

Opening of Leeuwenfontein Quarry

Beaufort West Local Municipality, Central Karoo District Municipality, Western Cape Province

Farm: Portion 2 Leeuwenfontein 6

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Palaeontological Impact Assessment: Phase 1: Field Study

Facilitated by: Chameleon Environmental Consultants

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0054

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2021/06/10

Ref: Pending

Regisaurus (ESI) (H. Fourie)



B. Executive summary

Outline of the development project: Chameleon Environmental Consultants has facilitated the appointment of Dr H. Fourie, a palaeontologist, to undertake a Palaeontological Impact Assessment (PIA), Field Study of the suitability of the Opening of Leeuwenfontein Quarry in the Beaufort West Local Municipality, Central Karoo District Municipality, Western Cape Province on Farm Portion 2 Leeuwenfontein 6.

The applicant, Barry Theron t/a BBT Contractor's Consultant proposes to open a quarry with crushing facilities.

The Project includes one locality Option (see Figure 2):

Option 1: An area outlined in red approximately 32 km north-west of the town of Murraysburg, the N1 National Road is to the north and west, and the R63 Road is due south. The approximate size of the site is 4.43 hectares.

Legal Requirements:

The **National Heritage Resources Act (Act No. 25 of 1999) (NHRA)** requires that all heritage resources, that is, all places or objects of aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance are protected. The Republic of South Africa (RSA) has a remarkably rich fossil record that stretches back in time for some 3.5 billion years and must be protected for its scientific value. Fossil heritage of national and international significance is found within all provinces of the RSA. South Africa's unique and non-renewable palaeontological heritage is protected in terms of the National Heritage Resources Act. According to this act, palaeontological resources may not be excavated, damaged, destroyed or otherwise impacted by any development without prior assessment and without a permit from the relevant heritage resources authority.

The main aim of the assessment process is to document resources in the development area and identify both the negative and positive impacts that the development brings to the receiving environment. The PIA therefore identifies palaeontological resources in the area to be developed and makes recommendations for protection or mitigation of these resources.

"palaeontological" means any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or traces.

For this study, resources such as geological maps, scientific literature, institutional fossil collections, satellite images, aerial maps and topographical maps were used. It provides an assessment of the observed or inferred palaeontological heritage within the study area, with recommendations (if any) for further specialist palaeontological input where this is considered necessary.

A Palaeontological Impact Assessment is generally warranted where rock units of **LOW** to **VERY HIGH** palaeontological sensitivity are concerned, levels of bedrock exposure within the study area are adequate; large scale projects with high potential heritage impact are planned; and where the distribution and nature of fossil remains in the proposed area is unknown. The specialist will inform whether further monitoring and mitigation are necessary.

Types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (Act No.25 of 1999):

(i) (i) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens.

This report adheres to the guidelines of Section 38 (1) of the National Heritage Resources Act (Act No. 25 of 1999).

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, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m 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 (see Section 38); (d) the re-zoning of a site exceeding 10 000 m² (1 ha) in extent; (e) or any other category of development provided for in regulations by SAHRA or a PHRA authority.

This report (1c) aims to provide comment and recommendations on the potential impacts that the proposed development could have on the fossil heritage of the area and to state if any mitigation or conservation measures are necessary.

Outline of the geology and the palaeontology:

The geology was obtained from map 1:100 000, Geology of the Republic of South Africa (Visser 1984), 3122 Victoria West (le Roux and de Beer 1987) 1:250 000 geological map.

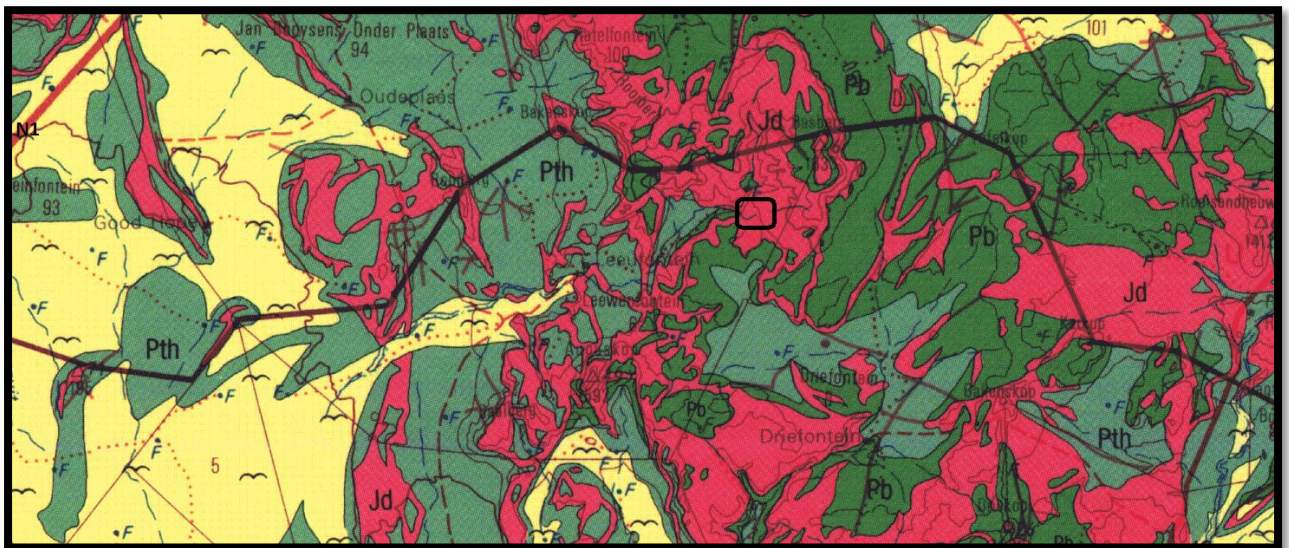


Figure: The geology of the development area.

Legend to Figure and short explanation.

ΛΛ – Alluvium, colluvium (m). Quaternary.

Jd – Karoo Dolerite suite (pink). Jurassic.

Pb – Green and red mudstone, sandstone; sandstone-rich Oudeberg Member at base (green). Balfour Formation, Adelaide Subgroup, Karoo Supergroup. Permian.

..... – (black) Lineament (Possible dyke).

--f-- Fault.

⊥5° - Strike and dip.

□ - Proposed development (in black on Figure).

Dolerite dykes (Jd) occur throughout the Karoo Supergroup. Structural geological features such as dykes and faults can have a measurable influence on ground water flow and mass transport. Permian sediments are extensively intruded and thermally metamorphosed (baked) by sub-horizontal sills and steeply inclined dykes of the Karoo Dolerite Suite. These early Jurassic (183 Ma) basic intrusions baked the adjacent mudrocks and sandstones to form splintery hornfels and quartzites respectively. Thermal metamorphism by dolerite intrusions tends to reduce the palaeontological heritage potential of the adjacent sediments.

Palaeontology – Fossils in South Africa mainly occur in rocks of sedimentary nature and not in rocks from igneous or metamorphic nature. Therefore, if there is the presence of Karoo Supergroup strata the palaeontological sensitivity can generally be **LOW** to **VERY HIGH**, and here locally **VERY HIGH** for the Adelaide Subgroup and **VERY LOW** for the dolerite (SG 2.2 SAHRA APMHOB, 2012).

The rocks of the Karoo Supergroup are internationally acclaimed for their richness and diversity of fossils. The rocks of the Beaufort Group of South Africa cover approximately one-third of the land surface and have yielded an abundance of well-preserved therapsids and other tetrapods which have been used to subdivide this Group into seven faunal Assemblage Zones.

The Adelaide Subgroup in the study area comprises the *Cistecephalus* Assemblage Zone (Smith *et al.* 2020) with the overlying *Daptocephalus* Assemblage Zone. This zone is named after the dicynodont *Cistecephalus*. Stratigraphically above this is the uppermost strata of the Middleton Formation and lowermost strata of the overlying Teekloof Formation. *Pristerognathus* is most common here. The lower part of the Balfour Formation is also present. It is characterised by the fossils *Pareiasaurus*, *Ictidosuchus*, *Lemurosaurus*, *Arctognathus*, *Aulacephalodon*, *Cistecephalus*, as well as amphibia (*Rhinesuchus*) fish (*Atherstonia*), plants (*Glossopteris*), mollusca (*Palaeomutela*) and reptiles (*Anthodon*). It reaches a maximum thickness of 300 m (Rubidge 1995).

Summary of findings (1d): The Phase 1: Field Study was undertaken in April 2021 in autumn in dry and hot conditions during the official Level 1 Covid-19 lockdown, and the following is reported:

The Project includes one locality Option (see Figure) with a **VERY HIGH** and **VERY LOW** sensitivity:

Option 1: An area outlined in red approximately 32 km north-west of the town of Murraysburg, the N1 National Road is to the north and west, and the R63 Road is due south. The approximate size of the site is 4.43 hectares.

Other locality options will not be feasible as all of the options will be situated on the underlying Beaufort Group sediments, but only the dolerite will be mined. The related infrastructure may be situated on the Beaufort sediments.

Field Observation - Fieldwork was done in April. The area is covered short grass and low bushes and is very rocky. Visibility is good. Outcrops are present and consist of dolerite and mudrock. No fossils were found.

Recommendation:

The potential impact of the development on fossil heritage is **VERY HIGH** and therefore a Phase 1: Field Survey was necessary for this development (according to SAHRA protocol), if a chance fossil is found during mining a Phase 2 Palaeontological Impact Assessment and Mitigation or conservation will be necessary.

Concerns/threats (1g) to be added to EMP:

1. Threats to the National Heritage are earth moving equipment/machinery (for example haul trucks, front end loaders, excavators, graders, dozers) during construction, the sealing-in, disturbance, damage or destruction of the fossils by development, vehicle traffic, clearing, prospecting, mining, and human disturbance.
2. Special care must be taken during the clearing, digging, drilling, blasting and excavating of foundations, trenches, channels and footings and removal of overburden not to intrude fossiliferous layers.

The recommendations are (1ni,1niA,1nii):

1. Mitigation may be needed if fossils are found during mining. Overburden and interburden must be surveyed for fossils.
2. No consultation with parties was necessary. The Environmental Control Officer must familiarise him- or herself with the formation present and its fossils.
3. The development may go ahead. The ECO must survey for fossils before and or after clearing, blasting or excavating (related infrastructure) and keep a photographic record.
4. The EMPr already covers the conservation of heritage and palaeontological material that may be exposed during construction activities. For a chance find, the protocol is to immediately cease all construction activities, construct a 30 m no-go barrier, and contact SAHRA for further investigation. It is recommended that the EMPr be updated to include the involvement of a palaeontologist for pre-construction training of the ECO.

Stakeholders: Developer – Barry Theron t/a BBT Contractor’s Consultant. 21 Melsetter Estate, Bernard Road, Lovemore Heights, Port Elizabeth, 6070.

Environmental – Chameleon Environmental Consultants, P.O. Box 11788, Silver Lakes, 0054. Tel: 082 571 6920.

Landowner – Jacques Theron.

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D. Background information on the project

Report

This report is part of the environmental impact assessment process under the National Environmental Management Act, as amended (Act No. 107 of 1998) (NEMA) and includes Appendix 6 (May 2019) of the Environmental Impact Assessment Regulations (see Appendix 2). It also is in compliance with The Minimum Standards for Palaeontological Components of Heritage Impact Assessment Reports, SAHRA, APMHOB, Guidelines 2012, Pp 1-15 (2).

Outline of development (1f)

This report discusses and aims to provide the developer with information regarding the location of palaeontological material that will be impacted by the development. In the pre-construction phase it is necessary for the developer to apply for the relevant permit from the South African Heritage Resources Agency (SAHRA / PHRA).

The applicant, Barry Theron t/a BBT Contractor's Consultant proposes to open a quarry with crushing facilities. The gravel will be used at the windfarm facility.

Related Infrastructure:

1. Temporary buildings such as offices,
2. Fencing,
3. Weighbridge,
4. Crusher,
5. Access road.

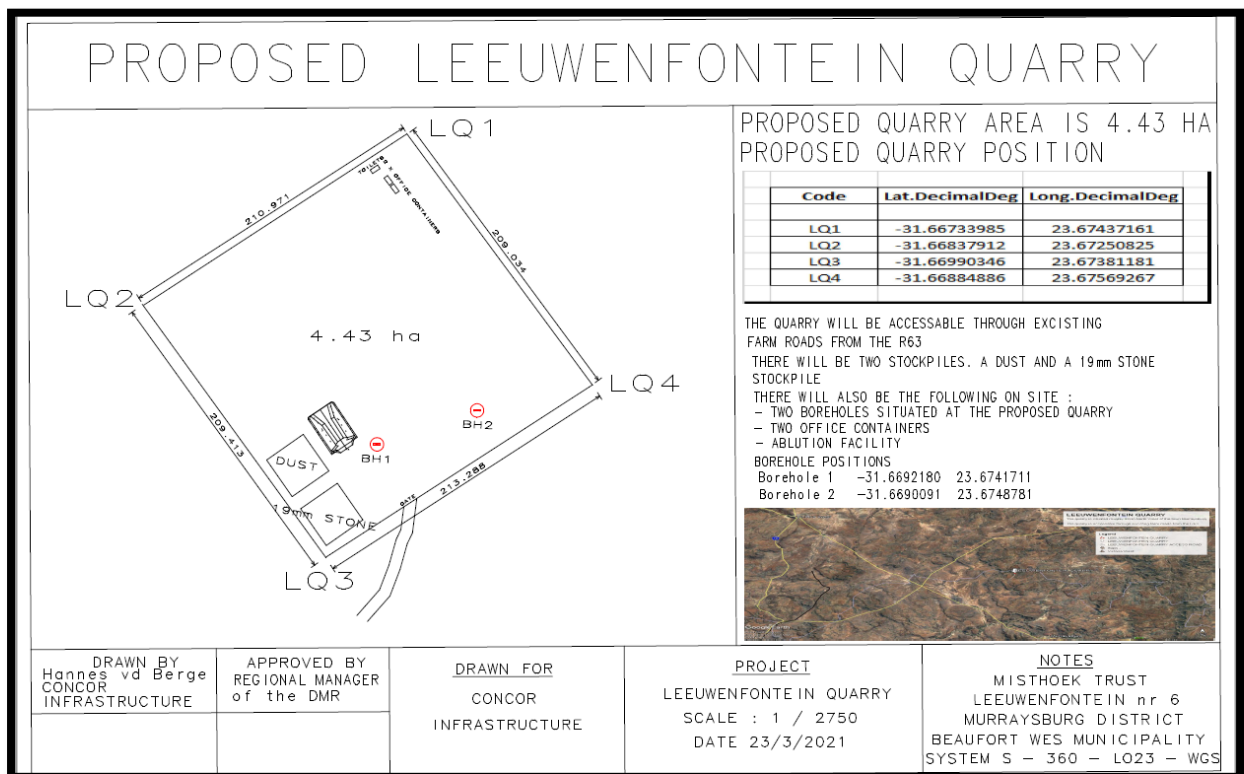


Figure 1: Figure showing quarry lay-out (Chameleon).

The Project includes one locality Option (see Figure 2):

Option 1: An area outlined in red approximately 32 km north-west of the town of Murraysburg, the N1 National Road is to the north and west, and the R63 Road is due south. The approximate size of the site is 4.43 hectares.

Rezoning/ and or subdivision of land: Agriculture to Industrial.

Name of Developer and Consultant: Barry Theron t/a BBT Contractor's Consultant and Chameleon Environmental Consultants.

Terms of reference: Dr H. Fourie is a palaeontologist commissioned to do a palaeontological impact assessment: field study to ascertain if any palaeontological sensitive material is present in the development area. This study will advise on the impact on fossil heritage mitigation or conservation necessary, if any.

Short Curriculum vitae:(1ai, 1aii) Dr Fourie obtained a Ph.D from the Bernard Price Institute for Palaeontological Research (now ESI), University of the Witwatersrand. Her undergraduate degree is in Geology and Zoology. She specialises in vertebrate morphology and function concentrating on the Therapsid Therocephalia. At present she

is curator of a large fossil invertebrate, Therapsid, dinosaur, amphibia, fish, reptile, and plant collections at Ditsong: National Museum of Natural History. For the past 14 years she carried out field work in the North West, Western Cape, Northern Cape, Eastern Cape, Limpopo, Mpumalanga, Gauteng and Free State Provinces and has done more than 200 PIA's since 2012. Dr Fourie has been employed at the Ditsong: National Museum of Natural History in Pretoria (formerly Transvaal Museum) for 26 years.

Legislative requirements: South African Heritage Resources Agency (SAHRA) for issue of permits if necessary. National Heritage Resources Act (Act No. 25 of 1999). An electronic copy of this report must be supplied to SAHRA (2).

E. Description of property or affected environment

Location and depth:

The Opening of Leeuwenfontein Quarry will be situated in the Beaufort West Local Municipality, Central Karoo District Municipality, Western Cape Province on Farm Portion 2 Leeuwenfontein 6.

Depth is determined by the infrastructure to be developed and the thickness of the formation in the development area. Details of the location and distribution of all significant fossil sites or key fossiliferous rock units are often difficult to determine due to thick topsoil, subsoil, overburden and alluvium. Depth of the overburden may vary a lot. Geological maps do not provide depth or superficial cover, it only provides mappable surface outcrops.

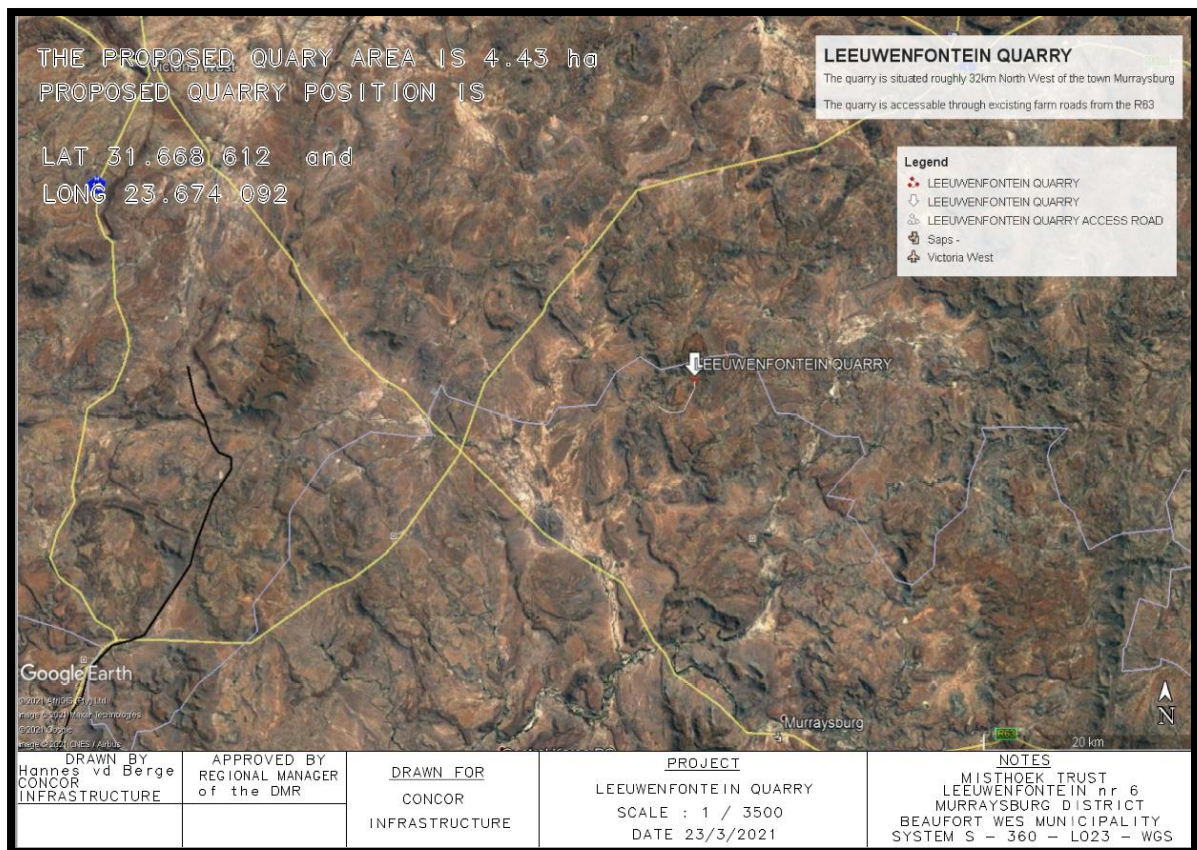


Figure 2: Google Earth image showing location (Chameleon).

The bulk of the site is underlain by the Karoo Supergroup Formations covered by vegetation and rocks.

F. Description of the Geological Setting

Description of the rock units:

Large areas of the southern African continent are covered by the Karoo Supergroup (Figure 3). It covers older geological formations with an almost horizontal blanket. Several basins are present with the main basin in the central part of south Africa and several smaller basins towards Lebombo, Springbok Flats and Soutpansberg. An estimated age is 150 – 180 Ma. And a maximum thickness of 7000 m is reached in the south. Three formations overlie the Beaufort Group, they are the Molteno, Elliot and Clarens Formations. The Elliot Formation is also known as the Red Beds and the old Cave Sandstone is known as the Clarens Formation. At the top is the Drakensberg Basalt Formation with its pillow lavas, pyroclasts, etc. (Kent 1980, Snyman 1996).

Dolerite dykes (Jd) occur throughout the Karoo Supergroup. Structural geological features such as dykes and faults can have a measurable influence on ground water flow and mass transport. Permian sediments are extensively intruded and thermally metamorphosed (baked) by sub-horizontal sills and steeply inclined dykes of the Karoo Dolerite Suite. These early Jurassic (183 Ma) basic intrusions baked the adjacent mudrocks and sandstones to form splintery hornfels and quartzites respectively. Thermal metamorphism by dolerite intrusions tends to reduce the palaeontological heritage potential of the adjacent sediments.

The rocks of the Beaufort Group were deposited by large, northward-flowing, meandering rivers in which sand accumulated, flanked by extensive floodplains where periodic floods deposited mud. Following the end-Permian mass extinction, the meandering rivers were replaced by multi-channelled, braided river systems that deposited sand rather than the silts and muds of the earlier meandering rivers. The sandstone-dominated strata deposited by these braided rivers, known as the Katberg Formation, can be as much as 1000 m. thick. As time passed, the high-energy, braided rivers of the Katberg Formation reverted to a meandering form, possibly reflecting recovery of the vegetation. These sedimentary deposits are the Burgersdorp Formation (McCarthy and Rubidge 2005).

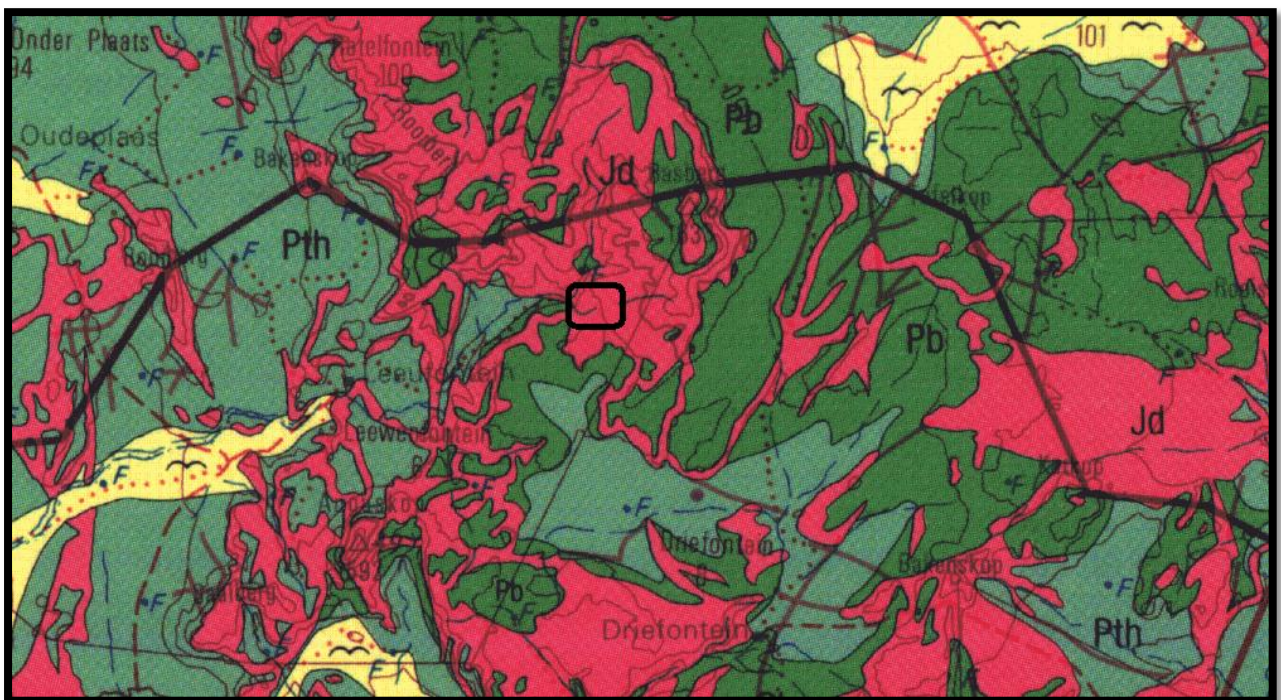


Figure 3: Geology of the development area (also see Figure 5) (1h).

Legend to Figure and short explanation.

ΛΛ – Alluvium, colluvium (m). Quaternary.

Jd – Karoo Dolerite suite (pink). Jurassic.

Pb – Green and red mudstone, sandstone; sandstone-rich Oudeberg Member at base (dark green). Balfour Formation, Adelaide Subgroup, Beaufort Group, Karoo Supergroup.

Pth – Red and purple mudstone, subordinate sandstone (medium green). Hoedemaker Member, Teekloof Formation, Adelaide Subgroup, Beaufort Group, Karoo Supergroup.

..... – (black) Lineament (Possible dyke).

--f— Fault.

⊥5° - Strike and dip.

* - Cistecephalus Assemblage Zone

□ - Proposed development (in black on Figure).

Mining Activities on Figure above:

None.

Several dolerite dykes are present near the development area.

The mining past and present has no influence on the project.

The Adelaide Subgroup consists of up to five formations (Koonap, Middleton, Balfour in the south-east; Abrahamskraal, Teekloof in the west). Mudrock predominates with subordinate sandstone and is Upper Permian in age. It overlies the Ecca Group conformably and is overlain by the Katberg Formation of the Tarkastad Subgroup. Siltstone beds are common (Cole *et al.* 2004). The Koonap Formation reaches a thickness of 1 300 m. (Kent 1980). The Balfour Formation is distinguished from the Middleton Formation by the lack of 'red' mudstone and is ± 2 150 m. thick, whereas the Middleton Formation is ± 1 600 m. thick (sheet info, Kent 1980). Five Members make up the Balfour Formation, Palingkloof at the top, followed by Elandsberg, Ripplemead, Daggaboersnek, and Oudeberg at the bottom (Smith *et al.* 2020). The Abrahamskraal and Teekloof Formations form part of the Adelaide Subgroup in the west (Snyman 1996) with the Member Poortjie at the top of the Teekloof Formation. The Steenkampsvlakte Member is at the top, underlain by the Oukloof Member, followed by the Hoedemaker Member. Chert is present in the Abrahamskraal Formation. The Adelaide Subgroup has a maximum thickness of 1750 m. in the south (Visser 1989).

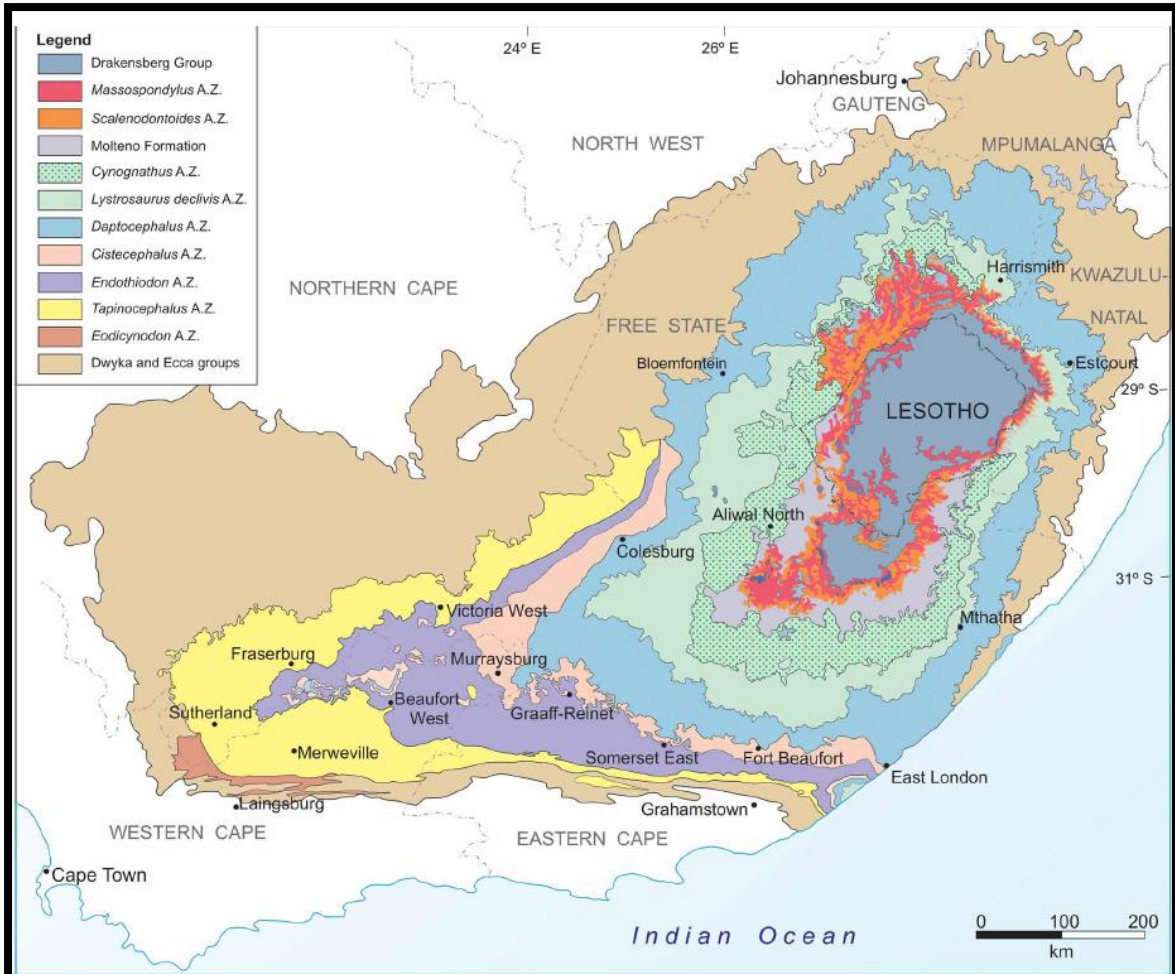


Figure 1. Distribution of vertebrate biozones in the Main Karoo Basin of South Africa. AZ=Assemblage Zone.

Figure 4: Geographic distribution of the vertebrate biozones of the Beaufort Group (Smith et al. 2020).

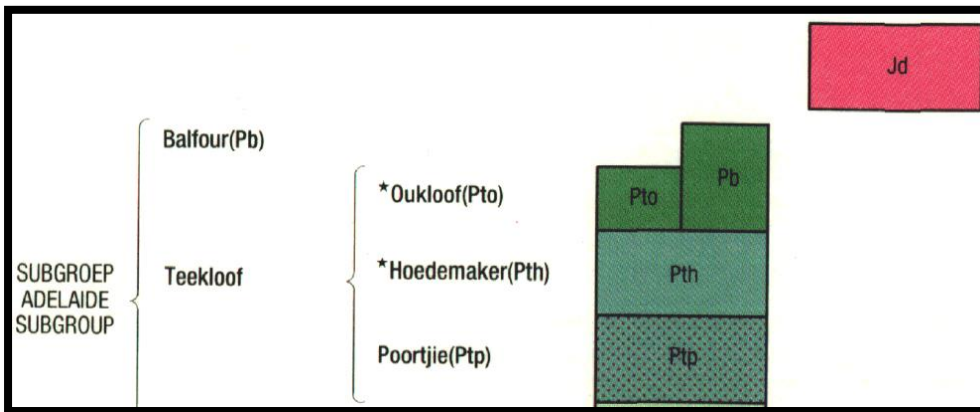


Figure 5: Lithostratigraphic column of the Karoo Supergroup present in the project area (3122 Victoria West)

The *Cistecephalus* AZ is correlated with the lowermost sandstone of the Balfour Formation i.e. the Oudeberg Member and with the mudstone dominated Middleton Formation (Kommetjiesfontein Member).

Field Observation – Fieldwork was done in April. The area is covered short grass and low bushes and is very rocky. Visibility is good. Outcrops are present and consist of dolerite and mudrock. No fossils were found.



Figure 6: View of area.



Figure 7: View of area towards north.



Figure 8: View of area towards mast.



Figure 9: Rock samples from holes that were drilled.

G. Background to Palaeontology of the area

Summary: When rock units of moderate to very high palaeontological sensitivity are present within the development footprint, a desk top and or field scoping (survey) study by a professional palaeontologist is usually warranted. The main purpose of a field scoping (survey) study would be to identify any areas within the development footprint where specialist palaeontological mitigation during the construction phase may be required (SG 2.2 SAHRA AMPHOB, 2012).

The rocks of the Karoo Supergroup are internationally acclaimed for their richness and diversity of fossils. The rocks of the Beaufort Group of South Africa cover approximately one-third of the land surface and have yielded an abundance of well-preserved therapsids and other tetrapods which have been used to subdivide this Group into eight faunal Assemblage Zones.

The Adelaide Subgroup in the study area comprises the *Cistecephalus* Assemblage Zone (Smith *et al.* 2020) with the overlying *Daptocephalus* Assemblage Zone. This zone is named after the dicynodont *Cistecephalus*. Stratigraphically above this is the uppermost strata of the Middelton Formation and lowermost strata of the overlying Teekloof Formation. *Pristerognathus* is most common here. The lower part of the Balfour Formation is also present. It is characterised by the fossils *Pareiasaurus*, *Ictidosuchus*, *Lemurosaurus*, *Arctognathus*, *Aulacephalodon*, *Cistecephalus*, as well as amphibia (*Rhinesuchus*) fish (*Atherstonia*), plants (*Glossopteris*), mollusca (*Palaeomutela*) and reptiles (*Anthodon*). It reaches a maximum thickness of 300 m (Rubidge 1995).

Fossils in South Africa mainly occur in rocks of sedimentary nature and not in rocks from *igneous* or metamorphic nature. Therefore, if there is the presence of Karoo Supergroup strata the *palaeontological* sensitivity is generally **LOW** to **VERY HIGH**, but here locally **VERY HIGH** for the Beaufort Group.

Table 1: Taken from Palaeotechnical Report (Groenewald 2012) (1cA).

8. BEAUFORT GROUP	8b. Tarkastad Subgroup: Katberg, Burgersdorp Fms (TRT)	continental (fluvial, lacustrine) siliciclastic sediments, pedocretes (calcretes)	diverse terrestrial and freshwater tetrapods of <i>Tapinocephalus</i> to <i>Cynognathus</i> Biozones (amphibians, true reptiles, synapsids – especially therapsids), palaeoniscoid fish, freshwater bivalves, trace fossils (including tetrapod trackways), sparse vascular plants (<i>Glossopteris</i> Flora, including petrified wood)	Biozonation of Beaufort Group in some areas of E. Cape still requires resolution richest Permotriassic tetrapod fauna from Pangaea / Gondwana key evidence for evolution of mammalian characters among therapsids continental record of Late Permian Mass Extinction Events
	8a. Adelaide Subgroup: Koonap, Middleton, Balfour Fms (Pa)	Late Permian – Early Triassic c. 266 – 250 Ma		

Table 2: Criteria used (Fossil Heritage Layer Browser/SAHRA) (1cB):

Rock Unit	Significance/vulnerability	Recommended Action
Jurassic Dolerite	Very Low	No action required
Adelaide Subgroup	Very High	Desktop Study and Field Assessment

Databases and collections: Ditsong: National Museum of Natural History. Evolutionary Studies Institute, University of the Witwatersrand (ESI).

Impact: **VERY HIGH** for the Adelaide Subgroup, Beaufort Group, Karoo Supergroup. There are significant fossil resources that may be impacted by the development (mudstone, shale) and if destroyed are no longer available for scientific research or other public good (Almond, *et al.* 2009).

The Project includes one locality Option (see Figure 2) with the above sensitivity (1j):

Option 1: An area outlined in red approximately 32 km north-west of the town of Murraysburg, the N1 National Road is to the north and west, and the R63 Road is due south. The approximate size of the site is 4.43 hectares.

H. Description of the Methodology (1e)

The palaeontological impact assessment field study was undertaken in April 2021 during the official Level 1 of the Covid-19 lockdown. A Phase 1: Field Study includes a survey of the affected portion with photographs taken (in 7.1 mega pixels) of the site with a digital camera (Canon PowerShot A470). Additionally, a Global Positioning System (GPS) (Garmin eTrex 10) is used to record fossiliferous finds and outcrops (bedrock) when the area is not covered with topsoil, subsoil, overburden, vegetation, grassland, trees or waste. The survey did identify the Karoo Supergroup. A literature survey is included and the study relied heavily on geological maps.

SAHRA document 7/6/9/2/1 requires track records/logs from archaeologists not palaeontologists as palaeontologists concentrate on outcrops which may be recorded with a GPS. Isolated occurrences of rocks usually do not constitute an outcrop. Fossils can occur in dongas, as nodules, in fresh rock exposures, and in riverbeds. Finding fossils require the experience and technical knowledge of the professional palaeontologist, but that does not mean that an amateur can't find fossils. The geology of the region is used to predict what type of fossil and zone will be found in any particular region. Archaeozoologists concentrate on more recent fossils in the quaternary and tertiary deposits.

Assumptions and Limitations (1i):-

The accuracy and reliability of the report **may be** limited by the following constraints:

1. Most development areas have never been surveyed by a palaeontologist or geophysicist.
2. Variable accuracy of geological maps and associated information.
3. Poor locality information on sheet explanations for geological maps.
4. Lack of published data.
5. Lack of rocky outcrops.
6. Inaccessibility of site.
7. Insufficient data from developer and exact lay-out plan for all structures.

A Phase 2 Palaeontological Impact Assessment: Mitigation will include:

1. Recommendations for the future of the site.
2. Description of work done (including number of people and their responsibilities).
3. A written assessment of the work done, fossils excavated, not removed or collected and observed.
4. Conclusion reached regarding the fossil material.
5. A detailed site plan.
6. Possible declaration as a heritage site or Site Management Plan.

The National Heritage Resources Act No. 25 of 1999 further prescribes:

Act No. 25 of 1999. National Heritage Resources Act, 1999.

National Estate: 3 (2) (f) archaeological and palaeontological sites,

(i)(1) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens,

Heritage assessment criteria and grading: (a) Grade 1: Heritage resources with qualities so exceptional that they are of special national significance;

(b) Grade 2: Heritage resources which, although forming part of the national estate, can be considered to have special qualities which make them significant within the context of a province or a region; and (c) Grade 3: Other heritage resources worthy of conservation.

SAHRA is responsible for the identification and management of Grade 1 heritage resources.

Provincial Heritage Resources Authority (PHRA) identifies and manages Grade 2 heritage resources.

Local authorities identify and manage Grade 3 heritage resources.

No person may damage, deface, excavate, alter, remove from its original position, subdivide or change the planning status of a provincially protected place or object without a permit issued by a heritage resources authority or local authority responsible for the provincial protection.

Archaeology, palaeontology and meteorites: Section 35.

(2) Subject to the provisions of subsection (8) (a), all archaeological objects, palaeontological material and meteorites are the property of the State.

(3) Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.

Mitigation involves planning the protection of significant fossil sites, rock units or other palaeontological resources and/or excavation, recording and sampling of fossil heritage that might be lost during development, together with pertinent geological data. The mitigation may take place before and / or during the construction

phase of development. The specialist will require a Phase 2 mitigation permit from the relevant Heritage Resources Authority before a Phase 2 may be implemented.

The Mitigation is done in order to rescue representative fossil material from the study area to allow and record the nature of each locality and establish its age before it is destroyed and to make samples accessible for future research. It also interprets the evidence recovered to allow for education of the public and promotion of palaeontological heritage.

Should further fossil material be discovered during the course of the development (e. g. during bedrock excavations), this must be safeguarded, where feasible *in situ*, and reported to a palaeontologist or to the Heritage Resources authority. In situations where the area is considered palaeontologically sensitive (e. g. Karoo Supergroup Formations, ancient marine deposits in the interior or along the coast) the palaeontologist might need to monitor all newly excavated bedrock. The developer needs to give the palaeontologist sufficient time to assess and document the finds and, if necessary, to rescue a representative sample.

When a Phase 2 palaeontological impact study is recommended, permission for the development to proceed can be given only once the heritage resources authority has received and approved a Phase 2 report and is satisfied that (a) the palaeontological resources under threat have been adequately recorded and sampled, and (b) adequate development on fossil heritage, including, where necessary, *in situ* conservation of heritage of high significance. Careful planning, including early consultation with a palaeontologist and heritage management authorities, can minimise the impact of palaeontological surveys on development projects by selecting options that cause the least amount of inconvenience and delay.

Three types of permits are available; Mitigation, Destruction and Interpretation. The specialist will apply for the permit at the beginning of the process (SAHRA 2012).

I. Description of significant fossil occurrences

All Karoo Supergroup geological formations are ranked as **LOW** to **VERY HIGH**, and here the impact is potentially **VERY HIGH** for the Beaufort Group.

The Jurassic Dolerite does not contain fossils.

Well preserved fossils of therapsids occur in mudrock horizons, and are usually found as dispersed, isolated specimens associated with an abundance of calcareous nodules. An abundant and varied therapsid fauna as well as amphibian and fish fossils have been recovered (Rubidge 1995).

The Adelaide Subgroup in the study area comprises the *Cistecephalus* Assemblage Zone (Smith *et al.* 2020) with the overlying *Daptocephalus* Assemblage Zone. This zone is named after the dicynodont *Cistecephalus*. Stratigraphically above this is the uppermost strata of the Middleton Formation and lowermost strata of the overlying Teekloof Formation. *Priesterognathus* is most common here. The lower part of the Balfour Formation is also present. It is characterised by the fossils *Pareiasaurus*, *Ictidosuchus*, *Lemurosaurus*, *Arctognathus*, *Aulacephalodon*, *Cistecephalus*, as well as amphibia (*Rhinesuchus*) fish (*Atherstonia*), plants (*Glossopteris*), mollusca (*Palaeomutela*) and reptiles (*Anthodon*). It reaches a maximum thickness of 300 m (Rubidge 1995) (Figure 4).

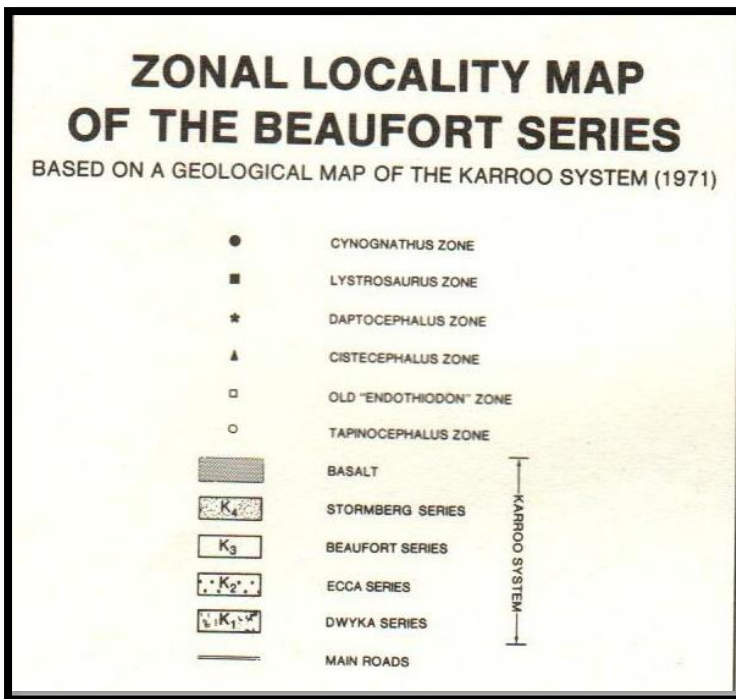
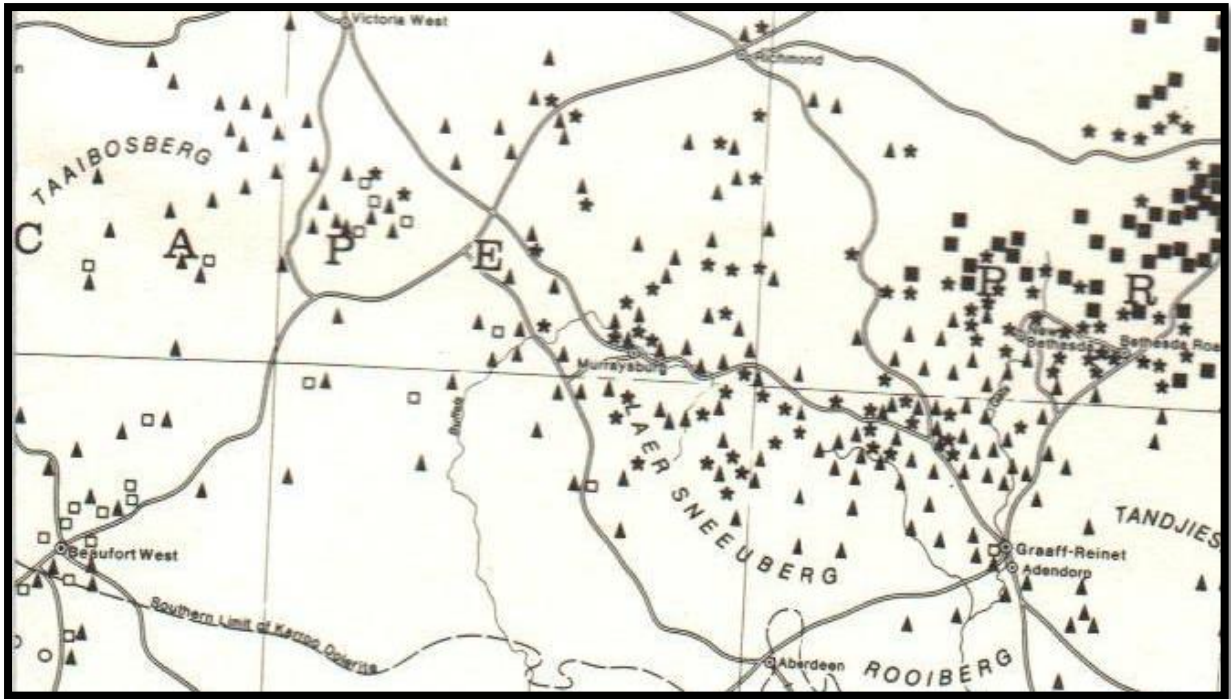


Figure 10: Map to show fossil localities close to Beaufort West (Kitching 1977).

There are 311 fossils recorded from the Beaufort West area and 216 from the Murraysburg area (Figure 10). Details of the location and distribution of all significant fossil sites or key fossiliferous rock units are often difficult to be determined due to thick topsoil, subsoil, overburden and alluvium. Depth of the overburden may vary a lot.

The threats are:-

- Earth moving equipment/machinery (front end loaders, excavators, graders, dozers) during mining,

- The sealing-in or destruction of fossils by development, vehicle traffic, and human disturbance. See Description of the Geological Setting (F) above.

J. Recommendation (1o,1p,1q)

- a. There is no objection (see Recommendation B) to the development, it was necessary to request a Phase 1 Palaeontological Impact Assessment: Field Study to determine whether the development will affect fossiliferous outcrops as the palaeontological sensitivity is **VERY HIGH**. If chance fossils are found during construction a Phase 2 Palaeontological Assessment: Mitigation is recommended. Protocol is attached (Appendix 2).
- b. This project may benefit the economy, the life expectancy of the community, the growth of the community and social development in general.
- c. Preferred choice: Only one locality Option is presented and possible. Dolerite will be mined.
- d. The following should be conserved: if any palaeontological material is exposed during clearing, digging, excavating, drilling or blasting (related infrastructure) SAHRA must be notified. All construction activities must be stopped, a 30 m no-go barrier constructed, and a palaeontologist should be called in to determine proper mitigation measures.
- e. No consultation with parties was necessary.
- f. This report must be submitted to SAHRA together with the Heritage Impact Assessment.

Sampling and collecting (6m,6k):

Wherefore a permit is needed from the South African Heritage Resources Agency (SAHRA / PHRA).

- a. Objections: Cautious. See heritage value and recommendation.
- b. Conditions of development: See Recommendation.
- c. Areas that may need a permit: Yes, if a fossil is found.
- d. Permits for mitigation: Should not be needed from SAHRA/PHRA.

K. Conclusions

- a. All the land involved in the development was assessed and none of the property is unsuitable for development (see Recommendation B).
- b. All information needed for the Palaeontological Impact Assessment was provided by the Consultant. All technical information was provided by Chameleon Environmental Consultants.
- c. Areas that would involve mitigation and may need a permit from the South African Heritage Resources Agency are discussed.
- d. The following should be conserved: if any palaeontological material is exposed during digging, excavating, drilling or blasting, SAHRA must be notified. All development activities must be stopped and a palaeontologist should be called in to determine proper mitigation measures.
- e. Condition in which development may proceed: It is further suggested that a Section 37(2) agreement of the Occupational, Health and Safety Act 85 of 1993 is signed with the relevant contractors to protect the environment (fossils/dongas) and adjacent areas as well as for safety and security reasons.

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Acknowledgement

A word of thanks to the men that took us to the site.

To my field assistant Candice Devenish for her keen eyes and enthusiasm.



Declaration (1b)

I, Heidi Fourie, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed development project for which I was appointed to do a palaeontological assessment. There are no circumstances that compromise the objectivity of me performing such work.

I accept no liability, and the client, by receiving this document, indemnifies me against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by the use of the information contained in this document.

It may be possible that the Palaeontological Impact Assessment may have missed palaeontological resources in the project area as outcrops are not always present or visible while others may lie below the overburden of earth and may only be present once development commences.

This report may not be altered in any way and any parts drawn from this report must make reference to this report.

Heidi Fourie
2021/06/10



Appendix 1: Protocol for Chance Finds and Management Plan (also include Section B) (1k,1l,1m)

This section covers the recommended protocol for a Phase 2 Mitigation process as well as for reports where the Palaeontological Sensitivity is **LOW**; this process guides the palaeontologist / palaeobotanist on site and should not be attempted by the layman / developer. As part of the Environmental Authorisation conditions, an Environmental Control Officer (ECO) will be appointed to oversee the construction activities in line with the legally binding Environmental Management Programme (EMPr). The EMPr already covers the conservation of heritage and palaeontological material that may be exposed during construction activities:

- For a chance find, the protocol is to immediately cease all construction activities, construct a 30 m no-go barrier, and contact SAHRA for further investigation.
- Construction workers must be informed that this is a no-go area. Any fossil find must be placed in a safe area.
- It is recommended that the EMPr be updated to include the involvement of a palaeontologist for pre-construction training of the ECO and possibly during the digging and excavation phase of the development.
- The ECO must visit the site after clearing, excavations, blasting or drilling and keep a photographic record.
- The developer may have to survey the areas affected by the development and indicate on plan where the construction / development may take place. Trenches may have to be dug to ascertain how deep the sediments are above the bedrock (can be a few hundred metres). This will give an indication of the depth of the topsoil, subsoil, and overburden, if need be trenches should be dug deeper to expose the interburden.

Mitigation will involve recording, rescue and judicious sampling of the fossil material present in the layers sandwiched between the geological / coal layers. It must include information on number of taxa, fossil abundance, preservational style, and taphonomy. This can only be done during mining or excavations. In order for this to happen, in case of coal mining operations, the process will have to be closely scrutinised by a professional palaeontologist / palaeobotanist to ensure that only the coal layers are mined and the interlayers (siltstone and mudstone) are surveyed for fossils or representative sampling of fossils are taking place.

The palaeontological impact assessment process presents an opportunity for identification, access and possibly salvage of fossils and add to the few good plant localities. Mitigation can provide valuable onsite research that can benefit both the community and the palaeontological fraternity.

A Phase 2 study is very often the last opportunity we will ever have to record the fossil heritage within the development area. Fossils excavated will be stored at a National Repository.

A Phase 2 Palaeontological Impact Assessment: Mitigation will include (SAHRA) -

1. Recommendations for the future of the site.
2. Description and purpose of work done (including number of people and their responsibilities).
3. A written assessment of the work done, fossils excavated, not removed or collected and observed.
4. Conclusion reached regarding the fossil material.
5. A detailed site plan and map.
6. Possible declaration as a heritage site or Site Management Plan.
7. Stakeholders.
8. Detailed report including the Desktop and Phase 1 study information.
9. Annual interim or progress Phase 2 permit reports as well as the final report.
10. Methodology used.

Mitigation involves planning the protection of significant fossil sites, rock units or other palaeontological resources and/or excavation, recording and sampling of fossil heritage that might be lost during development, together with pertinent geological data. The mitigation may take place before and / or during the construction phase of development. The specialist will require a Phase 2 mitigation permit from the relevant Heritage Resources Authority before a Phase 2 may be implemented.

The Mitigation is done in order to rescue representative fossil material from the study area to allow and record the nature of each locality and establish its age before it is destroyed and to make samples accessible for future research. It also interprets the evidence recovered to allow for education of the public and promotion of palaeontological heritage.

Should further fossil material be discovered during the course of the development (e. g. during bedrock excavations), this must be safeguarded, where feasible *in situ*, and reported to a palaeontologist or to the Heritage Resources authority. In situations where the area is considered palaeontologically sensitive (e. g. Karoo Supergroup Formations, ancient marine deposits in the interior or along the coast) the palaeontologist might need to monitor all newly excavated bedrock. The developer needs to give the palaeontologist sufficient time to assess and document the finds and, if necessary, to rescue a representative sample.

When a Phase 2 palaeontological impact study is recommended, permission for the development to proceed can be given only once the heritage resources authority has received and approved a Phase 2 report and is satisfied that (a) the palaeontological resources under threat have been adequately recorded and sampled, and (b) adequate development on fossil heritage, including, where necessary, *in situ* conservation of heritage of high significance. Careful planning, including early consultation with a palaeontologist and heritage management

authorities, can minimise the impact of palaeontological surveys on development projects by selecting options that cause the least amount of inconvenience and delay.

Three types of permits are available; Mitigation, Destruction and Interpretation. The specialist will apply for the permit at the beginning of the process (SAHRA 2012).

The Palaeontological Society of South Africa (PSSA) does not have guidelines on excavating or collecting, but the following is suggested:

1. The developer needs to clearly stake or peg-out (survey) the areas affected by the mining/ construction/ development operations and dig representative trenches and if possible supply geological borehole data. When the route is better defined, it is recommended that a specialist undertake a 'walk through' of the entire road as well as construction areas, including camps and access roads, prior to the start of any construction activities, this may be done in sections.
2. When clearing vegetation, topsoil, subsoil or overburden, hard rock (outcrop) is found, the contractor needs to stop all work.
3. A Palaeobotanist / palaeontologist (contact SAHRIS for list) must then inspect the affected areas and trenches for fossiliferous outcrops / layers. The contractor / developer may be asked to move structures, and put the development on hold.
4. If the palaeontologist / palaeobotanist is satisfied that no fossils will be destroyed or have removed the fossils, development and removing of the topsoil can continue.
5. After this process the same palaeontologist / palaeobotanist will have to inspect and offer advice through the Phase 2 Mitigation Process. Bedrock excavations for footings may expose, damage or destroy previously buried fossil material and must be inspected.
6. When permission for the development is granted, the next layer can be removed, if this is part of a fossiliferous layer, then with the removal of each layer of sediment, the palaeontologist / palaeobotanist must do an investigation (a minimum of once every week).
7. At this stage the palaeontologist / palaeobotanist in consultation with the developer / mining company must ensure that a further working protocol and schedule is in place. Onsite training should take place, followed by an annual visit by the palaeontologist / palaeobotanist.

Fossil excavation if necessary during Phase 2:

1. Photography of fossil / fossil layer and surrounding strata.
2. Once a fossil has been identified as such, the task of extraction begins.
3. It usually entails the taking of a GPS reading and recording lithostratigraphic, biostratigraphic, date, collector and locality information.
4. Using Paraloid (B-72) as an adhesive and protective glue, parts of the fossil can be kept together (not necessarily applicable to plant fossils).
5. Slowly chipping away of matrix surrounding the fossil using a geological pick, brushes and chisels.
6. Once the full extent of the fossil / fossils is visible, it can be covered with a plaster jacket (not necessarily applicable to plant fossils).
7. Chipping away sides to loosen underside.
8. Splitting of the rock containing palaeobotanical material should reveal any fossils sandwiched between the layers.

The South African Heritage Resources Agency has the following documents in place:

Guidelines to Palaeontological Permitting policy.

Minimum Standards: Palaeontological Component of Heritage Impact Assessment reports.

Guidelines for Field Reports.

Palaeotechnical Reports (Eastern Cape, North West, Northern Cape, Mpumalanga, Gauteng, Western Cape, Free State, KwaZulu Natal, and Limpopo)

Appendix 2:

Table 2: Listing points in Appendix 6 of the Act and position in Report (bold in text).

Section in Report	Point in Act	Requirement
B	1(c)	Scope and purpose of report
B	1(d)	Duration, date and season
B	1(g)	Areas to be avoided
D	1(ai)	Specialist who prepared report
D	1(aii)	Expertise of the specialist
F Figure 3	1(h)	Map
F	1(ni)	Authorisation
F	1(nii)	Avoidance, management, mitigation and closure plan
G Table 1	1(cA)	Quality and age of base data
G Table 2	1(cB)	Existing and cumulative impacts
G	1(f)	Details or activities of assessment
G	1(j)	Description of findings
H	1(e)	Description of methodology
H	1(i)	Assumptions
J	1(o)	Consultation
J	1(p)	Copies of comments during consultation
J	1(q)	Information requested by authority
Declaration	1(b)	Independent declaration
Appendix 2	1(k)	Mitigation included in EMPr
Appendix 2	1(l)	Conditions included in EMPr
Appendix 2	1(m)	Monitoring included in EMPr
D	2	Protocol or minimum standard