Phase 1 Palaeontological Impact Assessment of the proposed new Meerkat Hydroelectric facility on the Orange River between Douglas and Hopetown, NC Province.

Report prepared for:
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Summary

Potentially fossiliferous rock units found along the Orange River between Douglas and Hopetown include Early Permian marine sediments of the lowermost Ecca Group and Late Cenozoic fluvial gravels. The field assessment indicate that the proposed development will largely impact on Ventersdorp Supergroup lavas (Allanridge Formation) and various superficial deposits of low to very low palaeontological sensitivity. The only Karoo Supergroup rocks present that will also be impacted are unfossiliferous glacial tillites of the Dwyka Group.

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Introduction

At the request of Enviroworks Environmental Consultants, a Phase 1 Heritage impact assessment was carried out for the proposed new Meerkat hydroelectric power facility located on the Orange River, about 35 km northwest of Hopetown in the Northern Cape Province (**Fig 1**). The study is required in terms of Section 38 of the National Heritage Resources Act 25 of 1999 as a prerequisite for any development which will change the character of a site exceeding 5 000 m2 in extent or involve a linear development exceeding 300 m in length. The task involved identification and mapping of possible paleontological sites or occurrences within the proposed project area, an assessment of their significance, related impact by the proposed development and recommendations for mitigation where relevant.

Terms of Reference

Identify and map possible heritage sites and occurrences using available resources.

Determine and assess the potential impacts of the proposed development on potential heritage resources;

Recommend mitigation measures to minimize potential impacts associated with the proposed development.

Methodology

A pedestrian survey was conducted in the affected area. A Garmin Etrex Vista GPS hand model (set to the WGS 84 map datum) and a digital camera, were used to record relevant data. Relevant archaeological and palaeontological information were assimilated for the report and integrated with data acquired during the on-site inspection. Observations and comments relevant to a particular footprint are discussed in the Field Assessment and Recommendations section.

Field Rating

Site significance classification standards as prescribed by SAHRA (2005) were used for the purpose of this report (**Table 1**).

Locality Data

1 : 50 000 scale topographic map: 2923BD Torquay

1 : 250 000 scale geological map 2922 Prieska

The proposed facility is to be constructed on a section of the Orange River, which is covered by the 1 : 50 000 scale topographic map: 2923BD Torquay **(Fig. 1).** The facility will

comprise a dam wall and associated infrastructure including access roads, construction sites, as well as a 132kV powerline (layouts provided by Enviroworks Environmental Consultants).

Field Assessment

The geology of the study area is shown on the 1: 250 000 geology map 2922 Prieska (**Fig. 2**). The affected areas are underlain by Precambrian, Ventersdorp Supergroup lavas (Allanridge Formation, *Ra*), composed of resistant-weathering, dark green lavas and associated pyroclastic rocks. The lavas are exposed along stream incisions (**Fig. 3**) and high-lying outcrops where the formation is represented by coarse and blocky surface gravels that resulted from *in situ* weathering and downwasting (**Fig. 4).** The Ventersdorp lavas are unconformably overlain by Dwyka Group tillites of the Mbizane Formation, (*C-Pd,* Visser *et al.* 1977-78, 1990; Johnson *et al*. 2006) which represents valley and inlet fill deposits left behind on Ventersdorp basement rocks by retreating glaciers about 300 million years ago. While the lavas are not palaeontologically sensitive, glacial pavements that record the movement of the Dwyka ice sheets across the Ventersdorp basement rocks needs to be preserved as geological sites. Weathered Dwyka sediments contain bluish-grey unbedded tillite with sparse to concentrated boulder-sized and smaller erratics which are occasionally capped by well-developed and crudely bedded calcrete hardpan (**Fig. 5**). Locally laminated lenses of bedded tillites are ascribed to glaciolacustrine and fluvioglacial origin (Visser *et al.* 1977 – 78) **(Fig 6**). The glacial tillites of the Dwyka Group are not considered to be palaeontologically sensitive. Fossil-bearing, laminated basinal mudrocks of the Prince Albert Formation from the lowermost Ecca Group (*Pp*) have been recorded near Douglas, containing petrified wood, invertebrates, fish, coprolites and palynomorphs from calcareous concretions (McLachlan and Anderson 1973, Visser *et al.,* 1977-78)**.** No evidence of Lower Ecca sediments to be impacted by the proposed development was found during the field study. The Precambrian basement lavas and overlying Karoo Supergroup rocks are mantled by polymict surface gravels made up of Plio-Pleistocene or older terrace gravels, calcretized terraces (*T-Qc*), red brown aeolian sands (*Qs*) and alluvium (**Fig. 7**). No fossils have been explicitly reported from Plio-Pleistocene fluvial sediments between Douglas and Hopetown yet, but a variety of fossil fauna have been retrieved from alluvial gravel terraces along the Lower Vaal River basin (Cooke 1949; Maglio and Cooke 1978; Partridge and Maud 2000). Here, gravel terraces between 21m and 30m above present river level, contain frequent sandy lenses and have yielded vertebrate fauna such as the extinct proboscidian, *Mammuthus*

subplanifrons that are estimated to be ranging in age from 4.5 to 3.5 million years old. Other fossil remains include extinct suids and more proboscidian taxa, notably *Notochoerus capensis*, and *Elephas iolensis*. Geologically recent to modern alluvial sediments along the banks of the Orange River are made up well-developed sandy deposits with gravel to boulder size lenses (cf. reworked Dwyka Group and Allanridge Formation) of varying thicknesses (**Fig. 8**). It is noted that while the overall palaeontological sensitivity of the Quaternary aeolian sand cover component is considered to be low, Quaternary overbank deposits along major river courses in the central interior can be highly fossiliferous in places (Broom 1909 a, b; Cooke 1955; Maglio and Cooke 1978; Churchill *et al.* 2000; Rossouw 2006).

Impact Assessment

Assumptions and Uncertainties

Fossil databases for the South African region are mostly inadequate as large parts of the country have never been surveyed by a palaeontologist. Therefore, for the sake of prudence, it is assumed that fossil remains are always uniformly distributed in fossil-bearing strata, although in reality their distribution may vary significantly.

Nature of Impacts

It is expected that infrastructure development will involve installation of a dam wall and associated infrastructure, as well as a 132kV powerline, and that potential palaeontological impacts, if any, will be confined to the development footprint during the construction phase. In terms of possible palaeontological heritage, potentially sensitive rock units identified in the region include Prince Albert Formation mudrocks (Ecca Group) and Late Cenozoic alluvial terrace gravel deposits flanking the Orange River. However, the pedestrian survey shows that the development footprint is primarily underlain by Ventersdorp Supergroup lavas, while the powerline options for traverse non-fossiliferous glacial tillites (Karoo Supergroup) and polymict surface gravels, reworked calcretes and windblown Kalahari sands.

Extent of Impact

Possible extent of impact following the construction of the dam wall and associated infrastructure will be locally restricted to potential damage or destruction as a result of excavations into Ventersdorp Supergroup bedrock. Possible extent of impact following the construction of a powerline will be linear and locally restricted to potential damage or

destruction as a result of excavations into non-fossiliferous glacial tillites (Karoo Supergroup) and variable clasts of surface gravels, reworked calcretes and windblown Kalahari sands.

Duration of Impact

The proposed development is considered long term with the consequence that any damage or destruction to geological strata and palaeontological heritage within the affected area will be permanent.

Cumulative Impact

There are currently a number of renewable energy project applications within a 300 km radius of the proposed development. These projects have received Environmental Authorization or are in the process of receiving Environmental Authorization and have either proceeded into the construction phase, or are expected to be constructed in the near future. If all these projects proceed, then the Meerkat Hydroelectric Power Facility will be built on a landscape where renewable energy facilities are a common feature. There will be no significant cumulative impacts on the palaeontology and archaeology of the area provided that the recommended mitigation is reached.

Field Assessment and Recommendations

Inundation Area

Inundation of the footprint is not considered to be a negative palaeontological impact. The footprint is underlain by palaeontologically insignificant Ventersdorp lavas and geologically recent sandy alluvium. The field assessment of the study area found no evidence of Lower Ecca sediments above the Dwyka Group outcrop area. The Dwyka sediments are dominated by weathered tillites that are considered to be unfossiliferous.

Potential Impact without mitigation: Moderate

Potential Impact with mitigation: Low

Mitigation: The footprint was mapped and recorded during the Phase 1 field assessment.

Site rating of the development footprint pending mitigation measures: Generally Protected C (GP.C).

Construction Sites

Option 1 West (north of river)

The footprint is underlain by palaeontologically insignificant Ventersdorp lavas and capped by downwasted polymict gravels and unfossiliferous Quaternary aeolian sand.

Potential Impact without mitigation: High

Potential Impact with mitigation: Low

Mitigation: The footprint was mapped and recorded during the Phase 1 field assessment.

Site rating of footprint pending mitigation measures: Generally Protected C (GP.C).

Option 1 East (north of river)

The footprint is underlain by palaeontologically insignificant Ventersdorp lavas and capped by downwasted polymict gravels, calcretes and unfossiliferous Quaternary aeolian sand.

Potential Impact without mitigation: High

Potential Impact with mitigation: Low

Mitigation: The footprint was mapped and recorded during the Phase 1 field assessment.

Site rating of footprint pending mitigation measures: Generally Protected C (GP.C).

Option 2 West (south of river)

The footprint is underlain by palaeontologically insignificant Ventersdorp lavas and capped by downwasted polymict gravels and unfossiliferous Quaternary aeolian sand.

Potential Impact without mitigation: High

Potential Impact with mitigation: Low

Mitigation: The footprint was mapped and recorded during the Phase 1 field assessment.

Site rating of footprint pending mitigation measures: Generally Protected C (GP.C).

Option 2 East (south of river)

The footprint is underlain by palaeontologically insignificant Ventersdorp lavas and capped by downwasted polymict gravels and unfossiliferous Quaternary aeolian sand.

Potential Impact without mitigation: High

Potential Impact with mitigation: Low

Mitigation: The footprint was mapped and recorded during the Phase 1 field assessment.

Site rating of footprint pending mitigation measures: Generally Protected C (GP.C).

Dam Walls and associated Substations

Option 1

The footprint is underlain by palaeontologically insignificant Ventersdorp lavas and capped by downwasted polymict gravels and unfossiliferous Quaternary aeolian sand. The field assessment of the dam wall footprint found no evidence of glacial pavements where bedrock was exposed.

Potential Impact without mitigation: High

Potential Impact with mitigation: Low

Mitigation: The footprint was mapped and recorded during the Phase 1 field assessment.

Site rating of footprint pending mitigation measures: Generally Protected C (GP.C).

Option 2

The footprint is underlain by palaeontologically insignificant Ventersdorp lavas capped by downwasted polymict surface gravels and unfossiliferous Quaternary aeolian sand. The field assessment of the dam wall footprint found no evidence of glacial pavements where bedrock was exposed.

Potential Impact without mitigation: High

Potential Impact with mitigation: Low

Mitigation: The footprint was mapped and recorded during the Phase 1 field assessment.

Site rating of footprint pending mitigation measures: Generally Protected C (GP.C).

Option 3

The footprint is underlain by palaeontologically insignificant Ventersdorp lavas and capped by downwasted polymict gravels and unfossiliferous Quaternary aeolian sand. The field assessment of the dam wall footprint found no evidence of glacial pavements where bedrock was exposed.

Potential Impact without mitigation: High

Potential Impact with mitigation: Low

Mitigation: The footprint was mapped and recorded during the Phase 1 field assessment.

Site rating of footprint pending mitigation measures: Generally Protected C (GP.C).

Option 4

The footprint is underlain by palaeontologically insignificant Ventersdorp lavas and capped by downwasted polymict gravels and unfossiliferous Quaternary aeolian sand. The field assessment of the dam wall footprint found no evidence of glacial pavements where bedrock was exposed.

Potential Impact without mitigation: High

Potential Impact with mitigation: Low

Mitigation: The footprint was mapped and recorded during the Phase 1 field assessment.

Site rating of footprint pending mitigation measures: Generally Protected C (GP.C).

Eskom 132 kV High Voltage Line

The footprint is underlain by polymict surface gravels, Quaternary calcretes and aeolian sandy soils which are not considered to be paleontologically sensitive.

Potential Impact without mitigation: High

Potential Impact with mitigation: Low

Mitigation: The footprint was mapped and recorded during the Phase 1 field assessment.

Site rating of footprint pending mitigation measures: Generally Protected C (GP.C).

North Road

The footprint is underlain by palaeontologically insignificant Ventersdorp lavas capped by polymict surface gravels as well as Quaternary calcretes and aeolian sandy soils which are not considered to be paleontologically sensitive.

Potential Impact without mitigation: High

Potential Impact with mitigation: Low

Mitigation: The footprint was mapped and recorded during the Phase 1 field assessment.

Site rating of footprint pending mitigation measures: Generally Protected C (GP.C).

South Road

The footprint is underlain by palaeontologically insignificant Ventersdorp lavas, Dwyka sediments and alluvial gravels near the river as well as Quaternary calcretes and aeolian sandy soils that are mantled by polymict surface gravels along flat areas.

Potential Impact without mitigation: High

Potential Impact with mitigation: Low

Mitigation: The footprint was mapped and recorded during the Phase 1 field assessment.

Site rating of footprint pending mitigation measures: Generally Protected C (GP.C).

Transmission line North

The footprint is underlain by palaeontologically insignificant Ventersdorp lavas, Dwyka sediments and alluvium near the river as well as Quaternary calcretes, aeolian sandy soils that are mantled by polymict surface gravels along flat areas.

Potential Impact without mitigation: High

Potential Impact with mitigation: Low

Mitigation: The footprint was mapped and recorded during the Phase 1 field assessment.

Site rating of footprint pending mitigation measures: Generally Protected C (GP.C).

Transmission line South (incl. Options 1b &1c)

The footprint is underlain by palaeontologically insignificant Ventersdorp lavas, Dwyka sediments and alluvium near the river as well as Quaternary calcretes, aeolian sandy soils that are mantled by polymict surface gravels along flat areas.

Potential Impact without mitigation: High

Potential Impact with mitigation: Low

Mitigation: The footprint was mapped and recorded during the Phase 1 field assessment.

Site rating of footprint pending mitigation measures: Generally Protected C (GP.C).

Access to sand borrow pit 1

The footprint is underlain by palaeontologically insignificant Ventersdorp lavas, Dwyka sediments and alluvial gravels near the river as well as Quaternary calcretes and aeolian sandy soils that are mantled by polymict surface gravels along flat areas.

Potential Impact without mitigation: High

Potential Impact with mitigation: Low

Mitigation: The footprint was mapped and recorded during the Phase 1 field assessment.

Site rating of footprint pending mitigation measures: Generally Protected C (GP.C).

Access to sand borrow pit 2

The footprint is underlain by palaeontologically insignificant Ventersdorp lavas, Dwyka sediments and alluvial gravels near the river as well as Quaternary calcretes and aeolian sandy soils that are mantled by polymict surface gravels along flat areas.

Potential Impact without mitigation: High

Potential Impact with mitigation: Low

Mitigation: The footprint was mapped and recorded during the Phase 1 field assessment.

Site rating of footprint pending mitigation measures: Generally Protected C (GP.C).

Borrow Pit 1

The footprint is underlain by palaeontologically insignificant Ventersdorp lavas that are capped by geologically recent alluvium. The field assessment of the footprint found no evidence of glacial pavements where bedrock was exposed.

Potential Impact without mitigation: High

Potential Impact with mitigation: Low

Mitigation: The footprint was mapped and recorded during the Phase 1 field assessment.

Site rating of footprint pending mitigation measures: Generally Protected C (GP.C).

Borrow Pit 2

The footprint is underlain by palaeontologically insignificant Ventersdorp lavas that are capped by geologically recent alluvium. The field assessment of the footprint found no evidence of glacial pavements where bedrock was exposed.

Potential Impact without mitigation: High

Potential Impact with mitigation: Low

Mitigation: The footprint was mapped and recorded during the Phase 1 field assessment.

Site rating of footprint pending mitigation measures: Generally Protected C (GP.C).

Quarries South & associated access roads

The footprint is underlain by palaeontologically insignificant Ventersdorp lavas that are capped by river gravel deposits, aeolian sands and geologically recent alluvium. The field assessment of the footprint found no evidence of glacial pavements where bedrock was exposed.

Potential Impact without mitigation: High

Potential Impact with mitigation: Low

Mitigation: The footprint was mapped and recorded during the Phase 1 field assessment.

Site rating of footprint pending mitigation measures: Generally Protected C (GP.C).

Quarries North & associated access roads

The footprint is underlain by palaeontologically insignificant Ventersdorp lavas that are capped by river gravel deposits, aeolian sands and geologically recent alluvium. The field assessment of the footprint found no evidence of glacial pavements where bedrock was exposed.

Potential Impact without mitigation: High

Potential Impact with mitigation: Low

Mitigation: The footprint was mapped and recorded during the Phase 1 field assessment.

Site rating of footprint pending mitigation measures: Generally Protected C (GP.C).

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Tables and Figures

Table 1. Field rating categories for heritage sites as prescribed by SAHRA.

Field Rating	**Grade**	**Significance**	**Mitigation**
National Significance (NS)	Grade 1	-	Conservation; national site nomination
Provincial Significance (PS)	Grade 2	-	Conservation; provincial site nomination
Local Significance (LS)	Grade 3A	High significance	Conservation; mitigation not advised
Local Significance (LS)	Grade 3B	High significance	Mitigation (part of site should be retained)
Generally Protected A (GP.A)	-	High/medium significance	Mitigation before destruction
Generally Protected B (GP.B)	-	Medium significance	Recording before destruction
Generally Protected C (GP.C)	-	Low significance	Destruction

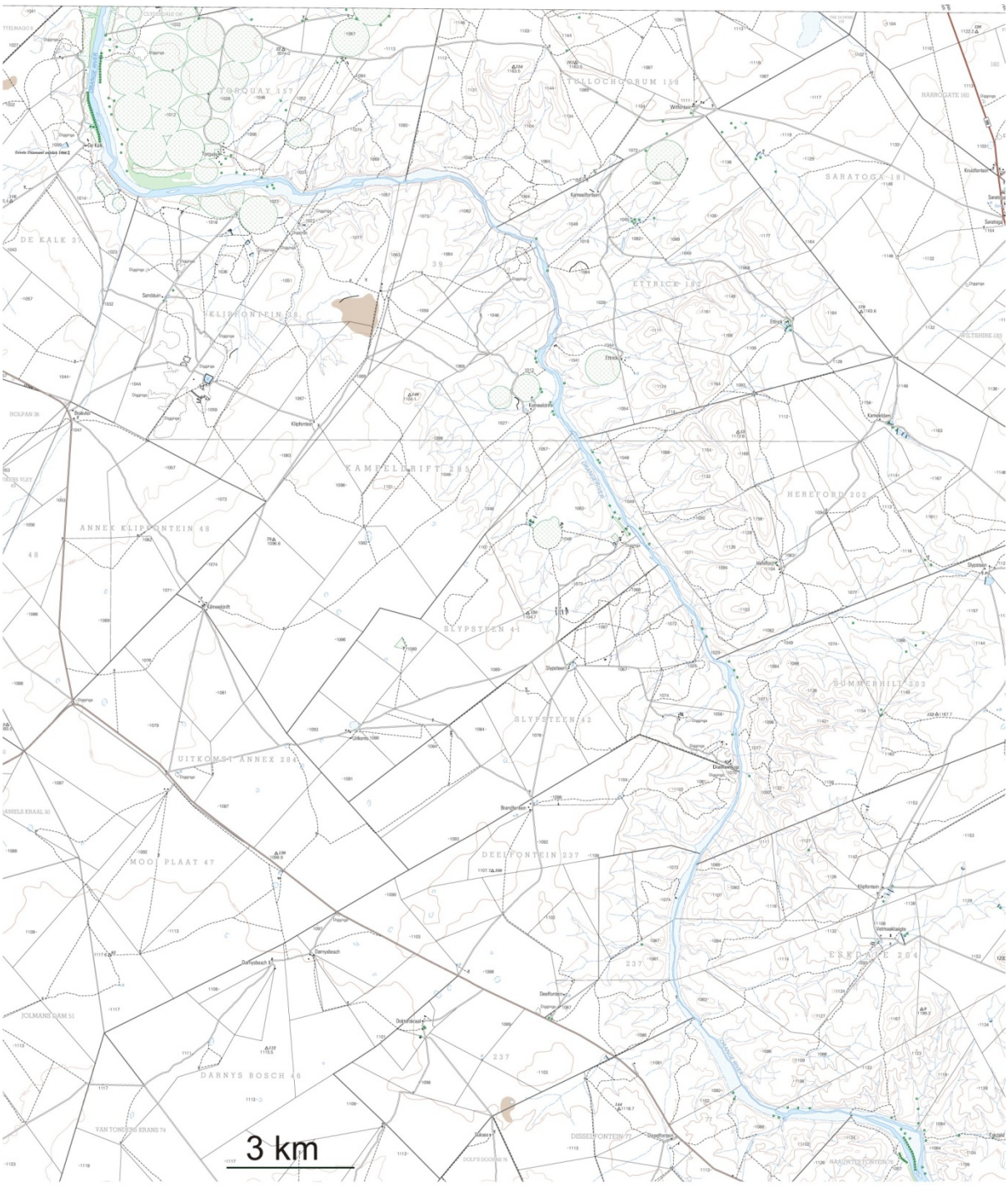

Figure 1. The proposed facility is to be constructed on a section of the Orange River, which is covered by the 1 : 50 000 scale topographic map: 2923BD Torquay.

Figure 2. Portion of 1: 250 000 geological map 2922 Prieska (Council for Geoscience, Pretoria) showing approximate location of the proposed hydroelectric facility 26 km south of Douglas. The study areas are underlain at depth by Precambrian lavas of the Allanridge Formation (Ventersdorp Group, *Ra)* as well as Dwyka tillites (Mbizane Formation, *C-Pd*) and basal Ecca mudrocks (Prince Albert Formation, *Pp*) of the Karoo Supergroup. The basement lavas and Karoo sediments are largely overlain by Late Cenozoic superficial deposits made up of cf. Plio-Pleistocene or older terrace gravels, aeolian sands (*T-Qc, Qs*) and geologically recent alluvium.

Figure 3. Blocky jointed lavas of the Allanridge Formation (Ventersdorp Supergroup) exposed by stream incision.

Figure 4. Angular and blocky (top left and right) and polymict surface gravels (bottom) overlying Allanridge Formation outcrop south and north of the proposed dam wall footprints.

Figure 5. Weathered Dwyka sediments contain bluish-grey unbedded tillite with concentrated erratics (top) and capped by thick calcrete hardpan (bottom).

Figure. 6. Locally thin lenses of poorly bedded tillites exposed by stream incision within the inundation footprint.

Figure 7. Alluvial gravels (left), calcrete terraces (middle left) and red brown aeolian sands (middle right) with calcrete exposures and reworked calcrete nodules (right).

Geologically recent alluvium with gravel to boulder size lenses made up of reworked Dwyka Group and Allanridge Formation material.