Ppr) of the Ecca Group.

### 5.2. The geology of the Big Hole of Kimberley

The stratigraphic profile of the Big Hole in the centre of the city provides an important reference point and control for this desktop palaeontological study (Fig 5). Caution is however always advised as there are unpredictable variations in the sedimentations and trending of the rock formations. But this succession of rock units is quite informative as a basic guidebook for purposes of this desk survey. This is considering that the Vooruitzigt 81 lies only 5km west of the Big Hole. The succession is summarised as follows:

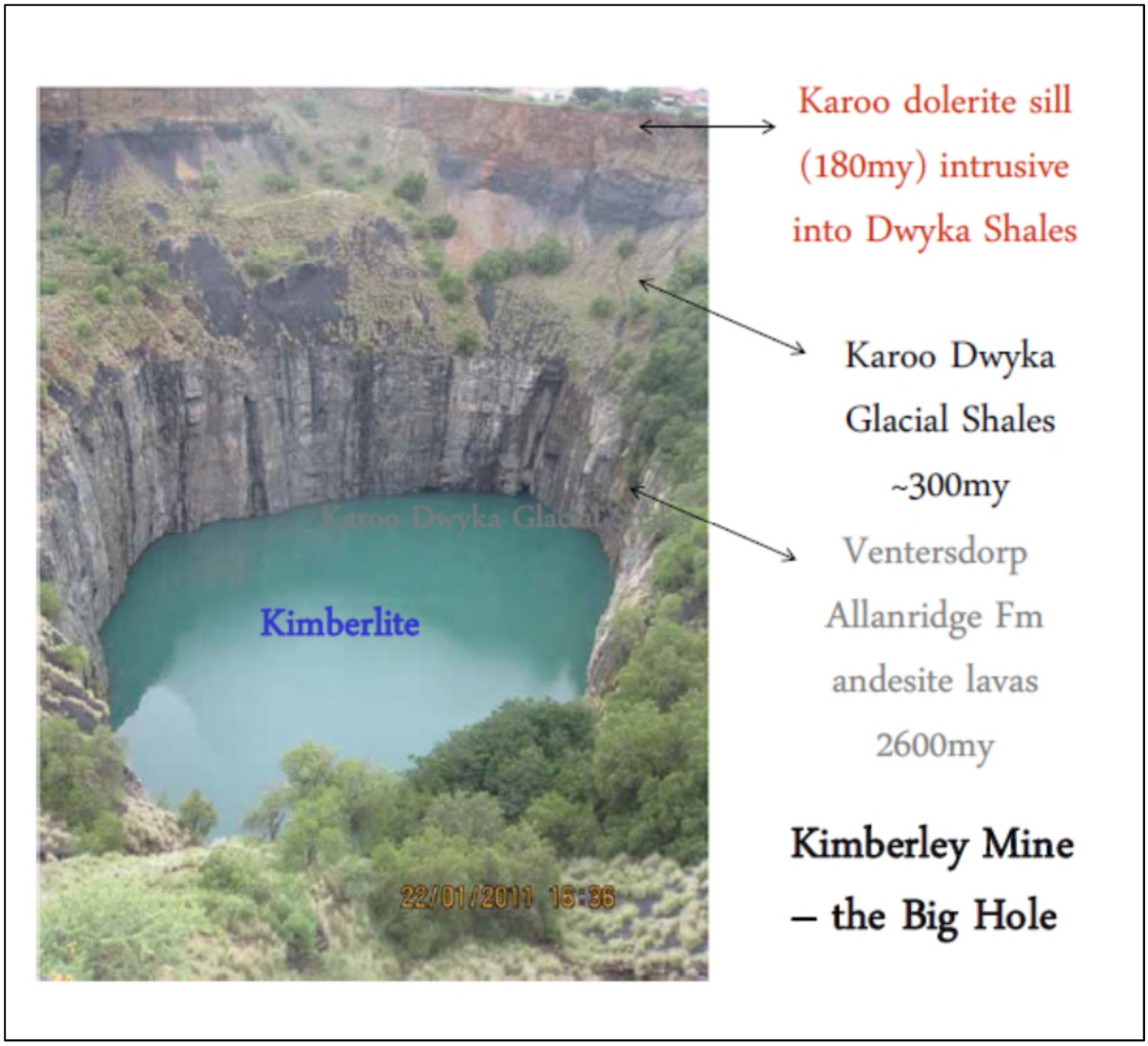


Fig 5. Chrono-stratigraphic sequence at the Big Hole Kimberly, located 3km south of the study area (courtesy of Jock Robey).[2]

[2] http://azef.co.za/.cm4all/iproc.php/2013/Presentations/4.1_Arid%20Zone%20Conference%20talk%20-%20J%20Robey.pdf?cdp=a.

The age of the rock units are summarised as follows (Jock Robey. Ibid):

| Ma | ROCK UNITS |
|---|---|
| ~90 | Kimberlite pipes |
| ~180 | Karoo dolerite sills |
| ~290 | Marine shales – Ecca Group – Prince Albert Fm. |
| ~300 | Basal Karoo glacial sediments – Dwyka Group – Mbizane Fm. |
| ~2600 | Allanridge Formation andesite lavas and quartzite of the Ventersdorp Supergroup (VSG) |
| ~3200 | Basement granitoids, amphibolites and schists |

## 6. CHRONOLOGICAL DEVELOPMENT OF ROCK UNITS IN KIMBERLEY AND SURROUNDINGS AND THEIR PALAEONTOLOGICAL SENSITIVITY

### 6.1. The Ventersdorp Allanridge Formation lavas (2600 Ma)

The Allanridge Formation andesite lavas belong to the Ventersdorp Supergroup (VSG) which dates back to the Precambrian 2600 Ma (Ma = million years ago). The **Ventersdorp Supergroup** represents a major episode of igneous extrusion, termed a Large Igneous Province (LIP), erupted from below the Kaapvaal Craton.

*Palaeontological sensitivity*

The Allanridge Formation of igneous lavas is **unfossilferous** (Almond 2012 p2)

### 6.2. Karoo Dwyka glacial sediments (300 Ma)

The Dwyka Group forms the lowermost and oldest deposit in the Karoo Supergroup basin, of Permo-Carboniferous age (*c*. 300 Ma). Northwest of Kimberley the bedrock of the Allanridge Formation exhibits glacially-striated pavements. The Dwyka tillite consists of a very fine-grained, blue-grey rock comprised of clay / mud matrix with inclusions (or clasts) of many other fragments picked up by glaciers during their travels. The Dwyka deposits represent long-term deposition of glaciogenic tills, including subglacial till, glacio-lacustrine till and terrestrial moraine. This sedimentation demonstrates the action of advancing and retreating ice-sheets on the borders of the Karoo Basin (Cadle *et al.* 1993).

The geology of the Dwyka Group shows lithological differences which led to the recognition of a northern and southern facies. The northern facies is applicable here and has been named the Mbizane Formation. Massive tillites at the base of the northern Dwyka succession were deposited by dry-based ice sheets in deeper basement valleys. Later climatic amelioration led to melting, marine transgression and the retreat of the ice sheets onto the continental highlands in the north. The valleys were then occupied by marine inlets within which drifting glaciers deposited dropstones onto the muddy sea bed ("boulder shales"). These Dwyka beds are typically heterolithic, with shales, siltstones and fine-grained sandstones of deltaic and turbiditic origin.

*Palaeontological sensitivity*

Fossils in the Mbizane Formation are sparse and mainly limited to trace fossils made by arthropods and fish, and plant fragments. According to Almond & Pether (2009) the paleontological sensitivity rating of the Mbizane Formation is considered to be moderate.

### 6.3. The Ecca Group – Prince Albert Formation ~290 Ma

The Prince Albert Formation crops out in the wider area (Fig. 4) and is mainly comprised of mudrocks deposited in the fresh to brackish, inland Ecca Sea established after the melting of the Dwyka ice sheets. It may lap into the study area from the east (Fig. 4). A low diversity fossil fauna is present and includes molluscs, brachiopods, fishes and various microfossils. Trace fossils made by arthropods, worms and fish occur.

*Palaeontological Sensitivity*

The Prince Albert Formation is of moderate sensitivity (Almond & Pether, 2009). There is an absence of the Prince Albert Formation at the Big Hole. It is unlikely that it occurs in the proposed mining area other than in thin patches baked by the ensuing Karoo dolerite intrusion.

### 6.4. The Karoo Dolerite Intrusion (Drakensberg Group) (≥180 Ma)

The Karoo Dolerite sill (the target of the mining), sometimes referred to as Kimberley Sheet, is found on the summits of ridges and koppies around Kimberley. The intrusion event happened between183.0 to 182.3 Ma as part of the Drakensberg Group (Coetzee 2016, p1). A larger proportion of the Kimberley municipal area is underlain by this sheet. The sheet is flat-lying and very regular in its mode of occurrence. The shales surrounding the dolerite sill have usually been metamorphosed to lydianite and hornfels as a result of the heat and pressure during the intrusion event. The intense heat and pressure have had a tendency to destroy fossil material in the underlying upper layers of the Dwyka sediments and in the overlying Prince Albert Formation (Ecca) mudrocks.

*Palaeontological sensitivity*
The igneous Karoo dolerite is **unfossilferous.**

### 6.5. Gordonia Formation of the Kalahari Group (< 3 Ma)

The Gordonia Formation aeolian sands and the calcrete layer or pedogenic limestones which lie below it (Figs. 6 & 7) probably date to the late Cenozoic (probably Plio-Pleistocene) (Almond, 2012, p10). The Gordonia sands and calcretes fall within late superficial sediments assigned to the Kalahari Group (Almond, 2012, p10).

The western outskirts of Kimberley on the farm Vooruitzigt 81 and Fieldsview north of the city (Fig 6) contain large areas of unconsolidated, reddish-brown aeolian (*i.e.* wind-blown) sands of the Quaternary Gordonia Formation (Kalahari Group). The Gordonia sands in the Kimberley area with approximate thicknesses of up to 8m are made up of up to 95% quartz associated with minor feldspar, mica and a range of heavy minerals (. The Gordonia Formation is typically exemplified by the long, linear, red dune ridges of the Kalahari that were active during drier and windy intervals of the late Quaternary. However, the red sands in the study area form a sand sheet mantle on the underlying dolerite and calcrete and are subject to soil-forming processes producing a pedogenic mud content (Fig. 6).
Trace fossils such as root casts and insect burrows, particularly termite burrows and termitaria, are the most common fossil type. Larger burrows in compact sands are made by lizards, ground squirrels, meerkats, moles and aardvarks. These may

contain fossil material.  Land snails (*Dorcasia*, *Xeroceratus*), tortoise carapaces and ostrich eggshell are typical.  The large aardvark burrows may sequester hyaena bone accumulations.

*Palaeontological Sensitivity*

Trace fossils are relatively common, but larger-mammal fossil bone finds are rare in the Gordonia Formation dunes and coversands and then are often in an archaeological context and associated with pans and water sources. Consequently the sensitivity of the Gordonia Formation is Low (Almond & Pether, 2009).  In the project area the pedogenesis affecting the coversands is unfavourable for fossil preservation.

Fig 6. Loamy sandy top soil which exemplify the Gordonia Formation (field photo: E. Matenga 2017).

Fig 7. Occasional exposures of the calcrete which underlies the Gordonia sand (field photo by E. Matenga)

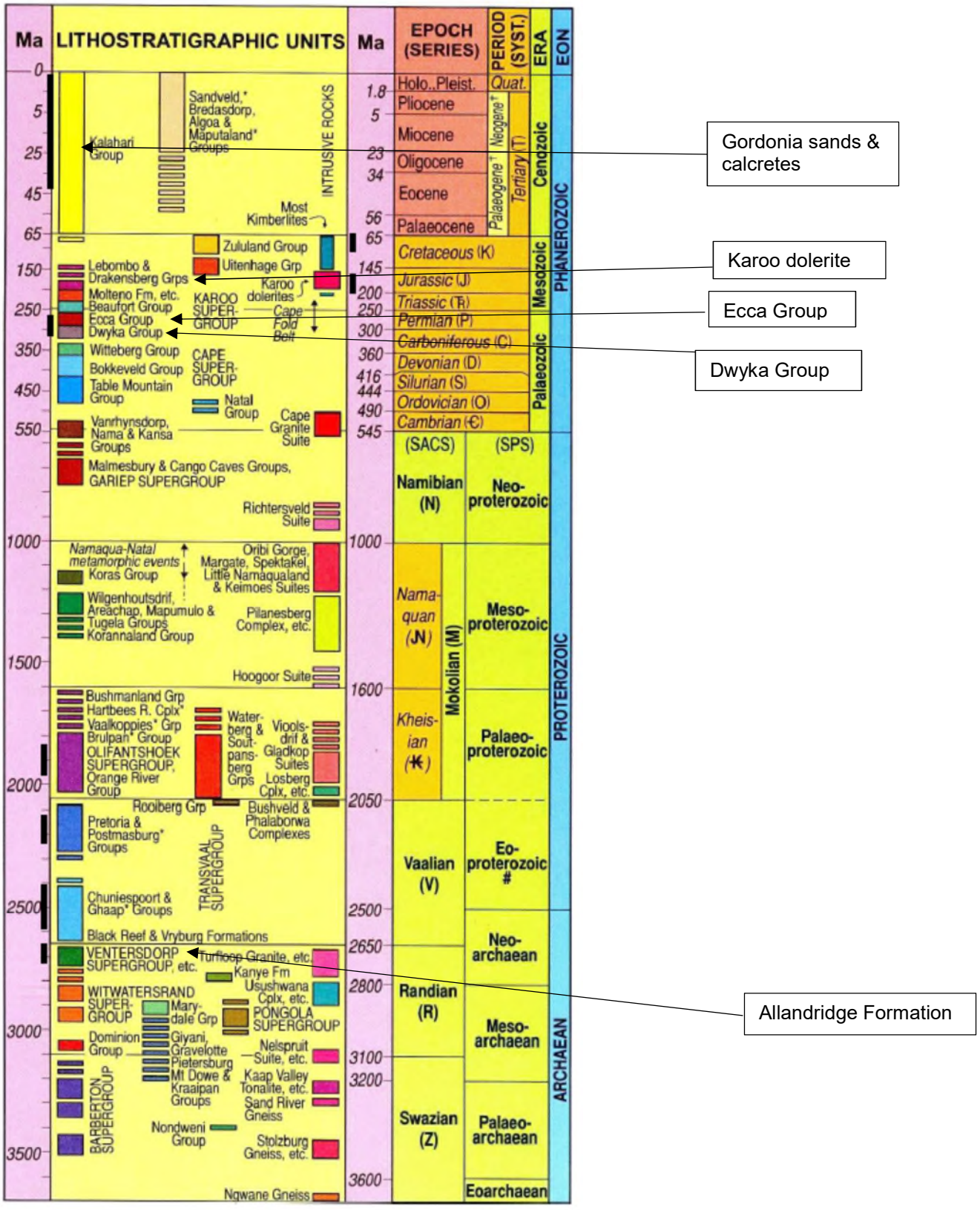


Fig 8. Chronological sequence of the rock units.

## 7. CONCLUSIONS AND RECOMMENDATIONS

The proposed mining intends to exploit the unfossiliferous Karoo dolerite rock which underlies the project area under a cover of Gordonia Formation sandy red soils. It is unlikely that fossiliferous Dwyka or Ecca formations will be affected. The affected Gordonia Formation is of low palaeontological sensitivity.

Besides the fact that the impact of the proposed development on fossil resources is expected to be minimal, it is recommended that the Environmental Control Officer (ECO) puts in place a contingency plan to rescue chance finds and where possible preserve them *in situ*. It is further advised that the recommendations made here should also be incorporated into the Environmental Management Plan (EMP) for the proposed mining operations. A standard Fossil Finds Procedure (FFP) has been drafted by Heritage Western Cape and is appended to this report to provide field guidance to the ECO.

## 8. DETAILS OF SPECIALIST

Specialist Details- Specialised in Palaeobotany which is a branch of Palaeontology dealing with the recovery and identification of plant remains from geological contexts, and their place in the reconstruction of past environments and the history of life. Palaeobotany includes the study of terrestrial plant fossils as well as the study of marine autotrophs, such as algae. A closely related field to palaeobotany is palynology, the study of fossil and extant spores and pollen. My PhD thesis focussed on the palaeoecology and anthracology of Great Zimbabwe. Paleoecology uses data from fossils and subfossils to reconstruct the ecosystems of the past. It includes the study of fossil organisms in terms of their life cycle, their living interactions, their natural environment, their manner of death, and their burial.

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## 10. ACKNOWLEDGEMENT

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