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Reg. No. 2016/281687/07

PALAEONTOLOGICAL ASSESSMENT (DESKTOP) REQUESTED IN TERMS OF SECTION 38 OF THE NATIONAL HERITAGE RESOURCES ACT NO 25/1999 FOR PROPOSED PROSPECTING ON THE REMAINING EXTENT OF PORTION 1 OF THE FARM ANNEX VIEGULANDS PUT 42, NEAR PRIESKA, SIYATHEMBA LOCAL MUNICIPALITY, PIXLEY KA SEME DISTRICT MUNICIPALITY, NORTHERN CAPE PROVINCE

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Friday, 08 September 2017

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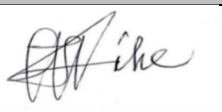
RESEARCH	**Dr Joseph Chikumbirike**		**29/08/2017**
REVIEW	**Mr John Pether**		**08/09/2017**

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 undertaken in the context of an application by Mr Paul Thukwe for a prospecting right for diamonds on the Remaining Extent of Portion 1 of the Farm Annex Viegulands Put 42 in the Pixley Ka Seme District, Northern Cape Province.

The proposed project intends to exploit the Mbizane Formation of the Dwyka Group. However, it is most unlikely the impact in palaeontological terms will be significant in view of the sparse occurrence of fossils in this unit.

The formations of the Kalahari Group present in the area include the Mokalanen Formation calcrete, the Obobogorop Formation red, colluvial “derived gravels” and the Gordonia Formation aeolian sands. The most common fossil types are trace fossils such as plant root casts and a variety insect burrows e.g. termitaria. Burrow systems made by a variety of vertebrates also occur. Land snails, tortoise carapaces and ostrich eggshell are typical. Finds of larger-mammal fossil bones are rare in the Kalahari formations and then are often in an archaeological context and associated with pans and water sources. Consequently the palaeontological sensitivity of the Kalahari Group formations is Low (Almond & Pether, 2009).

Although the overall impact of the proposed development on fossil resources is expected to be minimal, it is recommended that a standard Fossil Finds Procedure (FFP) be incorporated into the Environmental Management Plan (EMP) for the proposed mining prospecting operations. A FFP has been drafted by Heritage Western Cape and is appended to this report to provide field guidance to the Environmental Control Officer (ECO). The ECO must put in place a contingency plan to rescue chance finds and where possible preserve them in situ. However, exposed fossil bones, unless already lying in the excavated spoil, must not be retrieved by a worker or ECO. All work must cease and the ECO must inform SAHRA and a professional palaeontologist, who will then decide if avoidance or mitigation are preferred. Only a professional palaeontologist may excavate uncovered fossils with a valid mitigation permit from SAHRA.

1. INTRODUCTION

This desktop palaeontological assessment has been undertaken as part a Heritage Impact Assessment (HIA) as stipulated under Section 38 of the National African Heritage Resources Act (Act No. 25 of 1999) for an application a prospecting right on the Remaining Extent of Portion 1 of the Farm Annex Viegulands Put 42, Pixley Se District, Northern Cape Province.

1.1. Nature of development and expected impacts

Prospecting for minerals may entail the following activities:

- Open excavations and trenches
- Test pits
- Drilling
- Opening of temporary service roads
- Location of processing plant

1.2. Research value of the fossils

Palaeontological fossils are an important scientific resource as they provide critical data on the evolutionary path of living organisms. Under the National Heritage Resources Act no. 25 of 1999 palaeontological resources are defined 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. Scientists identify and reconstruct different types of plants and animals that are fossilised to describe the evolutionary relationships between them. Thus in the geological provenance in which fossils occur there lies natural libraries or archives in which a few ancient organisms (plants and animals) have been preserved. The window which fossils provide into the past have allowed scientists to put together a picture of the history of life on earth. The fossil record is better understood in the context of geological time which hundreds of millions of years. 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] Palaeontological research has provided knowledge on long-term physical changes in paleogeography and paleoclimatology and how they that

[1] http://sciencing.com/importance-fossils-2470.html (Consulted July 2017); July April 2017)

affected the history of life today's patterns of biodiversity. Palaeontological research identifies key moments that led to current patterns of biodiversity, and understand humanity's role in the story of life. This clearly demonstrates that fossils resources are significant and that they provide irrefutable empirical scientific data relevant to how and why biodiversity has changed in the past. Thus this brings to the fore the subject of extinctions and how best humans can deal with them.

2. LOCATION AND PHYSICAL SETTING

The Remaining Extent of Portion 1 of the Farm Annex Viegulands Put 42 is a commercial farm situated along the R357 road from Douglas to Prieska a distance of 75km and 50km respectively from the two towns. A large portion of the farm lies to the north of the R357 road. The terrain is generally flat with exposures of calcrete sometimes mixed with red-brown stones/grit. In a south-western portion of the property there are superficial deposits of Kalahari sands. Vegetation is karoo scrub dominated by acacia. In places there are thick stands of the short hooked thorn *Acacia mellifera subsp. Detinens* (*haakbos* in Afrikaans. Drainage channels start on the plain trending north-west to join the Orange River. In the upper reaches they are shallow streams incising relatively deep channels downstream as they cross the glacial tilllites which rise above the plain to form ridges and spurs.

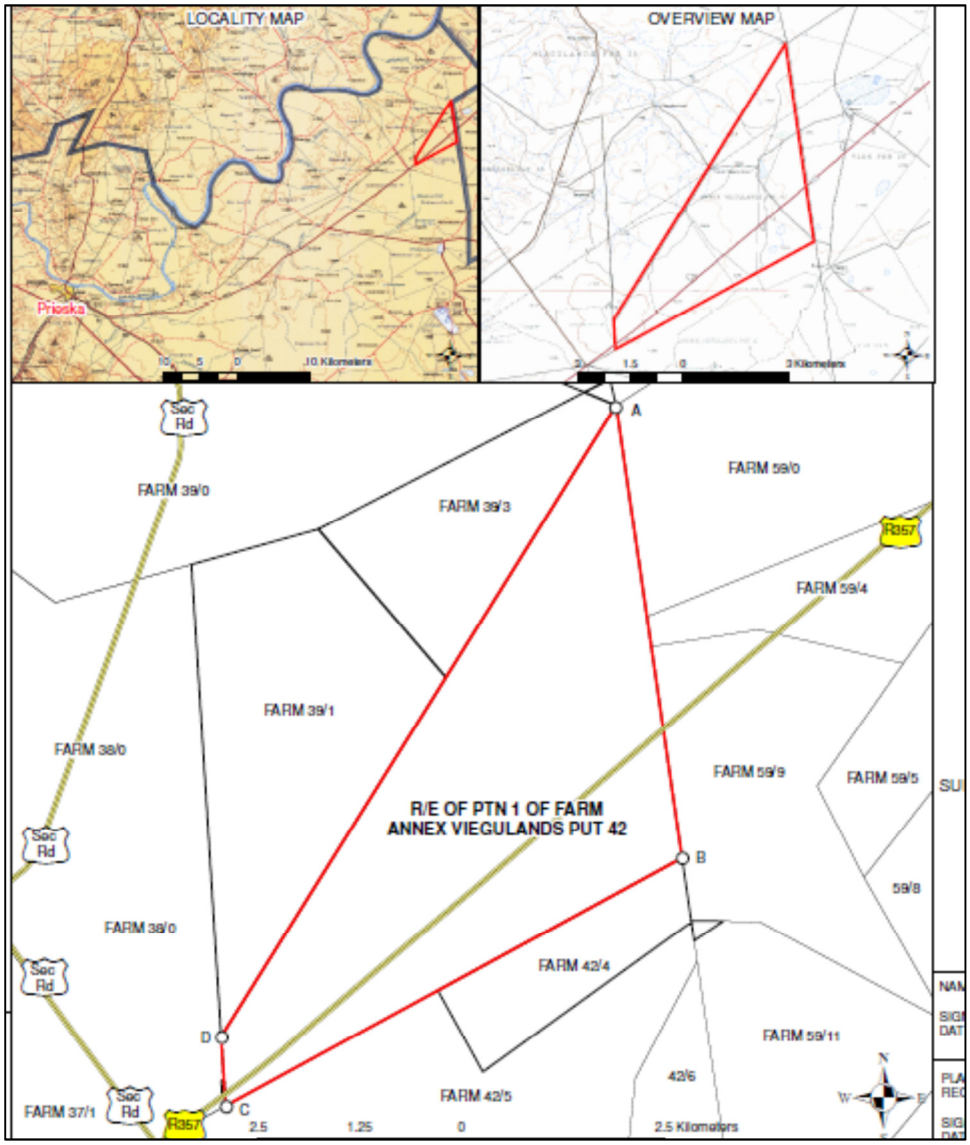


Fig 1. The locality of the farm Remainder of Ptn 1 of Annex Viegulands Put 42 (Courtesy of Mr Paul Thukwe).

3. RELEVANT LEGISLATION

Section 3 of the National Heritage Resources Act (25/1999) (NHRA) recognises various categories of heritage resources as part of the National Estate. These include:

- 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)). It is a requirement of Sections 35 and 38 of the NHRA 25/1999 that Heritage Impact Assessments are carried out prior to any development. Thus Sections 35 and 38 guided fieldwork and preparation of this report as a statutory reference. The PIA has been conducted to assess potential adverse impacts of the proposed development.

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 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 of 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 is argued in this study that palaeontological sensitivity of formations underlying the study area is similar to that noted for the formations in the wider region. To exactly predict buried fossil content of an area other than in general terms is difficult,

however, based on the fossils that have been found and the depositional environments of the formations this maybe possible. A number of factors militate against making such predictions, for example 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. 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

The knowledge of geology and palaeontological resources and sensitivity of the area was gleaned from the geological map - Prieska 2922-, scientific literature as well as previous impact assessments in the broader area.

5.1. Geology of the Project Area

The 1995 printed geological map shows that the bedrock of the area is comprised of the Dwyka Group sediments of the Karoo Supergroup (Fig. 2, C-Pd). Known more informally as the “Dwyka Tillites”, these sediments represent the melt-out content of glaciers and ice sheets when southern Africa, part of the Gondwana supercontinent, was in the vicinity of the South Pole. The updated map available on the Council for Geoscience GIS Portal reflects subsequent, more-detailed work by Dwyka sequence experts and specifically indicates that the Dwyka bedrock unit is the **Mbizane Formation**. This formation is exposed to the west of the project area, where slightly higher ground flanking the Gariep (Orange) River is incised by its local tributaries.

This Dwyka bedrock is extensively mantled by calcrete (Fig. 2, T-Qc), which has been confirmed by field observations during the HIA survey in July 2017 (Fig. 3). In turn, superficial, reddened, aeolian (windblown) Kalahari coversands on the calcrete are dispersed over the area, as is evident in aerial images. However, thicker sand cover is mapped in the south of the project area (Fig. 2, Qs). The calcrete and coversands are the upper formations in the Kalahari Group of terrestrial formations deposited since early Cenozoic time in the interior of southern Africa.

Fig 2. The project area (pink outline) is mainly underlain by calcrete (T-Qc), beneath a thin cover of red, Kalahari-type sands. Thicker sands occur in the south (Qs). The Dwyka Group (C-Pd), Mbizane Formation, crops out in the southernmost part of the area. Extract from 1:250000 Geological Sheet 2922 Prieska, Council for Geoscience, 1995.

Fig 3. Exposures of calcrete in the eastern, north-eastern and south-western parts of the farm Camera Position (CP2): 29°29'7.70"S; 23°11'30.94"E (Field photos – E. Matenga).

Fig 4. Superficial deposits of windblown Aeolian Kalahari sands in the central south-eastern part of the farm. Camera position (CP1) 29°29'44.80"S; 23°10'41.70"E.

Fig 5. The ridges and spurs which occupy the western portion of the farm formed from glacial tillite deposits, streams have incised channels trending north-west to the Orange River. Camera position (CP3): 29°27'41.96"S; 23°11'3.11"E. Not in study area!

Fig. 6. Red-brown gravel of the (Obobogorop Formation (CP4): Location: 29°29'23.51"s, 23°10'59.40"E.

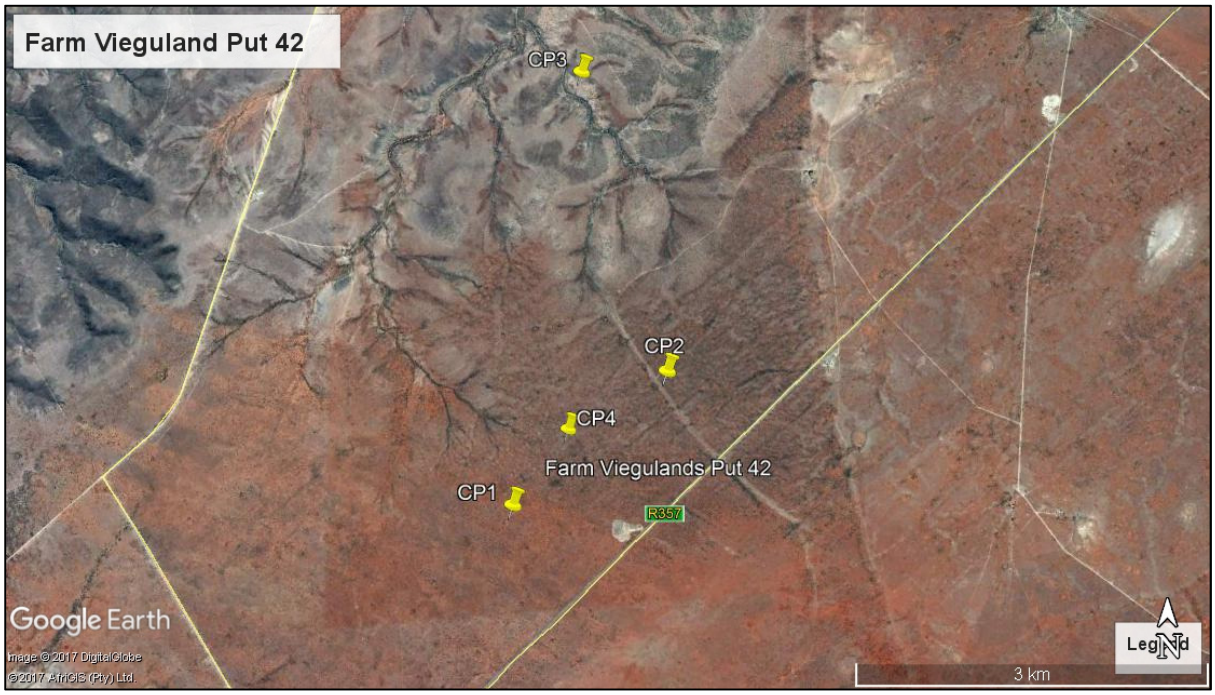


Fig 7. Google Earth map shows camera locations for Figs 3-6.

5.2. Karoo Dwyka Group – Mbizane Formation glacial sediments (300 Ma)

The Dwyka Group forms the lowermost and oldest deposit in the Karoo Supergroup basin, of Permo-Carboniferous age (~300 Ma) (300 million years ago). The Dwyka tillite consists of fine-grained, blue-grey "rock flour" mud matrix with clasts of large boulders to pebbles of the many rock types 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 that has led to the recognition of a northern and southern facies. The northern facies is applicable here and represents glaciogenic valley and inlet deposits which have been named the Mbizane Formation (Visser *et al*., 1990). The base of the Mbizane Formation consists of material eroded by ice sheets from the highlands to the north and northwest and deposited as massive tillites in the larger valleys carved in the basement rocks. During subsequent climatic warming and deglaciation the ice sheets melted back to the highlands and sea level rose, inundating the valleys. The tillites were then succeeded by marine muds with melt-out dropstones from floating icebergs (the "boulder shales"). The Mbizane Formation valley and inlet deposits are very variable, comprising tillites, conglomerates, sandstones and mudrocks which were left behind on the ice-scoured landscape by the retreating glaciers (Fig 5).

5.2.1 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.

5.3. Kalahari Group Formations (< 3 Ma)

5.3.1 The Mokalanen Formation

Thick calcrete (Fig. 2, T-Qc) is extensively developed in the wider area and, in addition to the calcreted surface of the Dwyka Mbizane Formation, has also formed in the diamondiferous fluvial gravel terrace deposits flanking the Gariep River (red labels DA, Fig. 2). Both the older, high fluvial gravels of probable mid-Miocene age, and the lower terrace gravels of Quaternary age, have superimposed calcrete formation, indicating a lengthy, polyphase development. The calcrete in the area is correlated with the Mokalanen Formation of the Kalahari Group which is the calcrete capping of the main Kalahari Group (Fig.3), considered to have formed due to climatic aridification since the late Pliocene (Partridge *et al*., 2006).

Support for the inception of calcrete formation comes from a well digging at Areb, east of Springbok, where fossil teeth of *Hipparion namaquense*, the three-toed ancestor of the horse, were found in local drainage deposits that are overlain by ~15 m of calcreted colluvial deposits. The age range of this *Hipparion* species is 6-4 Ma, indicating that the calcrete formation took place later, in the late Pliocene and Quaternary (Pickford *et al*., 1999), since about ~3 Ma.

The calcrete has formed across the landscape in both Dwyka bedrock and in overlying deposits. In the study area the calcrete may thus include unmapped fluvial, colluvial and aeolian deposits on top of the Dwyka.

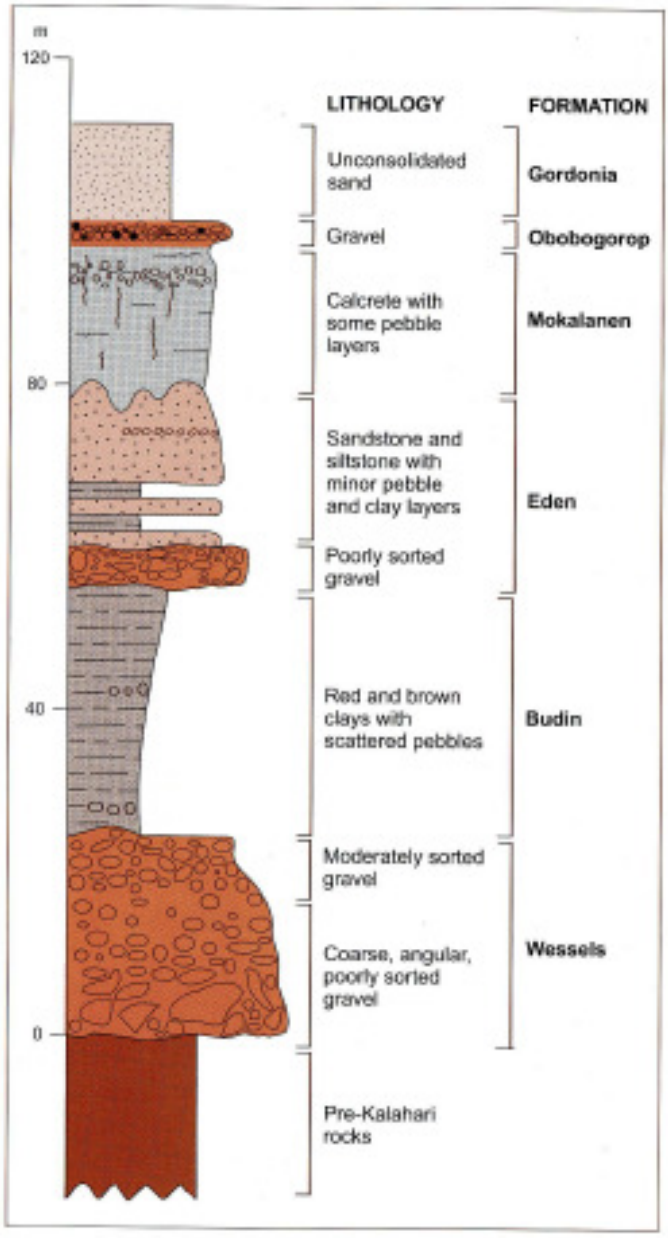


Figure 8. Schematic section of the Kalahari Group. From Partridge *et al.*, 2006).

5.3.2 *The Obobogorop Formation*

The surface of the Mokalanen Formation calcrete has been subjected to dissolution and downwasting. This has usually produced a bumpy surface of pits (makondos) and ridges. Reddened gravels are found on this surface and filling depressions. Known as the “derived gravels”, these are resistant clasts derived from the weathering and downwasting of the calcrete which released clasts from the host Dwyka tillites and, where present, from overlying, calcreted terrestrial deposits. These gravels are called the Obobogorop Formation (Fig. 6) (Partridge *et al.*, 2006).

5.3.3 *The Gordonia Formation*

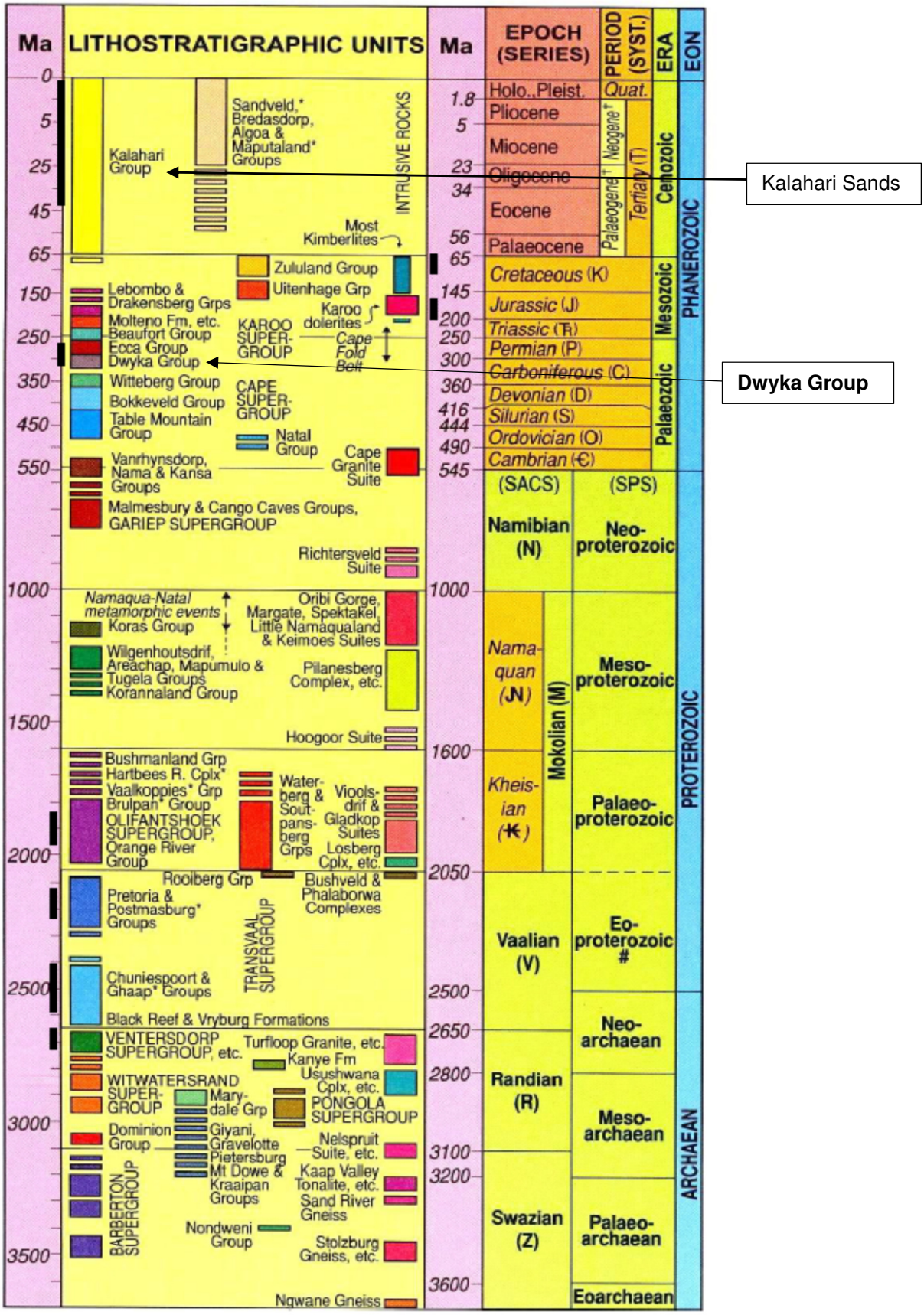
The Gordonia Formation is typically exemplified by the long, linear, red dune ridges of the Kalahari that were active during drier and windy intervals of the late Quaternary. However, the red Kalahari sands in the study area form a sand sheet layer overlying the calcrete and red gravels.

5.3.4 *Palaeontological Sensitivity*

In the Kalahari Group terrestrial deposits the most common fossil types are trace fossils such as root casts and insect burrows, particularly termite burrows and termitaria. Land snails (*Dorcasia*, *Xeroceratus*), tortoise carapaces and ostrich eggshell are typical. Larger burrows in compact sands are made by lizards, ground squirrels, meerkats, moles and aardvarks. These may contain fossil material and the large aardvark burrows may sequester hyaena bone accumulations. However, such finds of larger-mammal fossil bones 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 palaeontological sensitivity of the Gordonia Formation is Low (Almond & Pether, 2009).

The Mokalanen Formation calcrete is of low palaeontological sensitivity where it is hosted in the Mbizane Formation (Dwyka). When hosted in overlying late Pliocene – Quaternary superficial deposits the fossil types expected in the calcrete are the same as the Kalahari Group in general and the sensitivity is similarly Low. However, when present in calcrete, fossil shells and bones, as well as trace fossils, are usually quite well preserved due to enclosure in the calcium carbonate, but the cementing makes extraction more difficult.

The Obobogorop Formation colluvial “derived gravels” are weathered residue composed of siliceous, resistant clasts and preservation of fossil material is unlikely unless it is petrified, such as silicified wood which does occur in the gravels. There is a small possibility that petrified, abraded hard parts such as fossil teeth may occur. The sensitivity is nevertheless Low.



Kalahari Sands

Dwyka Group

Fig 9. Chronological sequence of the rock units (Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The Geology of South Africa, Geological Society of South Africa, Marshalltown.

6. CONCLUSIONS AND RECOMMENDATIONS

The proposed project intends to exploit the Mbizane Formation of the Dwyka Group. However, it is most unlikely the impact in palaeontological terms will be significant in view of the sparse occurrence of fossils in this unit.

The formations of the Kalahari Group present in the area include the Mokalanen Formation calcrete, the Obobogorop Formation red, colluvial "derived gravels" and the Gordonia Formation aeolian sands. The most common fossil types are trace fossils such as plant root casts and a variety insect burrows *e.g.* termitaria. Burrow systems made by a variety of vertebrates also occur. Land snails, tortoise carapaces and ostrich eggshell are typical. Finds of larger-mammal fossil bones are rare in the Kalahari formations and then are often in an archaeological context and associated with pans and water sources. Consequently the palaeontological sensitivity of the Kalahari Group formations is Low (Almond & Pether, 2009).

Although the overall impact of the proposed development on fossil resources is expected to be minimal, it is recommended that a standard Fossil Finds Procedure (FFP)[2] be incorporated into the Environmental Management Plan (EMP) for the proposed prospecting operations. A FFP has been drafted by Heritage Western Cape and is appended to this report to provide field guidance to the Environmental Control Officer (ECO). The ECO must put in place a contingency plan to rescue chance finds and where possible preserve them *in situ*. However, exposed fossil bones, unless already lying in the excavated spoil, must not be retrieved by a worker or ECO. All work must cease and the ECO must inform SAHRA and a professional palaeontologist, who will then decide if avoidance or mitigation are preferred. Only a professional palaeontologist may excavate uncovered fossils with a valid mitigation permit from SAHRA.

7. DETAILS OF SPECIALIST

[2] Heritage Western Cape Chance Fossil Finds Procedure.

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.

8. REFERENCES

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Websites

Council for Geoscience GIS Portal:-
http://sageoscience.maps.arcgis.com/home/index.html

9. ACKNOWLEDGEMENT

Mr John Pether (Consultant in Sedimentology, Palaeontology and Stratigraphy), for moderation and editorial supervision.