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**THE PROPOSED DEVELOPMENT OF FARM  
VREEDE 4317/HS; KWAZULU-NATAL  
PROVINCE.  
PALAEOLOGICAL IMPACT ASSESSMENT**

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**SKARAB CC**

**MARCH 2020**

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## DECLARATION OF INDEPENDENCE

I, \_\_\_\_\_ Jacobus Francois Durand \_\_\_\_\_, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.



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Signature of the Specialist

SKARAB CC Paleontological Services

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Name of Company:

March 2020

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Date

## **EXECUTIVE SUMMARY**

Shale and sandstone of the Vryheid Formation of the Ecca Group of the Karoo Supergroup underlies the eastern portion of the farm, including Site C where the dam is to be built. The western side of the farm, where Sites A and B, which are demarcated for the chicken houses and the sheep feedlot, is underlain by dolerite.

The sedimentary rocks of the Vryheid Formation are highly fossiliferous in places and there is a possibility that such layers could be exposed during development. The fossils that occur in the Vryheid Formation are mostly that of leaf and stem imprints of plants such as *Glossopteris*, lycopods, ferns, horsetails, conifers, cordaitaleans and ginkgoaleans. Rare fossils of silicified and coalified wood, insects, bivalves, conchostrachans and fish scales also occur in this formation.

Site C is situated directly against the extensive dolerite sill to the west of it which would have destroyed the fossils in the rocks surrounding the dolerite. There has also been extensive weathering of the underlying sandstones and mudstones of the rocks of the Vryheid Formation as could be seen in the material that came out of the inspection pit near where the dam is to be built. This too would have had a detrimental effect on the quality and preservations of sub-surface fossiliferous layers.

A palaeontologist should be contacted in the unlikely event if an exceptional fossil discovery is made in the shale or sandstone units during construction. The ECO should follow the guidelines as stipulated under the Chance Find Procedure on pp.17-18 in such an event.

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# 1 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 development.

The palaeontological heritage of South Africa is unsurpassed and can only be described in superlatives. The South African palaeontological record gives us insight in 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.

The Ecca Group of the Karoo Supergroup contains a vast amount of fossil leaf imprints of plants that occurred in Southern Gondwana during the Permian. These lacustrine deposits contained plant matter that turned into coal in certain parts of the Ecca Group. The resulting coal fields form a very important mineral resource for the country.

South Africa has the longest record of palaeontological endeavour 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 Palaeontological Impact Assessment 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 and a visit to the study sites for a field assessment.

## **2 TERMS OF REFERENCE FOR THE REPORT**

The objectives and approach of this report includes:

- Undertake a Palaeontological Impact Assessment in accordance with the National Heritage Resources Act (Act 25 of 1999);
- Identify and map any palaeontological resources in the proposed area and its surroundings;
- Assess the significance of any identified resources in terms of the palaeontological impact assessment criteria as set out in the South African Heritage Resources Agency (SAHRA) regulations;
- Provide mitigation measures to safeguard palaeontological resources identified on study area;
- Comply with specific requirements and guidelines of KwaZulu-Natal Provincial Heritage Resources Authority (Amafa) and the South African Heritage Resources Agency (SAHRA); and
- Submit final report to SAHRIS/Amafa for comments and decision making.

### 3 THEORETICAL BACKGROUND AND LEGAL FRAMEWORK

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 from 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 Environmental Affairs and Mineral resources (in cases of mining).

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.

## 4 METHODOLOGY

The process of assessment for the Palaeontological Impact Assessment specialist components of heritage impact assessments, involves the following:

- **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. A 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 remains in the proposed project area is unknown. In the recommendations of Phase 1, the specialist will inform whether further monitoring and mitigation are necessary. The 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.

The site survey was conducted and completed on 25 January 2020. This report was prepared according to the National Heritage Resources Act (Act 25 of 1999). Background

research of the study area was conducted using literature such as books, journals, previously conducted PIA's on the study area and the internet before and after the site visit. The Palaeontological (fossil) Sensitivity Map, accessible from the South African Heritage Resources Agency (SAHRA) website was used. The purpose of the research prior to the physical survey was to acquire information as to what to expect in the study area, the site visit was completed to identify any palaeontological resources that may be impacted due to the proposed development within Vreede Farm.

The site assessment was conducted on foot in order to record and locate any paleontological resources within the study areas. The table from SAHRA Regulations was used to grade the significance and evaluate the level of impact on the heritage resources identified.

#### **4.1 ASSUMPTIONS**

It was assumed based on the literature review and according to the Palaeontological (fossil) Sensitivity Map, accessible from the South African Heritage Resources Agency (SAHRA) website (Figure 3) that the proposed development site is within a very High palaeontological sensitivity area and may yield palaeontological resources especially the eastern site of the farm.

#### **4.2 LIMITATIONS**

No limitations were encountered on site during the site assessment.

## 5 DETAILS OF STUDY AREA

The study site is situated on the Farm Vreede approximately 11 km southwest of Newcastle in KwaZulu/Natal (see Fig. 1). The area is used for farming and is covered with grass (see Figs. 4-6). The geology is obscured by a thick soil cover and vegetation, limiting access to the underlying rocks. Outcrops of dolerite that is more resistant to erosion occur on the farm however (see Fig. 8).

Geomorphologically the study area is characterised by a gently undulating landscape consistent with the erosion of the almost horizontally orientated underlying sandstone and mudstone layers of the Ecca Group. The friable nature of the sandstone in the study site can be seen at the 7 m deep inspection pit that was dug and filled in with the excavated material (see Fig. 7).

The eastern part of the study area has a VERY HIGH PALAEOLOGICAL SENSITIVITY while the western side has NO PALAEOLOGICAL SENSITIVITY (SAHRA, 2020). The relevant literature and geological maps for the region in which the development is proposed to take place, have been studied and the site has been visited for a Palaeontological Impact Assessment.

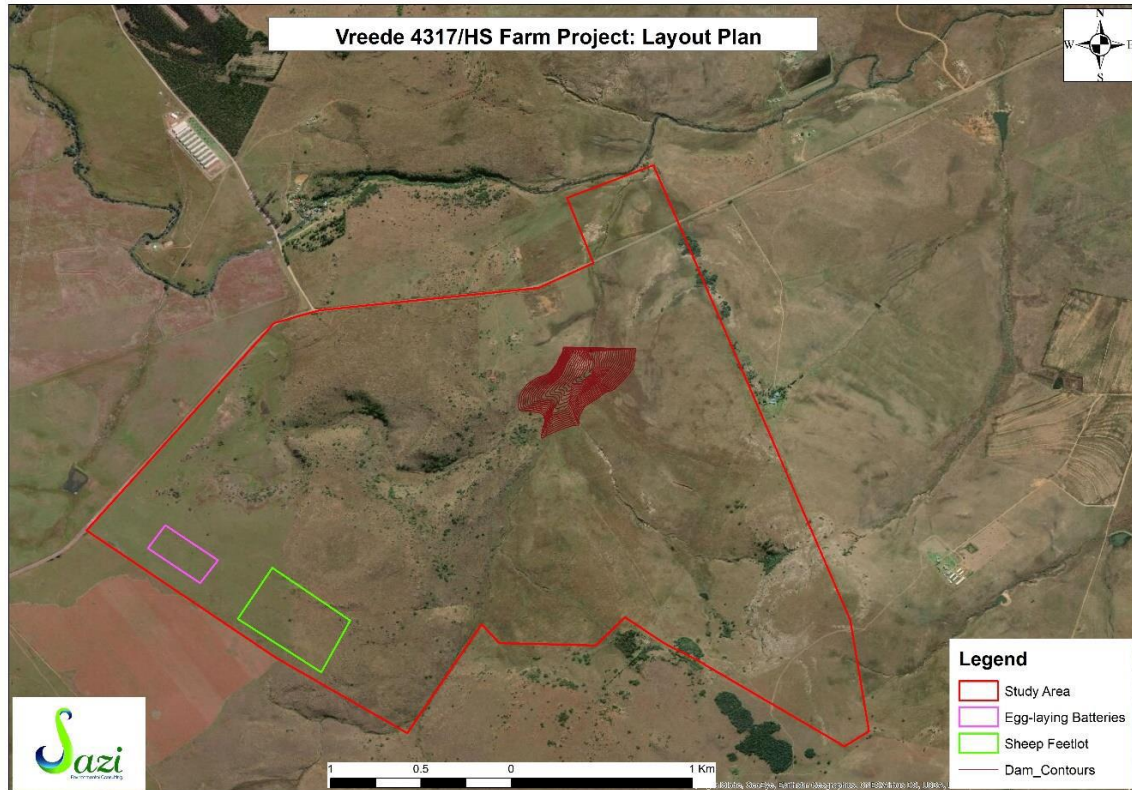


Figure 1: Google Earth photo indicating the study site

## 5.1 GEOLOGICAL SETTING

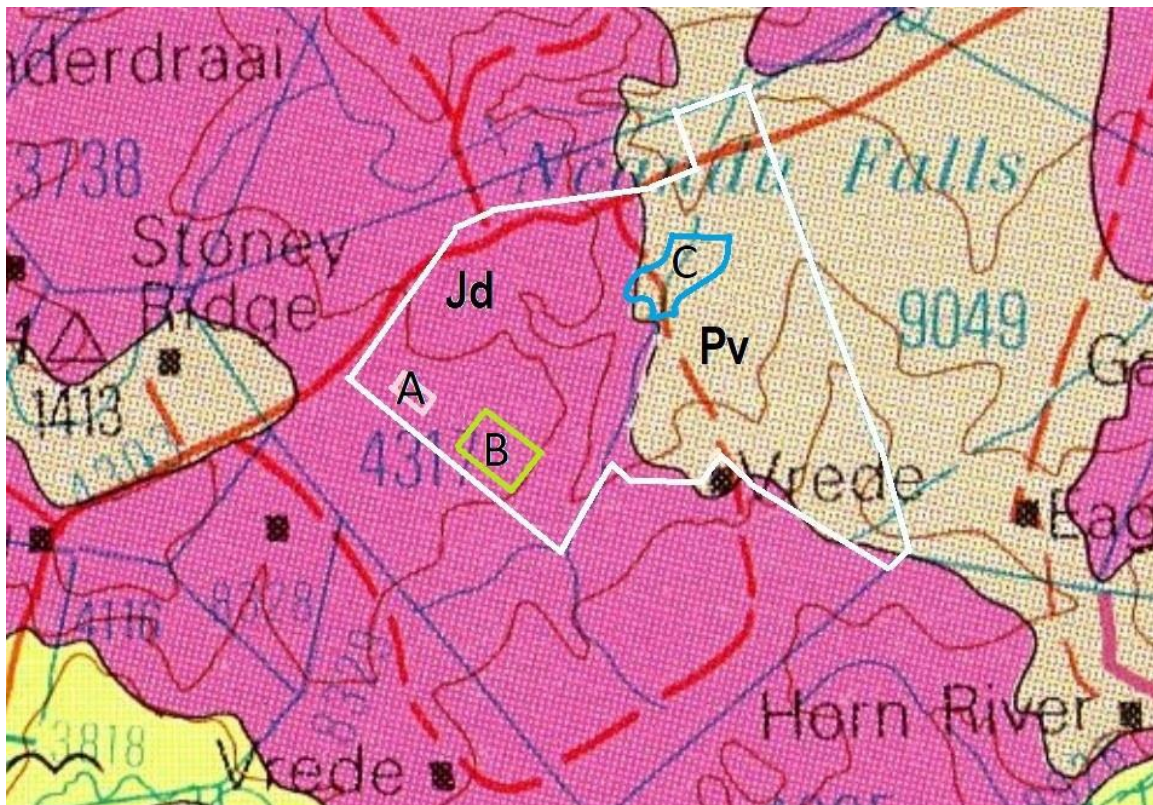
The study area is underlain by dolerite and sedimentary rocks consisting mostly of shale (metamorphosed mudstone), shaly sandstone, sandstone, grit, gravel, conglomerate and coal of the Vryheid Formation of the Ecca Group of the Karoo Supergroup (see Fig. 2).

The Karoo Supergroup sediments were deposited in valleys and basins that existed in the pre-Karoo topography in the region. The Karoo Supergroup rocks overlie unconformably the older Waterberg Group and Transvaal Supergroup rocks (Johnson et al. 2009).

The Vryheid Formation was formed when glacial and fluvio-glacial sediments were deposited in shallow marine to fluvio-deltaic environments approximately 280 Ma ago. In places coal seams are associated with these fluvial valley deposits. The coal seams formed in peat swamps which originated on alluvial plains or more rarely in back swamps (Johnson et al., 2009).

The Vryheid Formation is found mainly in the eastern part of the study area underlying Site C, while the remainder of the study area (including the localities of Sites A and B) is mainly underlain by dolerite (see Fig. 3). Dolerite intruded into the older sedimentary units comprising the Karoo Supergroup approximately 182.5 Mya. These igneous intrusions exposed the surrounding sedimentary rocks to thermal metamorphism. Site C lies on the sedimentary rocks of the Vryheid formation but also directly next to an extensive dolerite sill.

Alluvium that is associated with Quaternary river beds is found to the southwest of the farm.



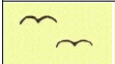
	Lithology	Stratigraphy		Age
	Alluvium			Quaternary
<b>Jd</b>	Dolerite			Jurassic
<b>Pv</b>	Shale, subordinate sandstone, coal	Vryheid Formation of the Ecca Group	Karoo Supergroup	Permian

Figure 2: Geology map of the study sites (A, B & C) and surroundings (adapted from the Frankfort 2728 1:250 000 Geology Map)



## 6 SITE VISIT



Figure 3: Google Earth picture showing sites where photos were taken



Figure 4: Site A facing northeast  $27^{\circ}52.082'S$   $29^{\circ}50.046'E$



Figure 5: Site B facing northeast  $27^{\circ}52.219'S$   $29^{\circ}50.244'E$



Figure 6: Site C facing northwest  $27^{\circ}51.747'S$   $29^{\circ}51.212'E$

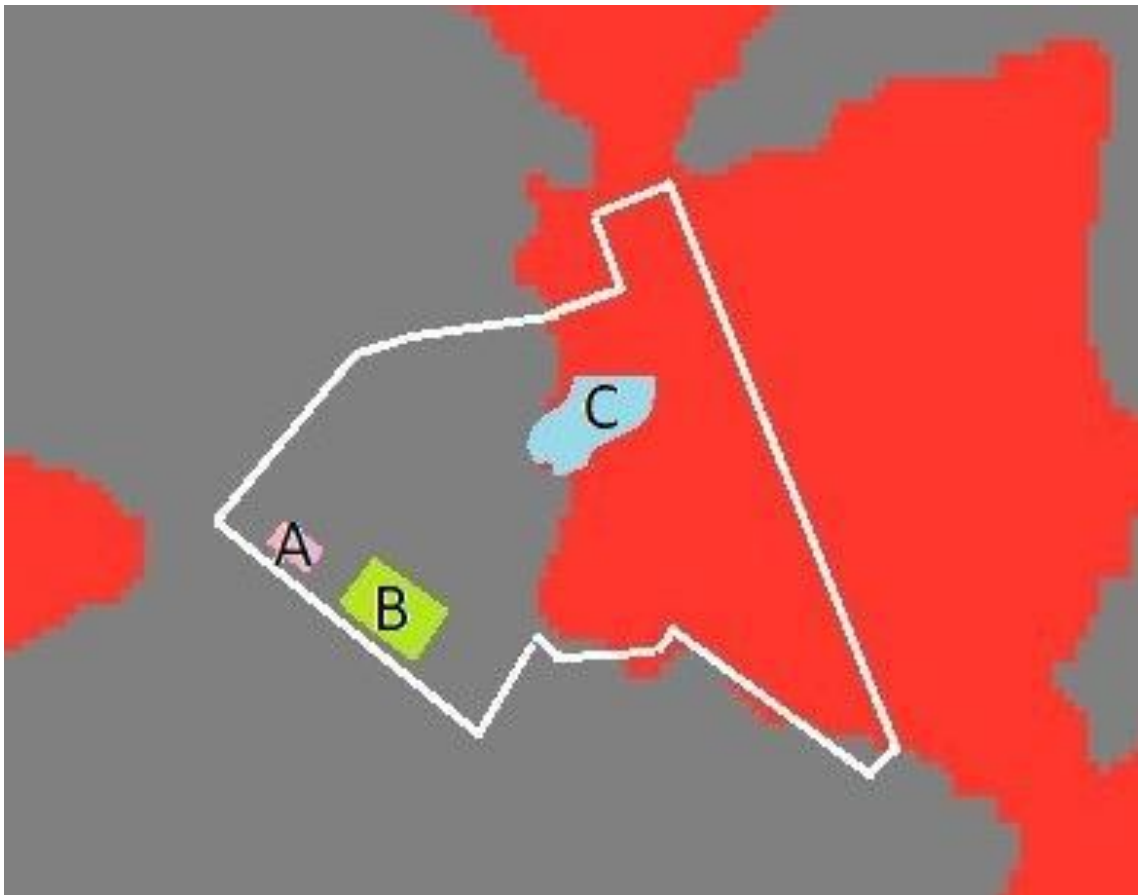


Figure 7: Sand and sandstone at inspection pit at 27°51.882'S 29°51.315'E



Figure 8: Dolerite outcrop at 27°51.865'S 29°51.230'E

## 7 PALAEOLOGICAL POTENTIAL OF THE STUDY SITE



Colour	Sensitivity	Required Action
RED	VERY HIGH	field assessment and protocol for finds is required
ORANGE/YELLOW	HIGH	desktop study is required and based on the outcome of the desktop study, a field assessment is likely
GREEN	MODERATE	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
WHITE/CLEAR	UNKNOWN	these areas will require a minimum of a desktop study. As more information comes to light, SAHRA will continue to populate the map.

Figure 9: Palaeosensitivity map of the study area and surroundings (SAHRA, 2020)

The proposed development will take place in an area that is partially underlain by rocks that are considered to have a High Palaeontological Sensitivity and are found mostly in the western and the northern parts of the study site (see Fig. 9).

Fossils have been found on the farms and the mines in the region. These Permian fossils are mostly leaf and stem imprints of *Glossopteris*, lycopods, ferns, horsetails, cordaitaleans, conifers and ginkgoaleans. Rare fossils of silicified and coalified wood, insects, bivalves, conchostrachans and fish scales have also been found in the shales and sandstones of the Vryheid Formation in the Free State (Groenewald & Groenewald, 2014).

The eastern part of the study area, where the proposed dam is to be built, falls within the Ecca Group of the Karoo Supergroup which is renowned for its fossil content. The Ecca Group is characterized by shale, mudstone, sandstone and seams of coal (Johnson *et al.*, 2009). The near horizontal layering of the geological strata and erosion of the adjacent and underlying rock strata results in a gently undulating landscape covered to a great extent by soil. Exposures of the underlying geology are therefore exceptionally scarce in the northern part of the Main Karoo Basin and are mostly limited to gullies, riverbanks, road cuttings and the mines in the region.

The Ecca Group of the Karoo Supergroup contain vast amounts of Permian leaf imprints of plants such as *Glossopteris* (Kovács-Endrödy, 1991). Millions of tons of fossiliferous material yielding mostly *Glossopteris* leaf imprints have been exposed at well-studied sites in the northern rim of the Main Karoo Basin such as Hammanskraal (Kovács-Endrödy, 1976), Witbank (Bamford, 2004) and Vereeniging (Rayner, 1986) and at Ryedale (Pack *et al.*, 2000).

Fossilised leaf imprints are not found evenly distributed throughout the Ecca Group, but in pockets such as in the eMalahleni and Vereeniging areas where the physical and chemical conditions during deposition resulted in the preservation of not only the structure of the leaves but also in some cases the organic material itself. The structure of the fossilised leaves is better preserved in the shales than in the sandstone units. The leaf structures are mostly lost in the coal layers.

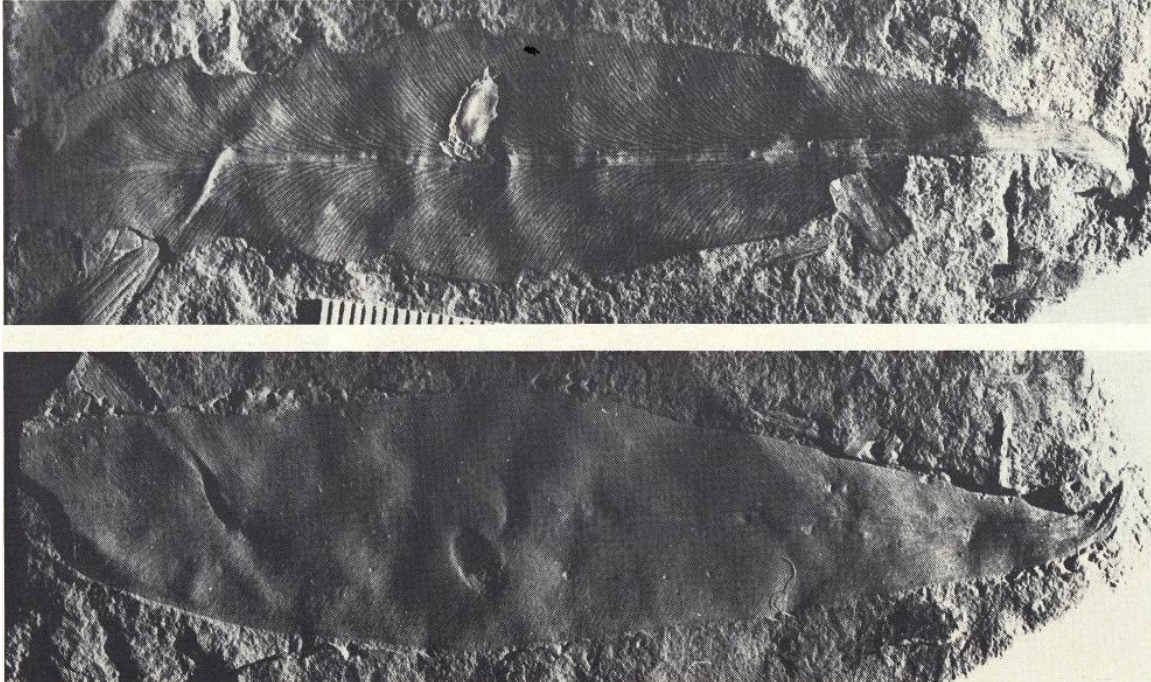


Figure 10: Glossopteris leaf imprint (from Kovács-Endrödy, 1976)

There is a high volume but low species diversity of fossil material from this region. Large and well described collections of fossil material from this region are housed at the Council for Geoscience, the University of the Witwatersrand and the Botanical Research Institute. Glossopteris leaves are abundant in Ecca Group sediments in Gauteng, Free State, Mpumalanga and KwaZulu-Natal and could be considered to be amongst the most common fossils in South Africa.

Dolerite, being of igneous nature, is non fossiliferous. The western part of the study area, earmarked for the chicken houses and sheep feedlot, is underlain by dolerite.

## 8 CONCLUSION AND RECOMMENDATIONS

The region is known for its fossiliferous shales and sandstones and it is highly probable that fossils will be encountered when the intact bedrock under the soil cover and layer of eroded rock is exposed during construction.

A thick layer of soil obscures the underlying geology and outcrops of the Vryheid Formation are scarce. The rocks that were exposed at the inspection pit are weathered coarse-grained sandstone. No fossiliferous rocks were found during the site inspection. The proposed sites for the chicken house (Site A) and sheep feedlot (Site B) are underlain by non-fossiliferous dolerite. Site C which is earmarked for the proposed dam is underlain by the highly palaeontologically sensitive Vryheid Formation.

Site C is situated directly adjacent to an extensive dolerite sill that would have caused thermal metamorphosis of the adjacent sedimentary rock during emplacement. Apart from the thermal metamorphosis that would have destroyed the fossils in the adjacent sedimentary rocks, the rocks have been extensively weathered at least 7 meters down as was seen in the material that came out of the test pit in the Vryheid Formation.

If an exceptionally fossil-rich layer of shale or sandstone is exposed during construction, it is advised that the ECO must follow the Chance Palaeontological Find Procedure as stipulated below and to contact a palaeontologist for further advice.

### PROCEDURE FOR CHANCE PALAEOLOGICAL 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 an inspection of the site must be scheduled as soon as possible in order to minimise delays to the development.
6. 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. 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.



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## **10 ANNEXURE 1: SPECIALIST CURRICULUM VITAE**

### **CV: FRANCOIS DURAND**

#### **ACADEMIC CAREER:**

BSc Botany & Zoology (Rand Afrikaans University: 1983)

BSc (Hons) Zoology (University of the Witwatersrand: 1984)

PhD Palaeontology (University of the Witwatersrand: 1990)

Post-graduate Diploma in Museology (University of Pretoria: 1993)

Higher Education Diploma (Rand Afrikaans University: 2001)

#### **AFFILIATION (PROFESSIONAL SOCIETIES AND BODIES):**

Member of Research Committee of the Cancer Association of South Africa (2010-2011)

Member of the Suid-Afrikaanse Akademie vir Wetenskap en Kuns (1998-present)

Appointed by the Minister of the Department of Arts, Culture, Science and Technology to serve on the board of the Foundation for Education, Science and Technology (1996-1999)

Registered Professional Natural Scientist (Earth Science & Zoological Science) with the South African Council for Natural Scientific Professions

Palaeontological Society of Southern Africa (1986-present)

#### **CAREER:**

1988-1997: Palaeontologist at the Council for Geosciences.

1998-2004: Lecturer at the Rand Afrikaans University in the Zoology Department.

2005-2017: Senior Lecturer at the University of Johannesburg, Zoology Department.

2018-Present: Assistant Professor at the University of Johannesburg, Zoology Dept.

#### **EXPERIENCE:**

- Urban development in Cradle of Humankind World Heritage Site (Gauteng):  
Letamo, Honingklip, Windgat, Sundowners, Ekutheni
- Urban development at Goose Bay, Vereeniging, Gauteng
- Urban development on Portions 98, 99, 179, 236, 284 and 364 of the farm Waterkloof 306 JQ, Rustenburg, North West Province
- Upgrade of R21 between N12 and Hans Strydom Drive, Gauteng
- Vele Colliery, Limpopo Province
- De Wildt 50 MW Solar Power Station, Gauteng

- 10 MW PV Plant Potchefstroom, North West Province
- Omega 342 50MW Solar Power Station, Viljoenskroon, Free State
- Springfontein wind and solar energy facility, Free State
- Solar power plant, Bethal, Mpumalanga
- Diamond mine on Endora, Limpopo Province
- Development at Tubatse Ext.15, Limpopo Province
- Manganese mine south of Hotazel, Northern Cape
- Wind energy facility at Cookhouse, Eastern Cape
- Energy facility at Noupoort, Northern Cape
- Fluorspar mine near Wallmannsthal, Gauteng
- ESKOM power line, Dumo, KwaZulu-Natal
- ESKOM Gamma-Omega 765KV transmission line, Western Cape
- ESKOM 44KV power line at Elandspruit near Middelburg, Mpumalanga
- ESKOM Makopane Substation, Limpopo Province
- ESKOM Platreef Substation and power lines to Borutho MTS Substation, Limpopo Province
- Solar energy facility at Prieska, Northern Cape.
- Marang B - a 3 x 500MVA 400/132kV Main Transmission Substation east of Rustenburg, North West Province
- Upgrading of storm water infrastructure in Valencia, Addo, Eastern Cape
- Development of a 10 MW Solar Energy facility on the Farm Liverpool 543 KQ Portion 2 at Koedoeskop, Limpopo Province
- Development of a fluorspar mine at Wallmannsthal, North of Pretoria
- Extension of limestone mine on the farms Buffelskraal 554 KQ Portion1 and Krokodilkraal 545 KQ, Limpopo Province
- Lesego Platinum Mine, Sekhukhune Area, Steelpoort, Limpopo Province
- Mine at Hotazel, Northern Cape
- Pollution control dams at Transalloys in Clewer, Emalaheni, Mpumalanga
- Erection of spill points on the Farm Kwikstaart 431 KQ Portion 2, Thabazimbi, Limpopo Province
- Construction of dam at Ethemba, Swaziland
- Construction of bridge at Busingatha, KwaZulu Natal
- Water Reticulation System - Kei Road and Berlin General, Eastern Cape

- Development at Kromdraai, COHWHS (Portion 26 of the Farm Kromdraai, West Rand Municipality)
- Construction of Nhlezi Bridge, KwaZulu Natal
- Erection of spill point and dam on the Farm Faure 72 KQ Portion 8, Makoppa near Thabazimbi, Limpopo Province
- Colliery on the Farm Goedehoop near Piet Retief, Mpumalanga
- Erection of spill points on the Farm Diepwater 302 KQ Portions 4 -8 near Thabazimbi, Limpopo Province
- Construction of 2 MW photovoltaic power plant on the farm De Hoek 32, Pixley ka Seme District Municipality, Northern Cape Province
- Road upgrade near Magogo, KwaZulu/Natal
- Construction of haul road & waste dump: Lylyveld, Sishen, Northern Cape
- Construction of 4 weirs and a road culvert on Portion 3 of the Farm Roodekrans 133JT, Dullstroom Area, Mpumalanga
- Construction of a solar energy facility on Blaubospan near Groblershoop, Northern Cape
- Construction of road from Macengeni to Macijo, KwaZulu/Natal
- Construction of the John Taole Gaetsewe school and hostels in Dithakgong, Northern Cape
- Development at Duduza Township, Gauteng
- Construction of roads near Ndanyana KwaZulu/Natal
- Development of colliery on the farm Goedehoop near Piet Retief, Mpumalanga
- Construction of Tiger Solar power plant near Windsorton, Northern Cape •
- Development of Amandelbult Open Cast Mine near Thabazimbi, Limpopo
- Development at The Shed in the Cradle of Humankind World Heritage Site
- Development of 800 ha dry lands on Farm Hoylesdale 163 KQ portion 1, Makoppa, Thabazimbi Local municipality, Limpopo Province
- Construction of solar energy facility on Blauwpospan near Groblershoop, Northern Cape.
- Development of the Doornhoek Fluorspar Mine near Zeerust, Northwest.
- Development on the Farm Haakdoringdrift, 373 KQ Portion 3, Thabazimbi, Limpopo Province.
- Development of bulk sewer line, Motherwell, Eastern Cape.

- Erection of spill points on the Farm De Hoop, Koedoeskop, near Thabazimbi, Limpopo Province.
- Development of orchards on the Farm Kromdraai, near Thabazimbi, Limpopo Province.
- Upgrade of Section 3 and Section 4 of the National Route R75, Eastern Cape.
- Construction of Concentrated Power Plants at Olyvenhout Drift, Upington, Northern Cape.
- Borrow pit at New Payne in Mthatha, Eastern Cape. • Borrow pit for rural road to Centuli Clinic, Eastern Cape.
- Juno Gromis 400kV power line (West Cape and North Cape).
- Barberton IAPS Wastewater Treatment Works, Barberton, Mpumalanga.
- Development of orchards on the Farm Kromdraai, Thabazimbi, Limpopo Province.
- Erection of spill points on the farm Knoppieskop, Limpopo Province.
- Development at O.R. Tambo International Airport, Gauteng.
- Development on Portion 12 of the Farm Tregaron in the Sundays River Municipality, Eastern Cape.
- Development of spill points and dam on the Farm Fairfield 306 KQ, Makoppa near Thabazimbi, Limpopo Province.
- Development at Erasmus Park (Waterkloof 378 JR), Pretoria, Gauteng.
- Development of shopping centre at Wright Park, Gauteng.
- Mining development on Thorncliffe and Helena Farms near Steelpoort, Sekhukhune District Municipality, Limpopo Province.
- Urban development at Pienaarspoort, Tshwane, Gauteng.
- Lydenburg-Merensky 132 kV Power Line within the Sekhukhune (Ward 31) and the Ehlanzeni (Wards 1, 5, 13) District Municipalities in the Limpopo and Mpumalanga Provinces.
- Mahikeng Main Transmission Substation and a 400kV Pluto-Mahikeng powerline, North West Province.
- Solar 1, Vryburg Solar 2 and Vryburg Solar 3 photovoltaic plants and associated electrical infrastructure, near Vryburg, in the North-West Province.
- Application for prospecting right on Portion 2 of the Farm Ganspan 194, Northwest Province.
- Mining development on the Farm Dutoitspan 119, Kimberley, Northern Cape.
- Development at De Bad, south of Schmidtsdrift, Northern Cape.

- The refurbishment of the existing 132kV powerline from the Oasis Substation at Keimoes to the Taaipit Substation at Kakamas, Northern Cape Province.
- Prospecting permit on Portion 11 of the farm Oersonskraal 250, between Bloemhof and Makwassie, North West Province.
- Application for mining right on the Farm Palmietfontein 208JP, near Pilanesberg, Moses Kotane Local Municipality, Bojanala District, Northwest Construction.
- Development on the Farm Rooifontein 1722, Kimberley, Northern Cape.
- Development on the Farm Gansfontein, Northwest Province.
- Development at the Door of Hope property, Johannesburg, Gauteng.
- Construction of SANBI building in the Botanical Gardens, Tshwane, Gauteng.
- Development on the Farm Biesiesputs south of Postmasburg, Northern Cape.
- Development on Farm At Last, west of Delpportshoop, Northern Cape.
- Outfall Sewer North of Krugersdorp, Mogale Local Municipality, Gauteng.
- Maphutha – Witkop 400KV powerline within the Sekhukhune and Capricorn District Municipalities, Limpopo Province.
- Development of a Pecan Nut Orchard at the Spitskop Special Needs School, east of Thabazimbi, Limpopo.
- Development of dams on the Farm Doornspruit, Vaalwater, Limpopo Province.
- Development of a 16 ha cherry orchard on the Farm Rietfontein JQ 348 Portion 46, near Rustenburg, North West.
- Development of the Ashkam PV Plant in the Northern Cape.
- Development of the Evening Star Opencast Alluvial Diamond Mine and associated infrastructure.
- Deviation and refurbishment of the existing 132kV powerline from the Oasis substation to the Taaipit substation, Northern Cape Province.
- Application for mining right (diamonds) on the Farm Palmietfontein 208JP, near Pilanesberg, Moses Kotane Local Municipality, Bojanala District, Northwest.
- Construction of the Mahikeng Main Transmission Substation and a 400kV Pluto-Mahikeng powerline.
- Drilling and mining related activities for Makhado Colliery, Vhembe District Municipality, Limpopo Province.
- Development of a 150 PV Solar Energy Facility on Portion 2 of Farm Roode Pan in Orania, Northern Cape.
- Proposed development on the Farm Rebelsvlei, Kirkwood, Eastern Cape.

- Development of the De Villiers 22 kV power line, near Douglas, Northern Cape.
- Prospecting rights for Metsimaholo Coal Mine, between Sasolburg and the Vaal Dam, Free State.
- EMP Upgrade for Demaneng Iron Ore Mine, Northern Cape.
- Development of the Ashkam PV Plant in the Northern Cape.
- Silimanite and quartz prospecting right and bulk sampling activities on a Portion of the Remainder of Pella Mission 39, Northern Cape.
- Construction of an off-stream storage dam and expansion of infrastructure for the bulk transportation of water on Restant of the Farm Overvlakte 125 MS and on remaining extant of Voorspoed 836 MS within Musina Local Munisipality, Vhembe District.
- Construction of 971 low cost houses and VIPs, in Ward 5, Mathulini, KwaZulu/Natal.
- Development of the Lephalale Railway Yard, Limpopo Province.
- Rebuilding of the Orania Strydenburg 22kV line from pole ORST500-80 to pole ORST500-152-2 in the Strydenburg area, adjacent to the N12 in the Northern Cape.
- Erection of a 582m 11kV power line on the Farm Goedehoop, Portion 12 of Farm 331, North West Province.
- Development of a 22kV line at Lockshoek, Griekwastad, Northern Cape
- Expansion of Kgaswane Country Lodge on Portions 21 and 85 of the farm Boschfontein 330JQ, Rustenburg, North West.
- Prospecting Rights Application on remaining extent and portion 1 of the Farm Bakhoutrantje 205JP, near Rustenburg, North West Province.
- Development of a 11 MW Solar Facility at Waterkloof, Rustenburg and a 108 MW Solar Facility at Boschhoek, North West Province.
- Development on Erf 30 Letamo Estate, Mogale Local Municipality, Gauteng
- Expansion of a feedlot for cattle on Portion 4 of the farm Vlaknek 472JP, Ditsobotla Local Municipality, North West Province.

**Palaeontological research:**

- Gauteng: Wonder Cave
- KwaZulu/Natal: Newcastle, Mooi River, Rosetta, Impendle, Himeville Underberg, Polela & Howick Districts, Sani Pass

- Eastern Cape: Cradock District, Algoa Basin
- Western Cape: Clanwilliam District
- Free State: Memel & Warden Districts
- Limpopo Province: Nyalaland (KNP), Vhembe Reserve, Pont Drift
- Zimbabwe: Sentinel Ranch, Nottingham

### **Publications:**

Durand, J.F. (1991) A revised description of the skull of *Moschorhinus* (THERAPSIDA, THEROCEPHALIA), *Annals of the South African Museum*, 99(11): 381-413.

Durand, J.F. (1995) Evolution and Fundamentalism, In: C.W. du Toit (Editor), *Nature, God and Humanity*, Proceedings of the third seminar of the South African Science and Religion Forum, University of South Africa, Pretoria, pp.244-258.

Maier, W., Van den Heever, J. & Durand, F. (1996) New therapsid specimens and the origin of the secondary hard and soft palate of mammals. *Journal of Zoological Systematics and Evolutionary Research*, 34:9-19.

Durand, F. (1996) First vertebrate fossil discovery in the Kruger National Park. *South African Journal for Science*, 92(7):302.

Thackeray, J.F., Durand, J.F. & Meyer, L. (1998) Morphometric analysis of South African therapsids attributed to *Lystrosaurus murrayi* (Huxley, 1859) and *L. declivis* (Owen, 1860): probabilities of conspecificity. *Transvaal Museum Annals*, 36(29):413-420.

Durand, J.F. (2001) The oldest juvenile dinosaurs from Africa. *Journal for African Earth Sciences*, 33(3-4):597-603.

Durand, J.F. (2003) The influence of religion and politics on the teaching of evolution in South Africa, *Ekklesiastikos Pharos*, 2003, New Series 13, Volume 85 (1&2), pp. 203-223.

Durand, J.F. (2004) Die ontdekking van 'n voorwerp naby Mapungubwe wat moontlik as 'n abakus gebruik is. *Suid-Afrikaanse Tydskrif vir Natuurwetenskap en Tegnologie* 23(3):46-51.



Durand, J.F. (2005) Major African contributions to Palaeozoic and Mesozoic vertebrate palaeontology, *Journal for African Earth Sciences*, 43(1-3):53-82.

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Durand, J.F. (2008) Die karst-ekologie van Suid-Afrika met spesiale verwysing na die Wieg van die Mensdom Wêrelderfenisgebied. *Suid-Afrikaanse Tydskrif vir Natuurwetenskap en Tegnologie* 24(4)5-15.

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Van Eeden, E.; Lieferink, M. & Durand, J.F. (2009). Legal issues concerning mine closure and social responsibility on the West Rand. *TD: The Journal for Interdisciplinary Research in Southern Africa* 5(1):51-71.

Durand, J.F.; Meeuwis, J. & Fourie, M. (2010) The threat of mine effluent to the UNESCO status of the Cradle of Humankind World Heritage Site. *TD: The Journal for Interdisciplinary Research in Southern Africa*, 6(1):73-92.

Durand, J.F. & Peinke, D. (2010) The state of karst ecology research in the Cradle of Humankind World Heritage Site. Report KV 241/10, Water Research Commission. *The Karst System of the Cradle of Humankind World Heritage Site*, pp. 88-101.

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Durand, J.F. (2013) Paleontologie en die Suid-Afrikaanse samelewing vandag. *Tydskrif vir Geesteswetenskappe* 53(3):331-345.

Durand, J.F. (2013) Emergence as cornerstone in understanding evolution: examples from zoology. *South African Science and Religion Forum Conference papers - Chance, causality, emergence: Interdisciplinary perspectives*, pp 67-101.

Durand, J.F. (2016) Nature, creation and morality: The case of parasites. *HTS Theological Studies* ISSN: (Online) 2072-8050, (Print) 0259-9422.

Durand, J.F. (2016) Die impak van suur mynwater op die ekologie van die Wieg van die Mensdom en die Krugersdorp- Wildreservaat aan die Wes-Rand. *Suid-Afrikaanse Tydskrif vir Natuurwetenskap en Tegnologie* ISSN: (Online) 2222-4173, (Print) 0254-3486.

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