PALAEONTOLOGICAL DESKTOP STUDY PROPOSED MINING RIGHT FOR MAXWILL 146 CC ALLUVIAL DIAMOND MINING, NORTHERN CAPE PROVINCE, SIYANCUMA LOCAL MUNICIPALITY UNDER PIXLEY KA SEME DISTRICT MUNICIPALITY

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1. Executive Summary

The study site is situated in an area of Very High, to High, to Moderate, to Low to Insignificant Palaeosensitivity.

Ecca Group shale and sandstone outcrop in two small areas in the study site. This geological unit is known for its fossil fish, reptile, invertebrates, and plants elsewhere and is therefore considered to have a Very High Palaeosensitivity (see Fig. 3).

The Ecca Group of the Karoo Supergroup abuts extensive dolerite intrusions at the study site, however. These igneous intrusions would have caused thermal metamorphosis of the adjacent Karoo rocks which would have had a negative impact on its fossil content.

The Quaternary sediments – the alluvium, aeolian sands, and calcrete - cover most of the older Carboniferous to Permian Karoo Supergroup rocks, the Jurassic-aged dolerite and the Randium-aged Allanridge Formation of the Ventersdorp Supergroup in the study area.

The fossil record of the surface calcrete and the overlying aeolian sands and alluvium is sparse, occurs sporadically and is low in diversity and is classified as having a Moderate Palaeontological Sensitivity (see Fig. 3). The fossils that have been discovered in this formation include root casts, burrows, termitaria, ostrich egg shells, mollusc shells and isolated bones (Almond & Pether 2008).

The ECO should take responsibility for supervising the development and should follow the Chance Find Procedure (p.15) if a significant fossil discovery is made.

2. Introduction

The Heritage Act of South Africa stipulates that fossils and fossil sites may not be altered or destroyed. The purpose of this document is to detail the probability of finding fossils in the study area that may be impacted by the proposed mining and development.

The palaeontological heritage of South Africa is unsurpassed and can only be described in superlatives. The South African palaeontological record gives us insight into inter alia the origin of dinosaurs, mammals, and humans. Fossils are also used to identify rock strata and determine the geological context of the subregion with other continents and played a crucial role in the discovery of Gondwanaland and the formulation of the theory of plate tectonics. Fossils are also used to study evolutionary relationships, sedimentary processes, and palaeoenvironments.

South Africa has the longest record of palaeontological endeavor in Africa. South Africa was even one of the first countries in the world in which museums displayed fossils and palaeontologists studied earth history. South African palaeontological institutions and their vast fossil collections are world-renowned and befittingly the South African Heritage Act is one of the most sophisticated and best considered in the world.

Fossils and palaeontological sites are protected by law in South Africa. Construction in fossiliferous areas may be mitigated in exceptional cases but there is a protocol to be followed.

This is a Desktop Study that was prepared in line with Regulation 28 of the National Environmental Management Act (No. 107 of 1998) Regulations on Environmental Impact Assessment. This involved an overview of the literature on the palaeontology and associated geology of the area.

3. Terms of reference for the report

According to the South African Heritage Resources Act (Act 25 of 1999) (Republic of South Africa, 1999), certain clauses are relevant to palaeontological aspects for a terrain suitability assessment.

- **Subsection 35(4)** 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 with the detection or recovery of metals or archaeological material or objects, or use such equipment for the recovery of meteorites.
- **Subsection 35(5)** When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedures in terms of section 38 has been followed, it may-
- (a) serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;
- (b) carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary;
- (c) if mitigation is deemed by the heritage resources authority to be necessary, assist the person on whom the order has been served under paragraph (a) to apply for a permit as required in subsection (4); and
- (d) recover the costs of such investigation form the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person

proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

South Africa's unique and non-renewable palaeontological heritage is protected in terms of the NHRA. According to this act, heritage 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.

As areas are developed and landscapes are modified, heritage resources, including palaeontological resources, are threatened. As such, both the environmental and heritage legislation require that development activities must be preceded by an assessment of the impact undertaken by qualified professionals. Palaeontological Impact Assessments (PIAs) are specialist reports that form part of the wider heritage component of:

- Heritage Impact Assessments (HIAs) called for in terms of Section 38 of the National Heritage Resources Act, Act No. 25, 1999 by a heritage resources authority.
- Environmental Impact Assessment process as required in terms of other legislation listed in s. 38(8) of NHRA;
- Environmental Management Plans (EMPs) required by the Department of Mineral Resources.

HIAs are intended to ensure that all heritage resources are protected, and where it is not possible to preserve them in situ, appropriate mitigation measures are applied. An HIA is a comprehensive study that comprises a palaeontological, archaeological, built environment, living heritage, etc specialist studies. Palaeontologists must acknowledge this and ensure that they collaborate with other heritage practitioners. Where palaeontologists are engaged for the entire HIA, they must refer heritage components for which they do not have expertise on to appropriate specialists. Where they are engaged specifically for the palaeontology, they must draw the attention of environmental consultants and developers to the need for assessment of other aspects of heritage. In this sense, Palaeontological Impact Assessments that are part of Heritage Impact Assessments are similar to specialist reports that form part of the EIA reports.

The standards and procedures discussed here are therefore meant to guide the conduct of PIAs and specialists undertaking such studies must adhere to them.

The process of assessment for the palaeontological (PIA) specialist components of heritage impact assessments, involves:

The scoping stage in line with regulation 28 of the National Environmental Management Act (No. 107 of 1998) Regulations on Environmental Impact Assessment. This involves an **initial assessment** where the specialist evaluates the scope of the project (based, for example, on NID/BIDs) and advises on the form and extent of the assessment process. At this stage, the palaeontologist may also decide to compile a **Letter of Recommendation for Exemption from further Palaeontological Studies**. This letter will state that there is little or no likelihood that any significant fossil resources will be impacted by the development. This letter should present a reasoned case for exemption, supported by consultation of the relevant geological maps and key literature.

A **Palaeontological Desktop Study** – the palaeontologist will investigate available resources (geological maps, scientific literature, previous impact assessment reports, institutional fossil collections, satellite images or aerial photos, etc) to inform an assessment of fossil heritage and/or exposure of potentially fossiliferous rocks within the study area. Desktop studies will conclude whether a further field assessment is warranted or not. Where further studies are required, the desktop study would normally be an integral part of a field assessment of relevant palaeontological resources.

A **Phase 1 Palaeontological Impact Assessment** is generally warranted where rock units of 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 remain in the proposed project area is unknown. In the recommendations of Phase 1, the specialist will inform whether further monitoring and mitigation are necessary. Phase 1 should identify the rock units and significant fossil heritage resources present, or by inference likely to be present, within the study area, assess the palaeontological significance of these rock units, fossil sites or other fossil heritage, comment on the impact of the development on palaeontological heritage resources and make recommendations for their mitigation or conservation, or for any further specialist studies that are required in order to adequately assess the nature, distribution and conservation value of palaeontological resources within the study area.

A **Phase 2 Palaeontological Mitigation** involves planning the protection of significant fossil sites, rock units or other palaeontological resources and/or the 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 Phase 2 may be implemented.

A **'Phase 3' Palaeontological Site Conservation and Management Plan** may be required in cases where the site is so important that development will not be allowed, or where development is to co-exist with the resource. Developers may be required to enhance the value of the sites retained on their properties with appropriate interpretive material or displays as a way of promoting access of such resources to the public.

The assessment reports will be assessed by the relevant heritage resources authority, and depending on which piece of legislation triggered the study, a response will be given in the form of a Review Comment or Record of Decision (ROD). In the case of PIAs that are part of EIAs or EMPs, the heritage resources authority will issue a comment or a record of decision that may be forwarded to the consultant or developer, relevant government department or heritage practitioner and where feasible to all three.

4. Details of study area and type of assessment:

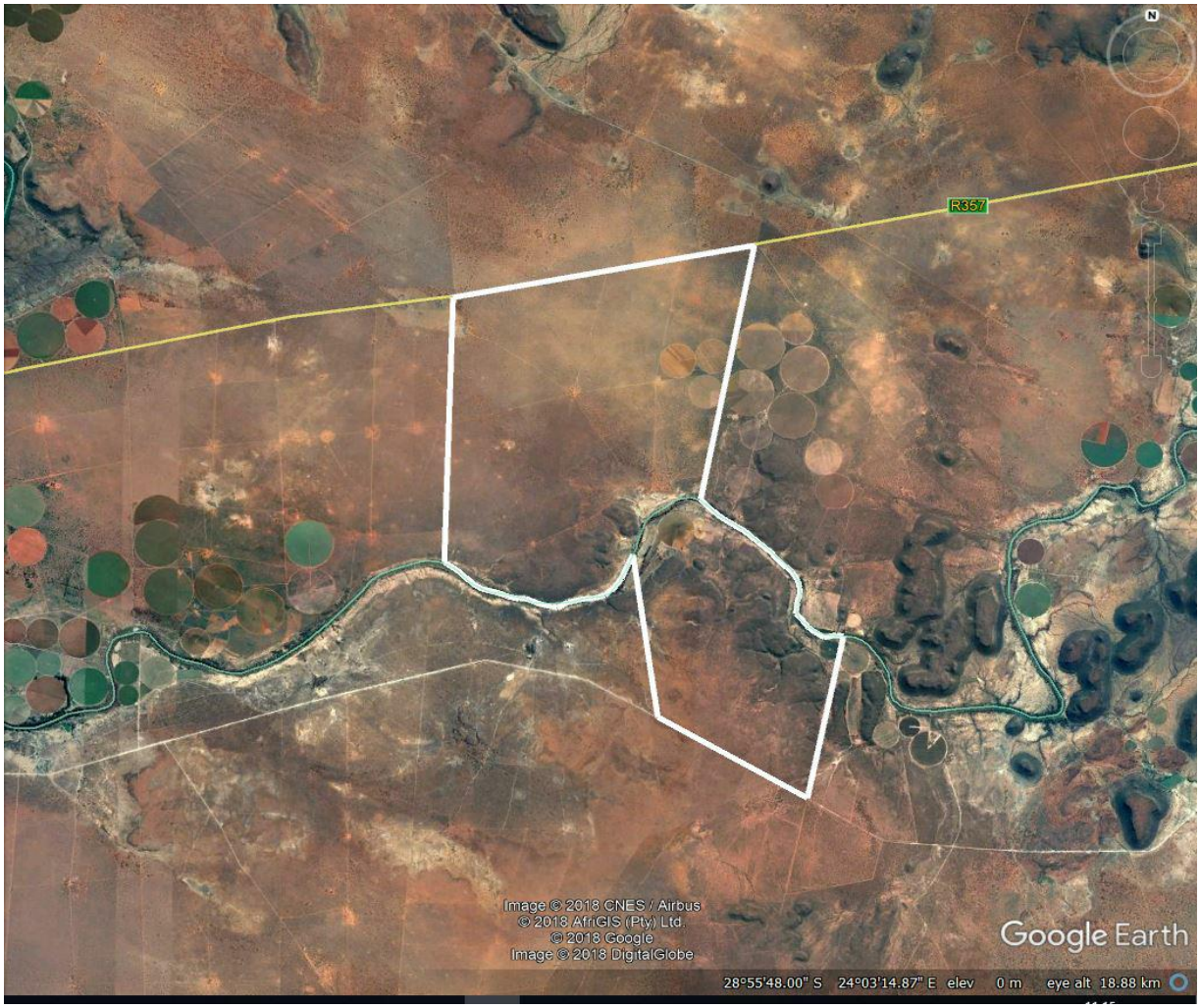
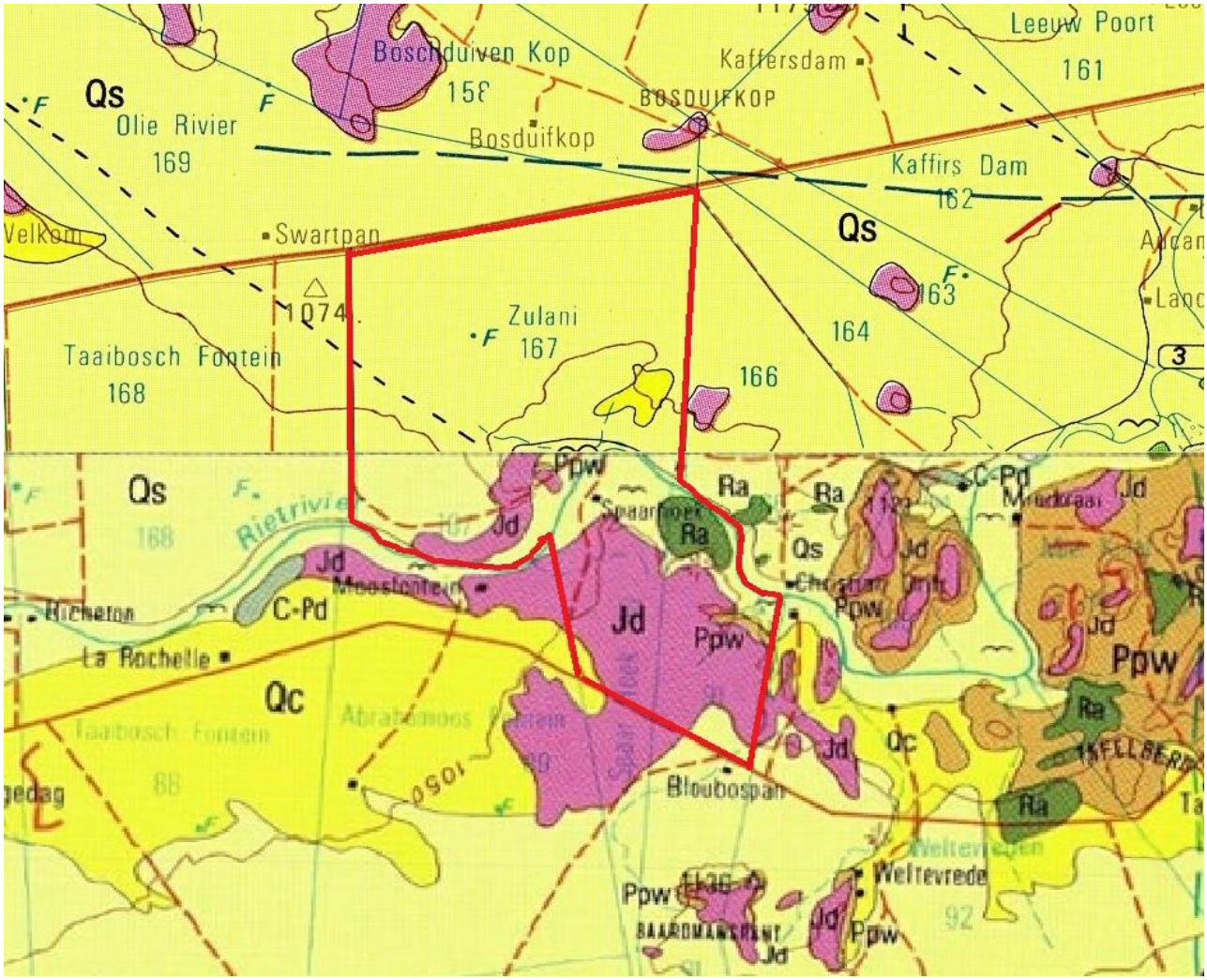


Figure 1: Google Earth photo indicating study site (white polygon)

The area in which the development is planned is relatively flat with a few low hills and was originally used for agriculture. The study site straddles the Riet River (see Fig.1). The study site lies approximately 8 km west of Plooysburg and 30 km east of Douglas.

The relevant literature and geological maps have been studied for a Desktop Study.

5. Geological setting



The study area is indicated by the red polygon

Figure 2: Geological map of the study area and surroundings (adapted from the 2924 Koffiefontein (bottom) and the 2824 Kimberley (top) 1:250 000 geology maps (Geological Survey, 1992; 1993)

GEOLOGICAL MAP LEGEND

	Lithology	Stratigraphy	Age
	Alluvium		Quaternary
Qs	Aeolian sand	Gordonia Formation of the Kalahari Group	
Qc	Calcrete		

Jd	Dolerite			Jurassic
Ppw	Dark grey to black shale with subordinate siltstone; iron rich carbonate concretions in basal part.	Whitehill and Prince Albert Formations, Ecca Group	Karoo Supergroup	Permian
C-Pd	Diamictite and boulder shale; subordinate sandstone and varved shale with limestone lenses.	Dwyka Group		Carboni-ferous
Ra	Amygdaloidal andesite	Allanridge Formation	Ventersdorp Supergroup	Randium

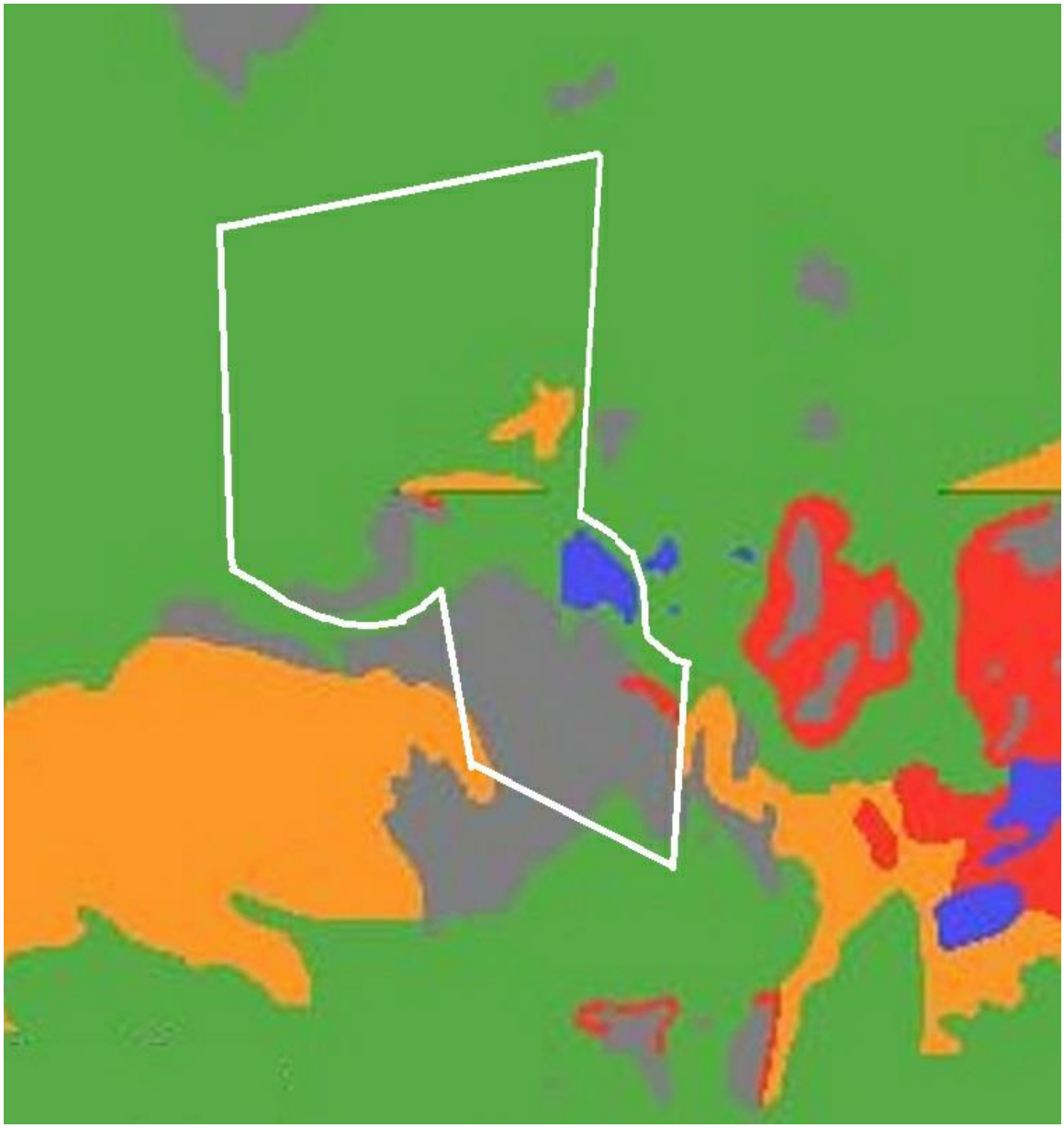
The largest part of the study site is situated on the Quaternary aeolian sands of the Gordonia Formation of the Kalahari Group north of the Riet River (Partridge *et al*., 2009) while the portion south of the Riet River is situated mostly on dolerite.

An exposure of calcrete occurs near the western border in the northern part of the study area while younger alluvial sediments occur on both sides of the Riet River.

Amygdaloidal andesite of the Allanridge Formation of the Ventersdorp Supergroup outcrops on the western side of the study site south of the Riet River (Van der Westhuizen *et al*., 2006).

Limited exposures of dark grey to black shale with subordinate siltstone of the Ecca Group of the Karoo Supergroup occur in the middle of the study site north of the Riet River and on the western border of the southern part of the study area. The Whitehill Formation overlies the Prince Albert Formation. It is characterised by carbonaceous, pyrite-bearing mudrocks that weather white on the surface while the subsurface rocks are black. Thin tuffaceous beds occur sporadically, while ferruginous carbonate concretions are dispersed throughout the formation (Johnson *et al*., 2009).

6. Palaeontological assessment of the region



(The study site is indicated with the white polygon)

Colour	Palaeontological Significance	Action
RED	VERY HIGH	Field assessment and protocol for finds are required.
ORANGE	HIGH	The desktop study is required and based on the outcome of the desktop study, a field assessment is likely.
GREEN	MODERATE	A desktop study is required.

BLUE	LOW	No palaeontological studies are required however a protocol for finds is required.
GREY	INSIGNIFICANT / ZERO	No palaeontological studies are required.

Figure 3: Palaeontological sensitivity of the region (SAHRA, 2019)

Although the area covered by the Allanridge Formation is classified as having a Low Palaeontological Sensitivity (see Fig. 3), it consists of igneous rocks and is therefore devoid of fossils and of no palaeontological concern.

The Ecca Group of the Karoo Supergroup is regarded as having a Very High Palaeontological Sensitivity (see Fig. 3). Fossils of a variety of palaeoniscoid fish (Fig. 4) and arthropods such as *Notocaris tapscotti* (Fig. 5) are common in the Whitehill Formation. This formation is famous for the fossils of the swimming reptile *Mesosaurus* (Fig. 6) that also occur in South America (Oelofsen & Araujo, 1987). Rare insect wings and cephalochordates have also been found in this formation (McLachlan & Anderson, 1977). Palynomorphs, petrified wood, and other sparse vascular plant remain such as *Glossopteris* leaves and lycopods have been found in this formation (Almond & Pether, 2008; Johnson *et al*., 2009).

The Karoo Supergroup rocks abuts extensive dolerite intrusions at the study site. These igneous intrusions would have caused thermal metamorphosis of the adjacent Karoo rocks which would have had a negative impact on its fossil content.

Figure 4: The palaeoniscoid fish *Ichnolepis bancrofti* (SAM-9338, iZiko South African Museum)

The Quaternary sediments – the alluvium, aeolian sands, and calcrete – in the study area cover most of the Carboniferous to Permian Karoo Supergroup rocks, the Jurassic-aged dolerite and the Randium-aged Allanridge Formation of the Ventersdorp Supergroup in the study area.

The fossil record of the surface calcrete and the overlying aeolian sands and alluvium is sparse, occurs sporadically and is low in diversity and is classified as having a Moderate Palaeontological Sensitivity (see Fig. 3). The fossils that have been discovered in this formation include root casts, burrows, termitaria, ostrich egg shells, mollusc shells and isolated bones (Almond & Pether 2008).

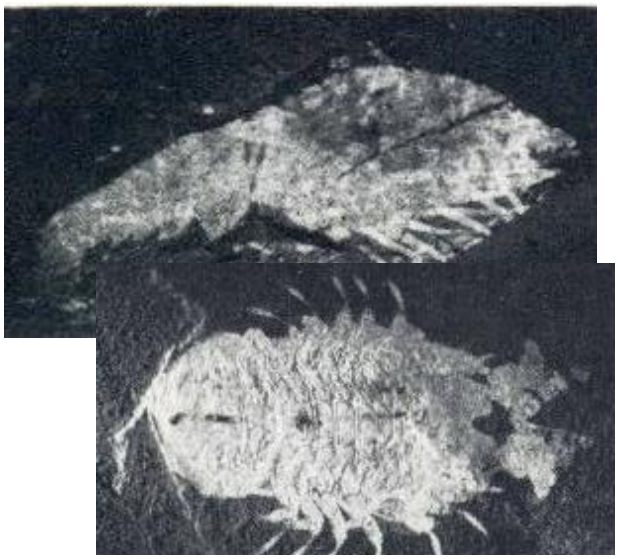


Figure 5: Fossils of the crustacean *Notocaris tapscotti* from the Whitehill Formation (adapted from Kensley, 1974)

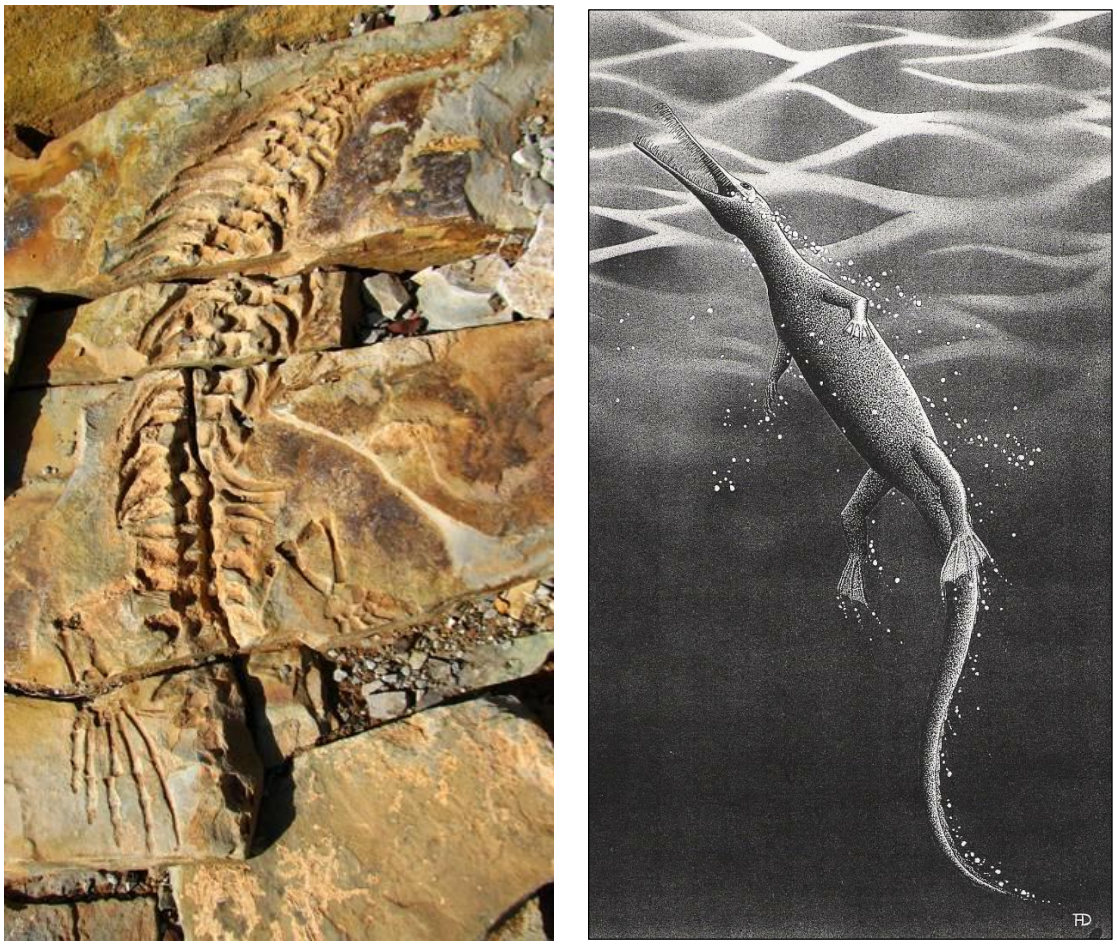


Figure 6: *Mesosaurus* fossil skeleton (left) and reconstruction (right)

7. Conclusion and recommendations:

Due to the proximity of dolerite intrusions to the potentially fossiliferous Ecca Group rocks at the study site, it is likely that its fossil content was destroyed through thermal metamorphosis. In the rare event that a significant fossil find is made in the Quaternary deposits or in the sedimentary rocks of the Karoo Supergroup rocks during construction, the ECO should take the following steps:

PROCEDURE FOR CHANCE PALAEONTOLOGICAL FINDS

Extracted and adapted from the National Heritage Resources Act, 1999 Regulations Reg No. 6820, GN: 548.

The following procedure must be considered in the event that previously unknown fossils or fossil sites are exposed or found during the life of the project:

1. Surface excavations should continuously be monitored by the ECO and any fossil material be unearthed the excavation must be halted.

2. If fossiliferous material has been disturbed during the excavation process it should be put aside to prevent it from being destroyed.

3. The ECO then has to take a GPS reading of the site and take digital pictures of the fossil material and the site from which it came.

4. The ECO then should contact a palaeontologist and supply the palaeontologist with the information (locality and pictures) so that the palaeontologist can assess the importance of the find and make recommendations.

5. If the palaeontologist is convinced that this is a major find inspection of the site must be scheduled as soon as possible in order to minimise delays to the development.

From the photographs and/or the site visit the palaeontologist will make one of the following recommendations:

a. The material is of no value so development can proceed, or:

b. The fossil material is of some interest and a representative sample should be collected and put aside for further study and to be incorporated into a recognised fossil repository after a permit was obtained from SAHRA for the removal of the fossils, after which the development may proceed, or:

c. The fossils are scientifically important and the palaeontologist must obtain a SAHRA permit to excavate the fossils and take them to a recognised fossil repository, after which the development may proceed.

7. If any fossils are found then a schedule of monitoring will be set up between the developer and palaeontologist in case of further discoveries.

REFERENCES:

Almond, J.E. & Pether, J. (2008) Palaeontological heritage of the Northern Cape. Interim SAHRA technical report, 124 pp. Natura Viva cc., Cape Town.

Geological Survey (1993) 2824 Kimberley 1:250 000 geology map, Geological Survey, Pretoria.

Geological Survey (1992) 2924 Koffiefontein 1:250 000 geology map, Geological Survey, Pretoria.

Kensley, B. (1974) Taxonomic status of the pygocephalomorphic crustacean of the Dwyka "White Band" (Permo-Carboniferous) of South Africa. *Annals of the South African Museum*, 67(3):25-33.

McLachlan, I.R. & Anderson, A.M. (1977). Fossil insect wings from the Early Permian White Band Formation, South Africa. *Palaeontologica africana* 20:83-86.

Oelofsen, B.W. & Araujo, D. (1987). *Mesosaurus tenuidens* and *Stereosternum tumidum* from the Permian Gondwana of both southern Arica and South America. *South African Journal of Science* 83: 370-372.

Johnson, M.T.; Van Vuuren, ClJ.; Visser, J.N.J.; Cole, D.I.; Wickens, H. De V.; Christie, A.D.M.; Roberts, D.L. & Brandl, G. (2009) Sedimentary rocks of the Karoo Supergroup. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (eds.) *The geology of South Africa*, pp. 461-500. Geological Society of South Africa, Johannesburg.

Partridge, T.C., Botha, G.A. & Haddon, I.G. (2009). Cenozoic deposits of the interior. In: Johnson, M. R., Anhaeusser, C. R. and Thomas, R. J. (eds.), *The geology of South Africa*, pp. 585-604. Geological Society of South Africa, Johannesburg.

Van der Westhuizen, W.A.; De Bruyn, H. & Meintjies, P.G. (2009) The Ventersdorp Supergroup. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (eds.) *The geology of South Africa*, pp. 187-208. Geological Society of South Africa, Johannesburg.

8. Declaration of Independence:

I. Jacobus Francois Durand declares that I am an independent consultant and have no business, financial, personal or other interest in the proposed development, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

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