PROPOSED FLUORSPAR MINE AT DOORNHOEK NEAR ZEERUST, NORTHWEST

DESKTOP STUDY REPORT
PALAEONTOLOGY

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For:

EXIGO3

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1. Introduction

The palaeontological heritage of South Africa is unsurpassed and can only be described in superlatives. The South African palaeontological record gives us insight in i.a. the diversification of early life and the origin of dinosaurs and mammals. 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. South Africa is probably best known palaeontologically for having more than half of all the hominin specimens in the world, the greatest variety of hominins in a country and the longest record of continuous hominin occupation in the world.

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 which may be impacted by the proposed development.

2. 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:

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.

3. Details of study area and the type of assessment:

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

The study area lies 12 km south southwest of Zeerust. The area contains mountains, rivers, roads and flat areas to the south which are used for farming (see Fig.1).

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

4. Geological setting

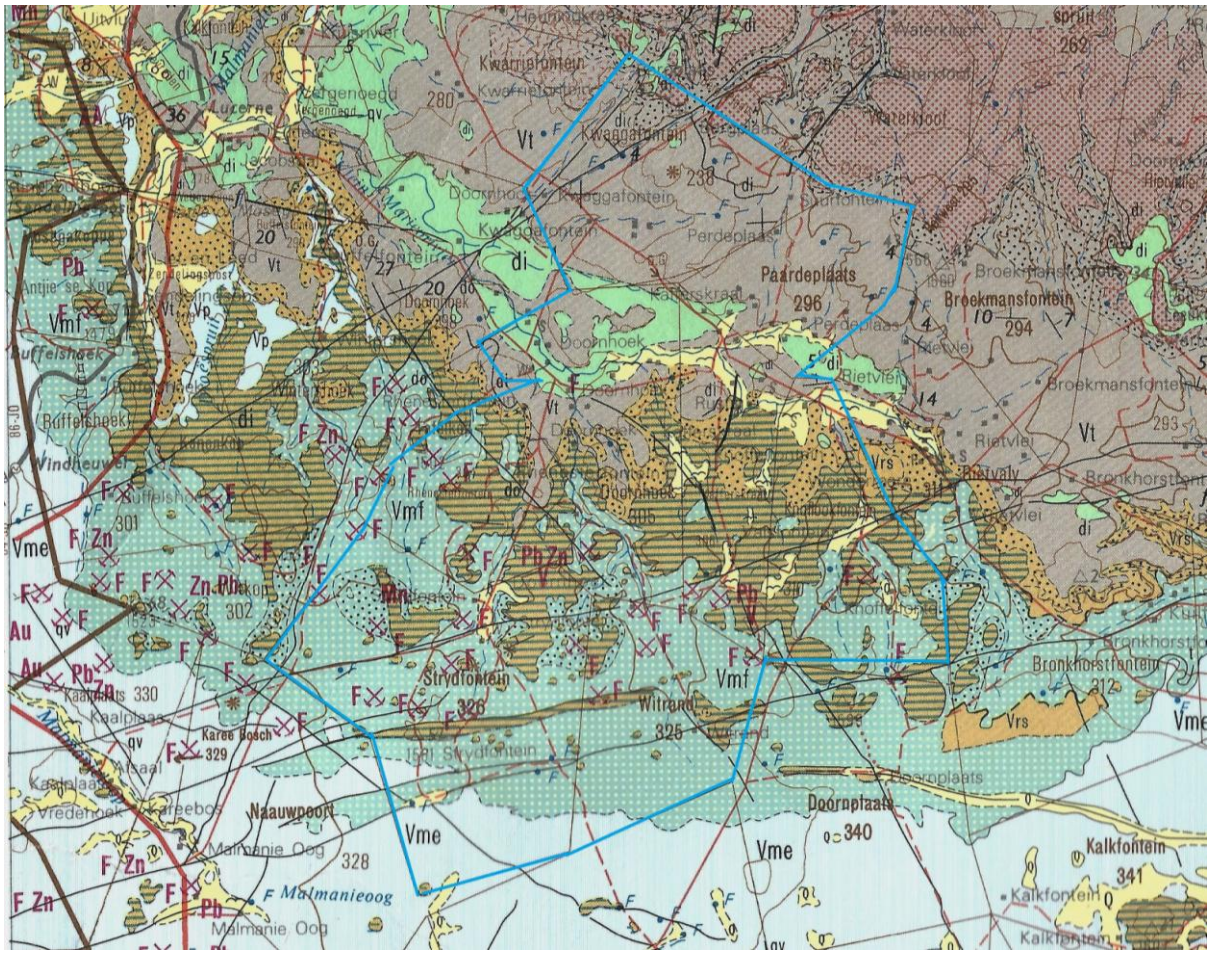

Figure 2: Geology map of the study area (blue polygon) and surroundings. Adapted from the 2526 Rustenburg 1: 250 000 Geology Map (Geological Survey, 1981)

LEGEND

	Lithology	Formation	Group	Age
~	Alluvium			Quartenary
di	Dolerite			Jurassic
do	Diabase			Mokolian
Vt	Shale, slate	Timeball Hill	Pretoria	Vaalian
	Quartzite, slate			
	Ferruginous quartzite			
	Shale, slate with andulusite			
Vrs	Shale	Rooihoogte		
	Giant chert			
	Quartzite			
Vp	Banded ironstone	Penge	Chuniespoort	
	Dark chert-free dolomite	Frisco		
	Stromatolitic dolomite			
Vme	Light banded dolomite and chert	Eccles		

The study area is dominated by sedimentary rocks of the Pretoria and the Chuniespoort Groups of the Transvaal Supergroup of Vaalian age (Eriksson *et al*., 2009). These rocks are covered in places by a layer of Quaternary age sand (Partridge *et al*., 2006) (see Fig. 2).

The 2.6 – 2.4 Ga Chuniespoort Group consists largely of stromatolitic dolomite and limestone. These carbonate deposits are overlain by banded iron formations which are of economic importance. This banded iron formation contains the world's largest iron and asbestos deposits (Eriksson *et al*., 2009).

The Pretoria Group consists mostly of mudrocks alternating with quartzitic sandstones, interbedded basaltic-andesitic lavas, and subordinate conglomerates, diamictites an carbonate rocks all of which have been submitted to low-grade thermal metamorphism (Eriksson *et al*., 2006).

Mokolian aged diabase and Jurassic aged dolerite intrusions occur in the study area (Geological Survey, 1981).

The study area is covered in places with Quaternary sand which overlies the metamorphic rocks of the region (Partridge *et al*., 2009).

5. Palaeontological assessment

Given the age and nature of the geology of the region the study area is of low palaeontological concern.

The Transvaal Supergroup consists of one of the world's oldest known carbonate platform successions which contain extensive stromatolites. Stromatolites are the fossilised remains left by cyanobacterial mats.

The conservation of stromatolites is a contentious matter because, although they are considered to be fossils, it is impossible to collect and store stromatolites in big quantities in fossil repositories – simply because they occur over thousands of square kilometres and can occur in layers tens of meters thick.

Despite the difficulty in collecting, curating and conserving stromatolites on the one hand and the ubiquitous and abundant nature of their occurrence on the other, it is recommended that the stromatolitic formations must be conserved where possible if well formed stromatolitic domes or columns (see Figs. 3 & 4 for examples) are present or exposed during excavations.

Figure 3: Domal stromatolites near Sabie, Mpumalanga (From: http://all-geo.org/highlyallochthonous/wp-content/uploads/2010/07/gc2b.jpg)

Although stromatolites and the associated microfossils have been poorly studied in the past, it does not detract from their importance. These sedimentary structures were formed by cyanobacterial mats from around 3.5 billion years ago. Cyanobacteria transformed the planet by facilitating the sequestering of CO_2 in the form of calcium carbonate by setting it down in the form of limestone. Cyanobacteria are also renowned for being the first photosynthesizing organisms that utilised sunlight and water for the production of energy rich compounds and the resultant release of oxygen as by-product. Cyanobacteria were responsible changing the planet's reducing atmosphere to an oxygen-rich atmosphere from approximately 2.5 billion years ago.

Figure 4: Stromatolites in the roof of Sudwala Cave (From: http://1.bp.blogspot.com/-likzu-0h1fU/UBy5VLS55nI/AAAAAAAAASI/ydc6CiwGAsQ/s1600/stromatalites.jpg)

Plio-Pleistocene fossils such as those found in the dolomite cave systems at Makopane's Cave and the Cradle of Humankind have not been reported from the study area.

Although there seems to be a paucity of fossils in the study area, fossils such as root casts, burrows, termitaria, ostrich egg shells, mollusc shells and isolated bones have been found elsewhere in Quaternary deposits (Almond & Pether, 2008).

References:

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

Eriksson, P.G.; Altermann, W. & Hartzer, F. (2009) The Transvaal Supergroup and its precursors. In: Johnson, M. R., Anhaeusser, C. R. and Thomas, R. J. (eds.), The Geology of South Africa. Geological Society of South Africa, Johannesburg & Council for Geoscience, Pretoria. Pp. 237-260.

Geological Survey (1981) 2526 Rustenburg 1: 250 000 Geology Map.

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. Geological Society of South Africa, Johannesburg & Council for Geoscience, Pretoria. Pp. 585-604.

6. Conclusion and recommendations:

It is inevitable that dolomite will be exposed, altered and removed during construction and mining. There is no need to avoid this at all costs. The on-site conservation of exceptional and well-preserved stromatolitic features is strongly recommended however.

Plio-Pleistocene fossils such as those found in the dolomite cave systems at Makopane's Cave and the Cradle of Humankind have not been reported from the study area. However, due to the importance of these fossils and their association with dolomitic caves, it is recommended that a palaeontologist should be appointed to do a site visit before the commencement of construction or mining to verify that no fossiliferous cave deposits or stromatolitic domes or columns will be damaged during development.

The overall palaeontological sensitivity of the study areas is considered to be low. Fossils are rare in the aeolian sands of the Gordonia Formation of the Kalahari Group.

In the unlikely event of fossils turning up during the construction process, the ECO should take the responsibility of marking the site and take a GPS reading of the locality. No attempt must be made to excavate fossils before they have been assessed by a palaeontologist. Photographs of the fossil site and fossils or sub-fossils should be taken. The advice of a qualified archaeozoologist or palaeontologist should be called in and if necessary a rescue collection could be undertaken by the palaeontologist (after obtaining a SAHRA permit) to remove the fossils from the building site. The fossils should then be taken to a fossil repository such as the Ditsong Museum in Pretoria for safekeeping.

Palaeontological specialist:
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BSc Botany & Zoology (RAU), BSc Zoology (WITS), Museology Dipl. (UP), Higher Education Diploma (RAU), PhD Palaeontology (WITS)

Experience:
Palaeontological assessments:

- 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, Northen 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, Emalahleni, 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 at Lylyveld, Sishen Mine, 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
- Development on the Farm Haakdoringdrift, 373 KQ Portion 3, Thabazimbi, Limpopo Province
- Construction of solar energy facility on Blauwpospan near Groblershoop, Northern Cape.

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