

**PALAEONTOLOGICAL DESKTOP ASSESSMENT FOR THE
PROPOSED EXPLORATION FOR OIL IN THE NANAGA
AREA IN THE ALGOA REGION, SUNDAYS RIVER VALLEY
LOCAL MUNICIPALITY, CACADU DISTRICT
MUNICIPALITY, EASTERN CAPE PROVINCE .**

For:

HIA CONSULTANTS



DATE: 1 June 2015

By

**Gideon Groenewald
0787136377**

EXECUTIVE SUMMARY

Gideon Groenewald was appointed by PGS Heritage to undertake a desktop survey, assessing the potential palaeontological impact of the proposed oil exploration activities in the Sunday's River Local Municipality, Cacadu District Municipality, Eastern Cape Province.

This report forms part of the Basic Environmental Impact Assessment and complies with the requirements of the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 (Heritage Resources Management), a Heritage Impact Assessment (HIA) is required to assess any potential impacts to palaeontological heritage within the development footprint of the development.

The Nanaga Study Area is mainly underlain by Cretaceous to Tertiary and Quaternary aged rocks of the Uitenhage Group and the Algoa Group (Johnson et al, 2009). The very high fossiliferous potential of both the Uitenhage Group and the Algoa Group leads to the allocation of a Very High Palaeontological Sensitivity to the development site.

Recommendations:

1. The EAP as well as the ECO for this project must be made aware of the fact that the Uitenhage Group and the Algoa Group sediments contain significant fossil remains. The Nanaga Formation underlies the larger part of the development site and will be affected by surface infrastructure development. Exploration drilling will however penetrate all the formations of the Uitenhage and Algoa Groups and the recording of micro-fossils during exploration drilling will provide highly significant information on the palaeo-environments of this region.
2. The entire development site is allocated a Very High Palaeontological Sensitivity and specifically where deep excavation (1.5m and more) is envisaged (following the geotechnical investigation), or where fossils are recorded during the geotechnical investigations, or with the recording of micro-fossils during exploration drilling, a qualified palaeontologist must be appointed to assess and record fossils at specific footprints of infrastructure developments and during drilling phases (Phase 1 and Phase 2 PIA's). This will also specifically refer to the recording of micro-fossils from drilling cores and chips during exploration for petroleum products.
3. These recommendations should form part of the EMP of the project.

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2. INTRODUCTION

2.1. Background

Gideon Groenewald was appointed by PGS Heritage to undertake a desktop survey, assessing the potential palaeontological impact of the proposed oil exploration activities in the Sunday's River Local Municipality, Cacadu District Municipality, Eastern Cape Province.

This report forms part of the Basic Environmental Impact Assessment and complies with the requirements of the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 (Heritage Resources Management), a Heritage Impact Assessment (HIA) is required to assess any potential impacts to palaeontological heritage within the development footprint of the development.

Categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act, and which therefore fall under its protection, include:

- geological sites of scientific or cultural importance;
- objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens;
- objects with the potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage.

2.2. Aims and Methodology

Following the *"SAHRA APM Guidelines: Minimum Standards for the Archaeological & Palaeontological Components of Impact Assessment Reports"* the aims of the palaeontological impact assessment are:

- to identify exposed and subsurface rock formations that are considered to be palaeontologically significant;
- to assess the level of palaeontological significance of these formations;
- to comment on the impact of the development on these exposed and/or potential fossil resources and
- to make recommendations as to how the developer should conserve or mitigate damage to these resources.

In preparing a palaeontological desktop study the potential fossiliferous rock units (groups, formations etc.) represented within the study area are determined from geological maps. The known fossil heritage within each rock unit is inventoried from the published scientific literature and previous palaeontological impact studies in the same region.

The likely impact of the proposed development on local fossil heritage is determined on the basis of the palaeontological sensitivity of the rock units concerned and the nature and scale of the development itself, most notably the extent of fresh bedrock excavation envisaged. The different sensitivity classes used are explained in Table 1.1 below.

Table 1 Palaeontological Sensitivity Analysis Outcome Classification

PALAEONTOLOGICAL SIGNIFICANCE/VULNERABILITY OF ROCK UNITS	
The following colour scheme is proposed for the indication of palaeontological sensitivity classes. This classification of sensitivity is adapted from that of Almond et al 2008.	
RED	Very High Palaeontological sensitivity/vulnerability. Development will most likely have a very significant impact on the Palaeontological Heritage of the region. Very high possibility that significant fossil assemblages will be present in all outcrops of the unit. Appointment of professional palaeontologist, desktop survey, phase I Palaeontological Impact Assessment (PIA) (field survey and recording of fossils) and phase II PIA (rescue of fossils during construction) as well as application for collection and destruction permit compulsory.
ORANGE	High Palaeontological sensitivity/vulnerability. High possibility that significant fossil assemblages will be present in most of the outcrop areas of the unit. Fossils most likely to occur in associated sediments or underlying units, for example in the areas underlain by Transvaal Supergroup dolomite where Cenozoic cave deposits are likely to occur. Appointment of professional palaeontologist, desktop survey and phase I Palaeontological Impact Assessment (field survey and collection of fossils) compulsory. Early application for collection permit recommended. Highly likely that a Phase II PIA will be applicable during the construction phase of projects.
GREEN	Moderate Palaeontological sensitivity/vulnerability. High possibility that fossils will be present in the outcrop areas of the unit or in associated sediments that underlie the unit. For example areas underlain by the Gordonia Formation or undifferentiated soils and alluvium. Fossils described in the literature are visible with the naked eye and development can have a significant impact on the Palaeontological Heritage of the area. Recording of fossils will contribute significantly to the present knowledge of the development of life in the geological record of the region. Appointment of a professional palaeontologist, desktop survey and phase I PIA (ground proofing of desktop survey) recommended.
BLUE	Low Palaeontological sensitivity/vulnerability. Low possibility that fossils that are described in the literature will be visible to the naked eye or be recognized as fossils by untrained persons. Fossils of for example small domal Stromatolites as well as micro-bacteria are associated with these rock units. Fossils of micro-bacteria are extremely important for our understanding of the development of Life, but are only visible under large magnification. Recording of the fossils will contribute significantly to the present knowledge and understanding of the development of Life in the region. Where geological units are allocated a blue colour of significance, and the geological unit is surrounded by highly significant geological units (red or orange coloured units), a palaeontologist must be appointed to do a desktop survey and to make professional recommendations on the impact of development on significant palaeontological finds that might occur in the unit that is allocated a blue colour. An example of this scenario will be where the scale of mapping on the 1:250 000 scale maps excludes small outcrops of highly significant sedimentary rock units occurring in dolerite sill outcrops. Collection of a representative sample of potential fossiliferous material recommended.

GREY	<p>Very Low Palaeontological sensitivity/vulnerability. Very low possibility that significant fossils will be present in the bedrock of these geological units. The rock units are associated with intrusive igneous activities and no life would have been possible during emplacement of the rocks. It is however essential to note that the geological units mapped out on the geological maps are invariably overlain by Cenozoic aged sediments that might contain significant fossil assemblages and archaeological material. Examples of significant finds occur in areas underlain by granite, just to the west of Hoedspruit in the Limpopo Province, where significant assemblages of fossils and clay-pot fragments are associated with large termite mounds. Where geological units are allocated a grey colour of significance, and the geological unit is surrounded by very high and highly significant geological units (red or orange coloured units), a palaeontologist must be appointed to do a desktop survey and to make professional recommendations on the impact of development on significant palaeontological finds that might occur in the unit that is allocated a grey colour. An example of this scenario will be where the scale of mapping on the 1:250 000 scale maps excludes small outcrops of highly significant sedimentary rock units occurring in dolerite sill outcrops. It is important that the report should also refer to archaeological reports and possible descriptions of palaeontological finds in Cenozoic aged surface deposits.</p>
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2.3. Scope and Limitations of the Desktop Study

The study will include: i) an analysis of the area's stratigraphy, age and depositional setting of fossil-bearing units; ii) a review of all relevant palaeontological and geological literature, including geological maps, and previous palaeontological impact reports; iii) data on the proposed development provided by the developer (e.g. location of footprint, depth and volume of bedrock excavation envisaged) and iv) where feasible, location and examination of any fossil collections from the study area (e.g. museums).

The key assumption for this scoping study is that the existing geological maps and datasets used to assess site sensitivity are correct and reliable. However, the geological maps used were not intended for fine scale planning work and are largely based on aerial photographs alone, without ground-truthing. There is also an inadequate database for fossil heritage for much of the RSA, due to the small number of professional palaeontologists carrying out fieldwork in RSA. Most development study areas have never been surveyed by a palaeontologist.

These factors may have a major influence on the assessment of the fossil heritage significance of a given development and without supporting field assessments may lead to either:

- an underestimation of the palaeontological significance of a given study area due to ignorance of significant recorded or unrecorded fossils preserved there, or
- an overestimation of the palaeontological sensitivity of a study area, for example when originally rich fossil assemblages inferred from geological maps have in fact been destroyed by weathering, or are buried beneath a thick mantle of unfossiliferous "drift" (soil, alluvium etc.).

3. DESCRIPTION OF THE PROPOSED DEVELOPMENT

The study area is located on several farms in the region of Algoa Bay, east of the Sunday's River mouth (Figure 2.1).

The proposed project includes the development of local infrastructure to upgrade an existing borehole for the extraction of petroleum products and the upgrading of the existing railway line to transport the petroleum product to Coega Harbour.

The existing borehole (AL1/69) was drilled by SOEKOR and the developer is of the opinion that the borehole needs renewed attention following improved methodologies of extracting petroleum products from underground resources. The borehole is situated in the southern section of the proposed development area (Figure 2.1).



Figure 3.1 Locality of the study area with position of borehole (AL1/69) indicated

4. GEOLOGY

The study area is underlain by Cretaceous aged Sundays River Formation mudstone, Tertiary aged Alexandria Formation calcareous sandstone, conglomerates and coquinite, Tertiary aged Kinkelbos silt sand and calc-tufa and Tertiary to Quaternary aged calcareous sandstone and sandy limestone of the Nanaga Formation, all belonging to the Algoa Group (Figure 3.1). The project aims specifically at the exploration of petroleum products from deep seated formations of the Uitenhage Group. The project will therefore have an impact on geological formations that do not outcrop on site. Micro-fossils associated with deep seated geological formations must therefore be included in this impact assessment.

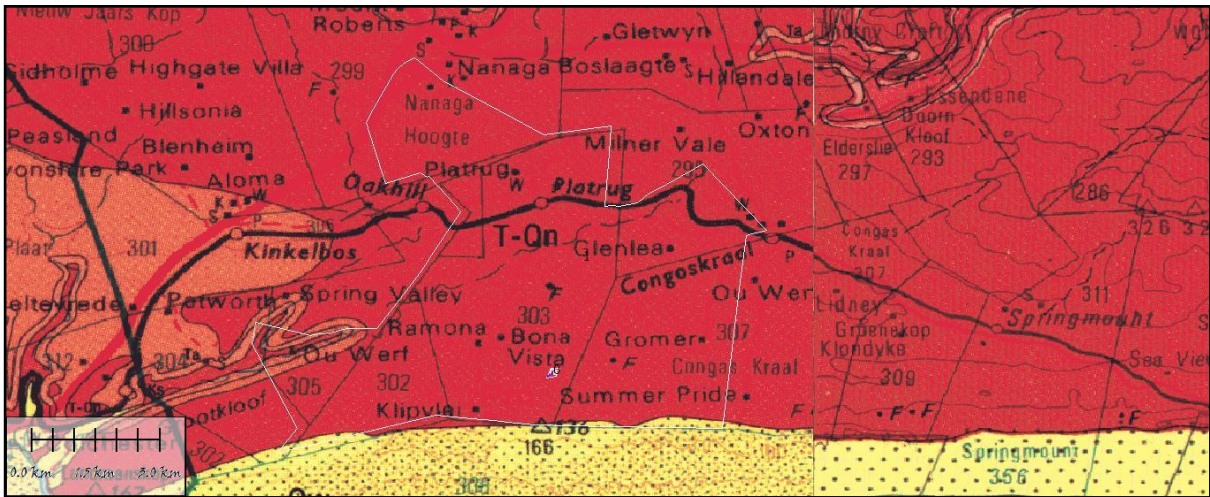


Figure 4.2 Geology of the study area. All the proposed infrastructure will be underlain by the Nanaga Formation (T-Qn).

4.1. Sundays River Formation

The Sundays River Formation consists largely of grey coloured mudstone, siltstone and subordinate sandstone (Johnson et al, 2009).

4.2. Alexandria Formation

The Alexandria Formation is a relatively thin unit of calcareous sandstone, conglomerate and coquinite.

4.3. Kinkelbos Formation

The Kinkelbos Formation consists largely of sand, silt, calc-tufa and minor gravel deposits.

4.4. Nanaga Formation

The Nanaga Formation consists of semi-consolidated to consolidated sandstone and sandy limestone that underlies most of the study area.

5. PALAEOLOGY OF THE STUDY AREA

All the geological formations that underlies the study area, all belonging to the Uitenhage Group and the Algoa Group (Johnson et al, 2009) are highly sensitive for Palaeontological Heritage, and include the remains of rich marine and estuarine invertebrate fauna, including diverse molluscs, plus corals, bryozoans, brachiopods, echinoids, crustaceans, microfossils, sharks' teeth, trace fossils (including human & other mammal tracks) and land snails. Mico-fossils are of critical importance in the identification and aging of petroleum bearing rock strata and the information gathered during the exploration of boreholes for petroleum research must be recorded and reported as part of the project planning. A professional palaeontologist must be appointed to record fossil finds and report these to SAHRA as well as to the Eastern Cape Heritage Authority.

The Sundays River, Alexandria and Kinkelbos Formations have very limited outcrops, with small areas affected in the most eastern part. These formations will however be penetrated during drilling operations and all fossils, including micro-fossils must be recorded during the exploration phase of the project. The nature of the development, namely the extraction of petroleum products from a well system, will not have any impact on areas that are not within the footprint of the well-fields. For

this reason, the Nanaga Formation is the only geological formation that will be affected by infrastructure development on the surface.

5.1. Nanaga Formation

The Nanaga Formation consists mainly of semi consolidated calcareous sandstone with aeolian cross-bedding and, unlike the more productive, fossil rich, underlying Alexandria Formation, relatively few fossils have been recorded from this Formation. Any fossils recorded from the Formation will however provide significant information on the palaeo-environments of the region and must be recorded.

6. PALAEOLOGICAL SENSITIVITY

The likely impact of the proposed development on local fossil heritage is determined on the basis of the palaeontological sensitivity of the rock units concerned and the nature and scale of the development itself, most notably the extent of fresh bedrock excavation envisaged (Figure 5.1). The different sensitivity classes used are explained in Table 1 above.

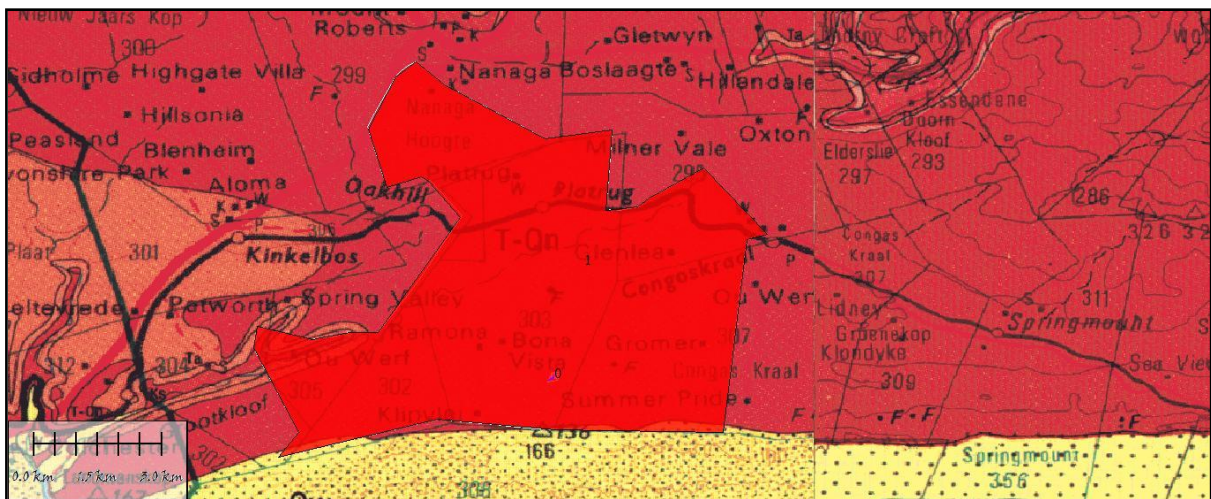


Figure 6.1 Palaeontological Sensitivity of the study area. The entire study area has a Very High Palaeontological Sensitivity (see Table 1).

The entire study area has a Very High Palaeontological Sensitivity and the recording of fossils from the site will significantly improve the interpretation of palaeo-environments from this area.

7. CONCLUSION AND RECOMMENDATIONS

The Nanaga Study Area is mainly underlain by Cretaceous to Tertiary and Quaternary aged rocks of the Uitenhage Group and the Algoa Group (Johnson et al, 2009). The very high fossiliferous potential of both the Uitenhage Group and the Algoa Group leads to the allocation of a Very High Palaeontological Sensitivity to the development site.

Recommendations:

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3. These recommendations should form part of the EMP of the project.

8. REFERENCES

Johnson MR, Anhausser CR and Thomas RJ. 2006. The Geology of South Africa. Geological Society of South Africa.

9. QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

Dr Gideon Groenewald has a PhD in Geology from the University of Port Elizabeth (Nelson Mandela Metropolitan University) (1996) and the National Diploma in Nature Conservation from Technicon RSA (the University of South Africa) (1989). He specialises in research on South African Permian and Triassic sedimentology and macrofossils with an interest in biostratigraphy, and palaeoecological aspects. He has extensive experience in the locating of fossil material in the Karoo Supergroup and has more than 20 years of experience in locating, collecting and curating fossils, including exploration field trips in search of new localities in the southern, western, eastern and north-eastern parts of the country. His publication record includes multiple articles in internationally recognized journals. Dr Groenewald is accredited by the Palaeontological Society of Southern Africa (society member for 25 years).

10. DECLARATION OF INDEPENDENCE

I, Gideon Groenewald, declare that I am an independent specialist consultant and have no financial, personal or other interest in the proposed development, nor the developers or any of their subsidiaries, apart from fair remuneration for work performed in the delivery of palaeontological heritage assessment services. There are no circumstances that compromise the objectivity of my performing such work.

A handwritten signature in dark ink, appearing to read 'G. Groenewald', with a stylized flourish at the end.

Dr Gideon Groenewald
Geologist