Phase 1 Palaeontological Impact Assessment of 17 burrow pits near Middelburg, Eastern Cape Province.

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Executive Summary

- The palaeontological footprint of the region around Middelburg suggests high potential for possible impact on Karoo vertebrate and trace fossils and to a lesser degree, localized Quaternary fossil deposits.
- The burrow pits are located entirely on rocks of the Beaufort Group (Karoo Supergroup) and areas where Karoo Dolerite and more recent, unconsolidated Quaternary sediments occur.
- The baseline study involved a foot survey of the area flanking both sides of the access road leading to each pit, the surroundings along each pit margin, and the exposures inside each pit.
- The burrow pits are easily accessible, being directly adjacent to the secondary roads.
- Burrow Pit no. 3 and 17 could not be located based on the coordinates provided.
- No fossils of Quaternary age were located near or in the vicinity of the burrow pits during the baseline survey.
- Two burrow pits exclusively comprise igneous (dolerite) rock and are not palaeontologically significant.
- Thirteen burrow pits contain fossil-bearing mudstone related to depositional events at the boundary between the Permian and Triassic periods.

- Thirteen burrow pits are identified as potentially sensitive based on the stratigraphic position and lithology of their deposits.
- A high degree of probability exists for locating *in situ* palaeontological remains in these sediments during implementation of the project.
- It is advised that newly uncovered objects of palaeontological significance, found during the course of excavation activities, may require a Phase 2 rescue operation at the cost of the developer.
- **It is recommended that**: 1) Excavation procedures related to the reparation of the gravel roads within the inspected area, must be accompanied by a follow-up palaeontological investigation at the cost of the developer by the following action: 2) a Karoo vertebrate specialist should check the mudstone-bearing burrow pits before and when earth-moving commences in order to determine whether, as is probable, palaeontological remains or features are exposed *in situ.*

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Introduction

A Phase 1 Palaeontological Impact Assessment was carried out on seventeen burrow pits in the Middelburg, Karoo area. These are pre-existing, but presently unused quarries that will be used for the reparation of three existing gravel roads in the vicinity (Fig 1). It is anticipated that the extent of the development will be localized and the duration short-term.

The survey is required as a prerequisite for new development in terms of the National Environmental Management Act and is also called for in terms of the National Heritage Resources Act 25 of 1999. The site visit and assessment took place from 24 to 25 September 2008.

Terms of reference

- Identify and map palaeontological heritage resources in the proposed areas of impact;
- determine the importance of palaeontological heritage resources in the proposed areas of impact;
- determine and assess the potential impacts of the proposed development on palaeontological heritage resources in the proposed areas of impact, and
- recommend mitigation measures to minimize impacts associated with the proposed development.

Description of the Affected Area

Details of area surveyed

Locality data

The survey areas are shown on the following 1:50 000 maps:

3125 CA Tafelberg

3125 CB Conway

3125 CC Spitskopvlei

The burrow pits are located alongside three separate gravel roads (Table 1 & Fig 1). All the pits are easily accessible, being directly adjacent to the road.

Table 1. Position of the burrow pits along the three marked gravel roads in Figure 1.

Road no.	Burrow Pit	Coordinates
DR2629	MID1	S31 28.574 E25 03.520
	MID2	S31 27.480 E25 03.520
	MID3	S31 26.447 E25 04.158
	MID4	S31 24.170 E25 09.116
	MID5	S31 23.553 E25 10.229
	MID6	S31 22.903 E25 11.461
	MID7	S31 21.966 E25 12.755
	MID8	S31 20.000 E25 13.395
	MID9	S31 18.055 E25 13.249
654	MID10	S31 56.780 E25 03.222
	MID11	S31 55.742 E25 03.914
	MID12	S31 52.976 E25 05.508
	MID13	S31 52.616 E25 07.418
	MID14	S31 50.978 E25 08.159
DR2631	MID15	S31 27.347 E25 11.375
	MID16	S31 26.310 E25 11.375
	MID17	S31 27.388 E25 13.551

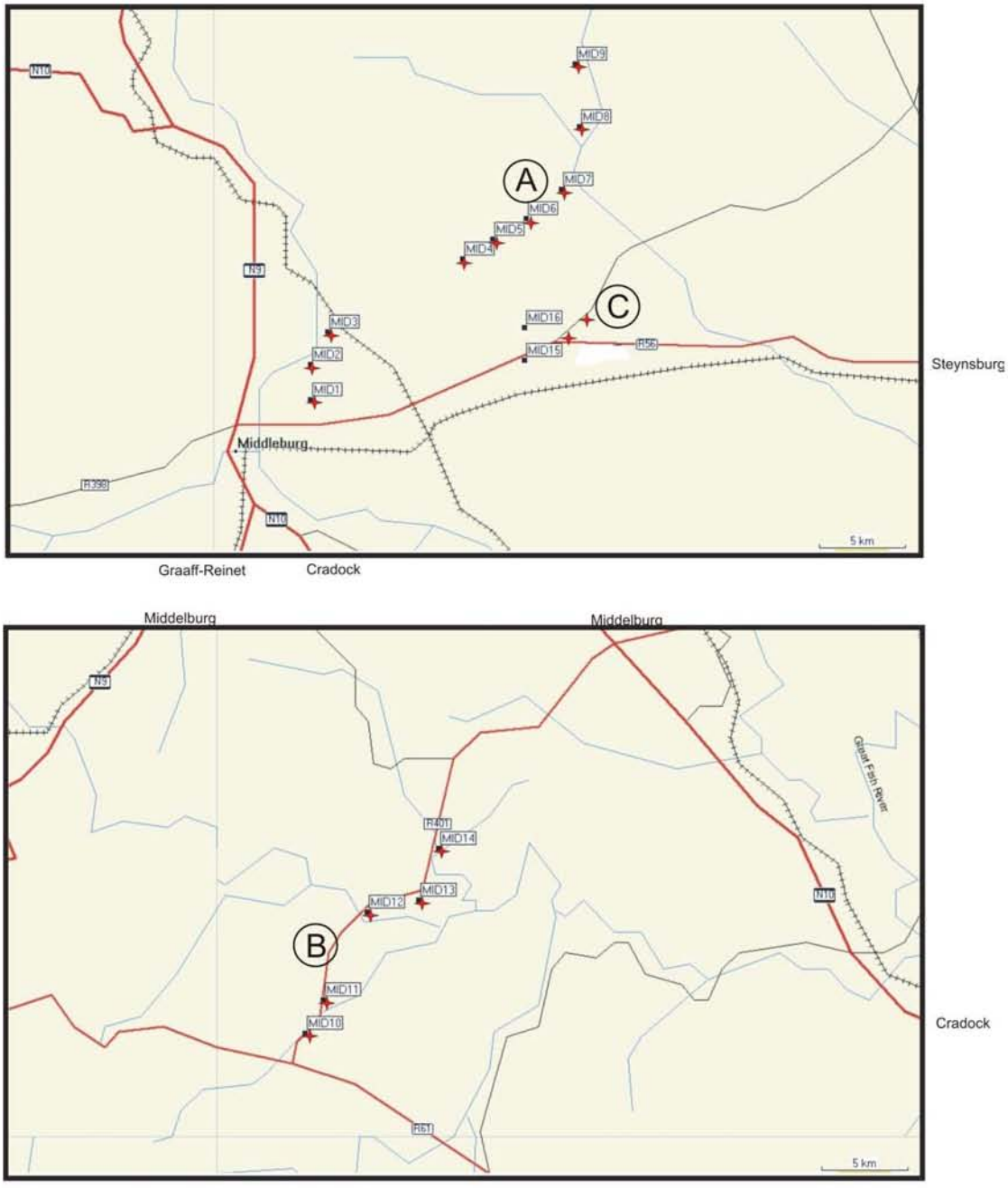

Figure 1. Position of the burrow pits. Road nos. (A) *DR 2629*, (B) *654* (R401), and (C) *DR2631* (Suurberg)

Geology

The burrow pits are located entirely on rocks of the Karoo Supergroup and areas where Karoo Dolerite, and more recent, unconsolidated Quaternary sediments occur. The deposits of the Karoo Supergroup in the south-western part of the Karoo Basin are assigned to the Beaufort Group, which is further subdivided into the Adelaide and Tarkastad subgroups (Table 2). The Beaufort Group of rocks is interpreted as a fluvio-lacustrine system characterized by a change from meandering to multi-channeled braided river systems following the end of the Permian Period. The change in depositional context from silts and mud to mostly sand in the Lower Triassic is reflected by the Katberg Formation, which marks the lower boundary of the Tarkastad Subgroup. In terms of the underlying geology, Roads *DR2629* and *DR2631* are more or less located on rocks of the lower Katberg Formation, while Road *654* disects the underlying Permian rocks of the Adelaide Subgroup.

Table 2. A simplified stratigraphic column of the geology in the Middelburg region.

Geological Period	Stratigraphic Unit			Lithology
Quaternary				Sand,silt, alluvium and colluvium; gravels in river valleys; calcrete and calcretised sediments; scree
Jurassic		Karoo Dolerite		Dykes and sills of igneous rock consisting of feldspar and pyroxene
Triassic	Karoo Supergroup	Beaufort Group	Tarkastad Subgroup, Katberg Formation	Silt and white-weathering feldspathic sandstones, maroon and grey mudstones
Permian		Beaufort Group	Adelaide Subgroup	Mottled grey and rare maroon mudstones with scattered calcareous concretions, thin fine-grained sandstones

Methodology

The baseline study involved a foot survey of each gravel pit and its access road where present. Three features were identified for investigation – the area flanking both sides of the access road leading to each pit, the surroundings along each pit margin, and the exposures inside each pit. A Garmin Etrex Vista GPS hand model (set to the WGS 84 map datum) and a digital camera were used to record relevant data.

Palaeontological Background

The south-western part of the Karoo Basin accounts for what has been described as continuous continental sedimentation across the Permian-Triassic boundary, around 250 million years ago. The transition between Upper Permian and Lower Triassic rocks also record a mass extinction event dubbed “The Mother of Mass Extinctions”. This Late Palaeozoic extinction event, which severely reduced the diversity of life represented in the terrestrial fossil record (a disappearance of over 70% in the number of tetrapod families), is used as a marker to define the boundary between the Permian and Triassic periods. The area around the Lootsberg Pass in particular, produces a wealth of Karoo vertebrate localities related to the Permian-Triassic transition and extinction event (Fig. 2, D). For example, the principal casualties of the end-Permian extinction include all Gorgonopsian predators, and most Dicynodontian herbivores, with the exception of *Lystrosaurus*. A shift to *Lystrosaurus*-dominated vertebrate faunas is seen in early Triassic sections of the Katberg Formation. Unlike the wealth of Karoo vertebrate fossil localities found in the region, the distribution of Late Cenozoic (primarily Quaternary) palaeontological deposits is localized and rare. A 36 000 year old prehistoric human skull, discovered in 1952 in a dry channel bed of the Vlekpoort River

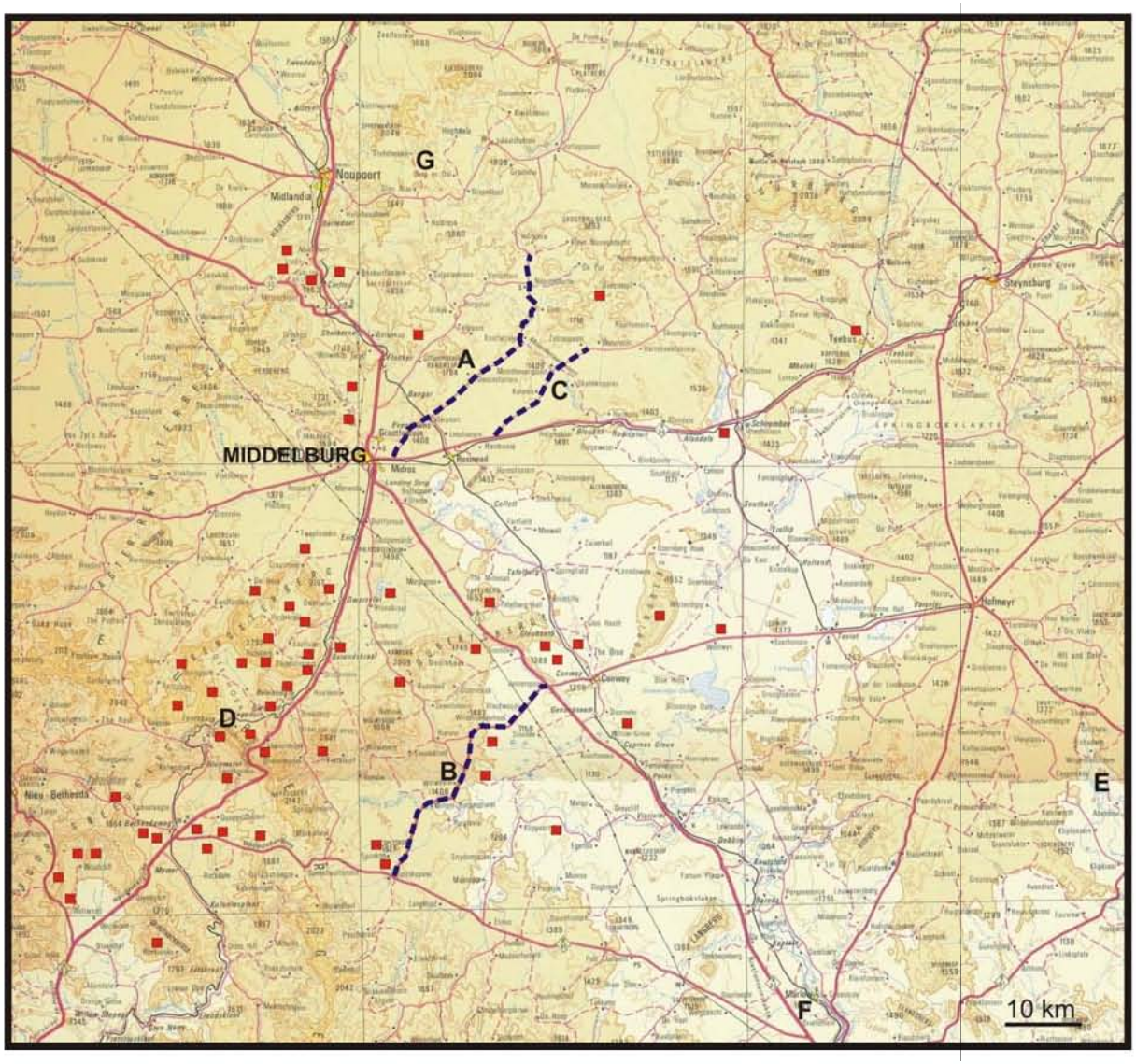

Figure 2. Location of roads where burrow pits are situated and general positions of previously recorded fossil sites in the region.

near Hofmeyr, corroborates genetic evidence about the African origins of modern humans (Fig 2, E). A faunal assemblage of mostly extinct, Florisian ungulates (*Syncerus antiquus, Damaliscus niro* and *Antidorcas bondi*) was recorded in a fluvial context at Buysfontein, between Aliwal North and Burgersdorp. Another late Pleistocene faunal assemblage, that contains five extinct taxa, was recovered at a depth of 8m from spring deposits on the farm Driefontein near Cradock (Fig. 2, F). The extinct forms from Driefontein include a number of open grassland adapted herbivores, namely *Equus capensis, Syncerus antiquus, Damaliscus niro, Megalotragus priscus* and *Antidorcas bondi*. The abundance of these different sized grazers in the Karoo is a reflection of the availability of abundant seasonal grassland and offers strong evidence for a stable and sustainable grassland ecosystem in the central interior of South Africa thousands of years ago. Further north, the Blydefontein Basin near Noupoort includes late Pleistocene and Holocene valley fills with associated pollen spectra, and fossil faunal remains (Fig. 2, G).

Brief description of the burrow pits

MID 1

Situated next to a dolerite outcrop. Approximately 2000m^2. Blue-grey mudstones capped by a thin layer of red sand, silt and colluvium.

MID 2

Situated in open veld. Approximately 3000m^2. Weathered maroon shales with intercalated grey-green shale. Thin cover of red-coloured gravel.

MID 3 (could not be located)

MID 4

Maroon mudstone with grey-green capping. Approximately 4000m^2. Inclusions of fine-grained sand bodies and calcrete concretions. Thin veneer of, red windblown sand and silt.

MID 5

Situated in open veld. Maroon mudstone with grey-green shale intercalations and capping. Approximately 3400m^2. Calcrete concretions occur for c. 0.5 – 1.0 m in top of exposure. A 20cm of red sand and silt capping.

MID 6

Situated in open veld. Approximately 3600m^2. Weathered maroon mudstone capped by grey-green shale. Approximately 5000m^2. Thin veneer of recent sand and silt. About 2km from a dolerite outcrop.

MID 7

Next to a dolerite outcrop. Approximately 3200m^2. Grey-green shale, possibly indurated. Red-brown colluvial gravel.

MID 8

About 1 km from dolerite outcrop. Approximately 1500m^2. Grey-green shale, with some ripple marks visible on a horizontal exposure. Potential for fossil tracks (Fig 3).

MID 9

Situated against dolerite outcrop. Approximately 3400m^2. Contact zone between weathered maroon mudstone and dolerite. Thin cover of yellow-red to brown sandy gravel capping.

Figure 3. Burrow Pit no. 8. Partly exposed bedding plane. Potential for fossil tracks.

MID. 10

Near dolerite outcrop. Approximately 5000m^2. Grey-green mudstone, with purple patination of bedding planes. Thin red to brown sandy capping.

MID 11

Grey-green shale with red-purple bedding planes. – Approximately 4500m^2. Thin layer of red-brown cover sandy gravel and silt. Excavation of sediments already undergoing (Fig. 4).

MID 13

Dolerite outcrop. Weathered dolerite with calcrete infillings in cracks. – Approximately 3500m^2. Yellow-brown sand, silt and colluvium capping.

MID 14

Dolerite outcrop. Weathered dolerite with calcrete infillings in cracks. Approximately 3000m^2. Thin lens of yellow-brown sand and colluvium capping.

MID 15

Situated in open veld. Maroon mudstone with intercalations of grey-green shale. Approximately 3500m^2. At the top of the section the purple shale is filled in by calcrete along bedding planes and cracks.

MID 16

Situated in open veld. Approximately 3000m^2. Weathered maroon mudstones, Red sand and silt capping.

Figure 4. Burrow Pit no. 11. Excavations are already underway in the mudstone deposits

MID 17 (could not be located)

Results of Survey

The assessment of the potential impact on palaeontological resources within the inspected area is summarized in Table 3. No fossils or trace fossils were located during the survey of the burrow pits and their surroundings. Pits 3 and 17 could not be located based on the coordinates provided. The unconsolidated Quaternary sediments overlying the Permian-Triassic rocks around the burrow pits are made up of thin deposits and are not fossilliferous. The geology of Pits 13 and 14 are exclusively doleritic and therefore not palaeontologically significant. The geology of the remaining pits consists of fossil-bearing strata of Permian and Triassic age. A partly exposed bedding plane in Pit no. 8 may hold potential for fossil tracks (Fig 3). Excavation activities have already started at Pit no. 11 with potential consequences for palaeontological impact.

Statement of Significance

The palaeontological footprint of the region suggests high potential for Karoo vertebrate and trace fossils and to a lesser degree, localized Quaternary fossil deposits. This region is also one of the most intensively studied sections of the continental Permian-Triassic boundary. Thirteen burrow pits were identified as potentially sensitive based on the stratigraphic position and lithology of their deposits. A high degree of probability exists for locating *in situ* palaeontological remains in these sediments during implementation of the project. It is also advised that newly uncovered objects of palaeontological significance, found during the course of excavation activities, may require a Phase 2 rescue operation at the cost of the developer.

Table 3. Palaeontological impact assessment of the burrow pits in the vicinity of Middelburg

Road no.	Burrow Pit	Coordinates	Lithology	Palaeontological significance of sediments		Potential Impact
				Permian-Triassic	Quaternary	
DR2629	MID1	S31 28.574 E25 03.520	Grey mudstone, indurated shale, colluvium, calcretised sediments	High	Low	High
	MID2	S31 27.480 E25 03.520	Maroon & grey mudstone, red sand and silt	High	Low	High
	MID3	S31 26.447 E25 04.158		?	?	?
	MID4	S31 24.170 E25 09.116	Maroon mudstone with sand inclusions & calcretions, red sand	High	Low	High
	MID5	S31 23.553 E25 10.229	Maroon mudstone with calcrete intercalations, red sand & silt	High	Low	High
	MID6	S31 22.903 E25 11.461	Maroon mudstone, red sand & silt	High	Low	High
	MID7	S31 21.966 E25 12.755	Grey-green & purple mudstone, colluvial gravels	High	Low	High
	MID8	S31 20.000 E25 13.395	Grey blue mudstone (potential for fossil tracks), red sand & silt	High	Low	High
	MID9	S31 18.055 E25 13.249	Maroon mudstone, dolerite, colluvium, silt, calcretised sediments	High	Low	High
654	MID10	S31 56.780 E25 03.222	Grey-green & purple mudstone, colluvium, red sand & silt	High	Low	High
	MID11	S31 55.742 E25 03.914	Grey-green mudstone, red sand & silt	High	Low	High
	MID12	S31 52.976 E25 05.508	Grey mudstone, colluvium	High	Low	High
	MID13	S31 52.616 E25 07.418	Weathered dolerite, calcretised infilings	Low	Low	Low
	MID14	S31 50.978 E25 08.159	Weathered dolerite, calcretised infilings	Low	Low	Low
DR2631	MID15	S31 27.347 E25 11.375	Maroon mudstone, red sand & silt	High	Low	High
	MID16	S31 26.310 E25 11.375	Maroon & grey mudstone, red sand & silt	High	Low	High
	MID17	S31 27.388 E25 13.551		?	?	?

Recommendations

It is recommended that: 1) Excavation procedures related to the reparation of the gravel roads within the inspected area, must be accompanied by a follow-up palaeontological investigation of the Karoo strata at the cost of the developer; 2) a Karoo vertebrate specialist should check the mudstone-bearing burrow pits before and when earth-moving commences in order to determine whether, as is probable, palaeontological remains or features are exposed *in situ.*

The South African Heritage Resources Agency can be contacted to obtain a list of suitable qualified specialists.

Acknowledgements

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