# MARITIME HERITAGE IMPACT ASSESSMENT FOR OFFSDHORE EXPLORATION RIGHT APPLICATION FOR BLOCK 3B/4B

(Assessment conducted under Section 38 (8) of theNational Heritage Resources Act as part of an Environmental Impact Assessment)

Prepared for

**Environnemental Impact Management Services**

On behalf of

**Africa Oil SA Corp, Ricocure (Pty) Ltd and Azinam Limited**

Draft for Comment: 15 December 2023


Prepared by

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## EXECUTIVE SUMMARY

TerraMare Archaeology (Pty) Ltd was appointed by Environnemental Impact Management Services, on behalf of Africa Oil SA Corp, Ricocure (Pty) Ltd and Azinam Limited, to undertake a desktop maritime heritage impact assessment to support a Exploration Right application for Block 3B/4B off the south-west coast of South Africa.

Block 3B/4B extends from approximately 120 km west of St Helena Bay to approximately 145 km south-west of Hondeklip Bay. The block covers a total area of approximately 17 581 $km^2$ and is located in in the Exclusive Economic Zone, in water ranging from 200 m – 2000 m in depth.

Prior to exploration drilling, a number of non-intrusive geophysical surveys, involving a combination of multi- and single beam echo sounding and sub-bottom profiling will be undertaken within the block. In addition, pre-drill survey work is also likely to involve the collection of sediment samples in order to characterise the seafloor and for laboratory geochemical analyses. No specific target areas have as yet been identified for the sediment sampling but it is anticipated that up to 20 grab samples, using a combination of piston corers and box grabs could be taken across the block, potentially removing a cumulative volume of ~ 35 $m^3$ of seabed sediment.

The Applicants propose drilling up to five exploration wells within one of the identified areas of interest  within Block 3B/4B. Based on the anticipated sea conditions, either a semi-submersible drilling unit or a drill-ship, both with dynamic positioning systems suitable for expected environment, will be deployed.

The selection of the well locations will be based on a number of factors, including detailed analysis of the seismic and pre-drilling survey data and the geological samples. A Remote Operating Vehicle will be used to finalise the well position based on inter alia the presence of any seafloor obstacles or the presence of any sensitive features that may become evident.

The expected target drilling depth has not yet been confirmed but a notional well depth of 3,570 m below sea floor is assumed at this stage. Once drilling and logging have been completed, the exploration wells will be sealed with cement plugs, tested for integrity, and abandoned according to international best practices. The intention is to remove the wellheads from the sea floor on non-productive wells. On productive wells, it may be decided to abandon the wellheads on the seafloor after installation of over trawlable protective equipment. Except for the over trawlable protective equipment over abandoned wellheads and drilling discharges deposited on the seabed, no further physical remnants of the drilling operation will be left on the seafloor.

This desktop maritime heritage impact assessment provides an assessment of the palaeontological and maritime cultural heritage potential of Block 3B/4B, within a study defined as the extent of the block, buffered by 20 km.

The assessment of the potential for the presence of submerged pre-colonial archaeological material in or on the seabed which ordinarily forms part of a maritime HIA has been excluded from this report because the water depth in Block 3B/4B is too great for pre-colonial archaeological material to be present.

### Findings

The fossils which are known to occur on the continental shelf have mainly been found at middle shelf depths where they come to light during diamond mining and sampling. In contrast, evidence from historical cores and grabs samples collected. In Block 3B/4B indicates that basic composition of the surficial sediments on the shelf and slope within the block is largely composed of the shells of planktonic foraminifera microfossils, generally referred to as “foram ooze”.

These cores illustrate the prime palaeontological value of the species of microfossils deposited in deep-sea environments: dating by the age ranges of species, palaeo-oceanographic information from the water masses they preferentially occupy, and a variety of oceanic parameter proxies from their geochemistry. Other microfossils which are likely to occur are siliceous radiolarians and diatoms, and terrestrial pollen blown out to sea.

Macrofossils such as molluscs are not recorded from these cores, but certainly occur in the deep-sea environment. Notably, molluscs from deep dredging examined by Barnard (1963) comprised a host of new species, mostly small gastropods. This deep-sea fauna remains poorly known. Giant benthic foraminifera may also occur, and vertebrates will mainly be represented by shark and other fish teeth and bones. The remains of marine mammals such as cetaceans and seals are likely to be very sparsely distributed.

According to) the shipwreck database maintained by TerraMare Archaeology and records held by SAHRA and curated on the South African Heritage Resources Information System, there are numerous wrecks recorded between the Saldanha Bay at the southern end of Block 3B/4B and Kreefte Baai at the northern end of the block.

The bulk of these vessels were lost while involved in coastal trade and fishing and most are known to be on or close to the shore along the stretch of coastline landward of Block 3B/4B. These wrecks are well outside of Block 3B/4B and the study area for this assessment and will not interfere with or be impacted by the proposed exploration activities in the block.

The records consulted for this study do contain records of shipping casualties further offshore, in the vicinity of Block 3B/4B, but none of these are within the block. Potentially the closest to the block is the *Kalewa*, a British freighter which sank after a collision with the *Boringia* in August 1942 approximately 300 miles north of Cape Town, placing the wreck just north of Block 3B/4B. There are conflicting records of this loss, however, and there is a suggestion that the vessel may have been lost 300 miles south of Cape Town instead.

German U-boat activity around the South African coats during World War II accounts for many of the deep water wrecks in the shipwreck record, one of which is the *Columbine*, a steamship torpedoed and sunk by U-198 approximately 72 km east of the southern end of Block 3B/4B in June 1944.

Lastly, it must be stated that although unlikely, the possibility does exist for the remains of currently unknown and unrecorded wrecks to be present in Block 3B/4B.

## Conclusions

Based on current understanding, potential impacts associated with the activities proposed in Block 3B/4B are likely to be limited to palaeontological resources.

Overall, the palaeontological sensitivity of marine deposits is <u>high</u> (Almond & Pether, 2009) due to a few, crucial fossil bone finds of high scientific importance that provided the age constraints for the formations. However, there are complications as marine formations usually contain more than one type of fossil of differing importance, *e.g*. common shells and rare bones as discrete objects, and formations entirely composed of fossils, as in biogenic limestones such as the foram-nannofossil formation beneath Block 3B/4B, wherein a small piece contains thousands of microfossils.

The proposed baseline environmental sampling and exploration well drilling activities within Block 3B/4B have a very small footprint in the continental shelf environment and a relatively small subsurface volume of excavation. Due to the small affected volume the impact of the proposed sampling and drilling activities on the palaeontological heritage of the continental shelf deposits may be considered to be negligible or low, at most.

The assessment of maritime heritage resources in and around Block 3B/4B indicates that there are no historical shipwrecks recorded within the block. The nearest recorded wreck, that of the *Kalewa*, appears to be well outside Block 3B/4B, but its position is very approximate and there is a possibility, albeit extremely low, that this wreck could be present within the block.

The possibility also exists that currently unknown historical wrecks or maritime debris are present on the seabed in Block 3B/4B, but this is so low that it can probably be discounted.

There is thus unlikely to be any impact arising from exploration activities on maritime heritage resources within Block 3B/4B and they are scoped out of this impact assessment.

In respect of recommended mitigation measures, it is presumed that the box cores and piston cores will be handed over to consultant marine biologists for analysis for the baseline environmental inventory. This intended analysis for baseline purposes constitutes mitigation.

As mentioned above, the modern deep-sea shell fauna is hardly sampled and poorly known. New samples from any deep-water location have the potential to discover unknown species, or at least add to the very small existing museum collections of specimens. In this respect the concerns of palaeontology and marine biology coincide.

It is expected that the molluscs shells and any other fossil material (fish teeth, otoliths *etc*.) will be sieved out of the retrieved box samples. Fine sieves must be used as some deep-sea molluscs are tiny. It is recommended that all shells and other material of interest must have the details of context recorded and be kept for identification by an appropriate specialist, and ultimately be deposited in a curatorial institution such as the IZIKO Museum. It is also recommended that if possible, core splits, or site duplicate cores, are the subject of a detailed study, such as for a B.Sc. Honours or M.Sc. project.

In respect of well-drilling, the size of typical drill cuttings are in the range of 0.1 mm (100 µm - very fine sand) to 3-4 mm (granules) (Kern *et al*., 2022). Macrofossils are destroyed and not delivered to the “shale shaker” screen and only very small fossils will be enclosed in the coarse cuttings, such as larval mollusc shells, micro-molluscs, barnacle fragments and opercula, polychaete worm mouthparts, tiny fish teeth *etc*. from marine deposits and small aquatic molluscs and plant material from terrestrial deposits. Such will be in the cuttings samples and inform palaeo-environmental interpretations. The palaeontological impact assessment found, therefore, that there is no special requirement for additional observations and a Fossil Finds Procedure at the “shale shaker” on the vessel.

Regarding maritime archaeological resources, should unrecorded wreck material be present in the project area, it may be subject to accidental impact, and it is recommended that:

- The interpretation of any future seabed bathymetric data / review of ROV video footage must include the requirement to flag any shipwreck or related material;
- Any such finds must be reported to SAHRA; and
- Any shipwreck finds must be excluded from areas subject to seabed sampling or well drilling by the implementation of a buffer of at least 50 m around the site or material.

It is our reasoned opinion that the proposed exploration activities in Block 3B/4B are likely to have a very low impact on palaeontological resources, and no impact on maritime archaeological sites and materials.

Provided the recommendations to mitigate and offset potential impacts are implemented, the proposed exploration activities can be considered to be palaeontologically and archaeologically acceptable.

## THE AUTHOR

This study has been undertaken by John Gribble of TerraMare Archaeology (Pty) Ltd.

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John Gribble has an MA (UCT, 1989), in archaeology and has been working in cultural resource management since the early 1990s. He has worked in both the regulatory and commercial heritage management fields: the former during 13 years at the National Monuments Council / South African Heritage Resources Agency (SAHRA), and the latter as both a terrestrial and maritime archaeological consultant in South Africa and the UK.

He holds archaeological accreditation with the Association of Southern African Professional Archaeologists CRM section (Member #43) as follows:

- Principal Investigator: Maritime Archaeology and Colonial Archaeology; and
- Field Director: Stone Age Archaeology.

A signed and certified specialist statement of independence is attached to this report as Appendix 1 and the author's CV is attached as Appendix 2.

## SPECIALIST REPORT REQUIREMENTS IN TERMS OF NEMA

This report is compiled in such a manner that it adheres to the EIA Regulation requirements as detailed in Appendix 6 of the NEMA EIA Regulations of 2014, as amended.

| Section | Requirements | Section addressed in report |
|---|---|---|
| (a) | Details of | |
| | (i) the specialist who prepared the report; and | The Author |
| | (ii) the expertise of that specialist to compile a specialist report including a curriculum vitae; | Appendix C |
| (b) | A declaration that the specialist is independent in a form as may be specified by the competent authority; | Appendix B |
| (c) | An indication of the scope of, and the purpose for which, the report was prepared, the quality and age of base data used for the specialist report and a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change; | Section **Error! Reference source not found.** |
| (d) | The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment; | N/A |
| (e) | A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used; | Section 4 |
| (f) | Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives; | Section 8 |
| (g) | An identification of any areas to be avoided, including buffers (if and where applicable); | Section 9 |
| (h) | A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers (if and where applicable); | Figure 3-5 and 7-8 |
| (i) | A description of any assumptions made and any uncertainties or gaps in knowledge; | Section 3 |
| (j) | A description of the findings and potential implications of such findings on the impact of the proposed activity or activities; | Sections 7-10 |
| (k) | Any mitigation measures for inclusion in the EMPr; | Section 9 |

| | | |
|---|---|---|
| (l) | Any conditions for inclusion in the environmental authorisation; | Section 10 |
| (m) | Any monitoring requirements for inclusion in the EMPr or environmental authorization; | N/A |
| (n) | A reasoned opinion— | |
| | (i) whether the proposed activity, activities or portions thereof should be authorized regarding the acceptability of the proposed activity or activities; and | Section 10 |
| | (ii) if the opinion is that the proposed activity, activities, or portions thereof should be authorised, an avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan; | Section 9 & 10 |
| (o) | A description of any consultation process that was undertaken during the course of preparing the specialist report; | Section 5 |
| (p) | A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and | Section 5 |
| (q) | Any other information requested by the competent authority. | N/A |

## GLOSSARY

| | |
|---|---|
| **Archaeology** | Remains resulting from human activity which are in a state of disuse and are in or on land and which are older than 100 years, including artefacts, human and hominid remains and artificial features and structures. |
| **Baseline** | Information gathered at the beginning of a study which describes the environment prior to development of a project and against which predicted changes (impacts) are measured. |
| **Cumulative Impacts** | Direct and indirect impacts that act together with current or future potential impacts of other activities or proposed activities in the area/region that affect the same resources and/or receptors. |
| **Environmental Authorisation** | Permission granted by the competent authority for the applicant to undertake listed activities in terms of the NEMA EIA Regulations, 2014 (GNR 982, as amended by GNR 326) |
| **Environmental Impact Assessment** | A process of evaluating the environmental and socio-economic consequences of a proposed course of action or project. |
| **Environmental Impact Assessment Report** | The report produced to relay the information gathered and assessments undertaken during the Environmental Impact Assessment. |
| **Environmental Management Programme** | A description of the means (the environmental specification) to achieve environmental objectives and targets during all stages of a specific proposed activity. |
| **Heritage** | That which is inherited and forms part of the National Estate (Historical places, objects, fossils as defined by the National Heritage Resources Act 25 of 1999. |
| **Impact** | A change to the existing environment, either adverse or beneficial, that is directly or indirectly due to the development of the project and its associated activities. |
| **Late Stone Age** | The archaeology of the last 20 000 years associated with fully modern people. |
| **Marine Isotope Stage** | Alternating warm and cool periods in the Earth's paleoclimate, deduced from oxygen isotope data reflecting changes in temperature derived from data from deep sea core samples. |
| **Mitigation measures** | Design or management measures that are intended to minimise or enhance an impact, depending on the desired effect. These measures are ideally incorporated into a design at an early stage. |

**Quaternary** The current and most recent of the three periods of the Cenozoic Era spanning the period from ± 2.5 million years ago to the present.

**Scoping** A procedure to consult with stakeholders to determine issues and concerns and for determining the extent of and approach to an EIA and EMPr (one of the phases in an EIA and EMPr). This process results in the development of a scope of work for the EIA, EMPr and specialist studies.

**Specialist study** A study into a particular aspect of the environment, undertaken by an expert in that discipline.

**Stakeholders** All parties affected by and/or able to influence a project, often those in a position of authority and/or representing others.

## ACRONYMS

| Abbreviation | Explanation |
|---|---|
| **AOI** | Areas of Interest |
| **BOP** | Blow-out Preventor |
| **DFFE** | Department of Forestry, Fisheries, and the Environment |
| **EA** | Environmental Authorisation |
| **EAP** | Environmental Assessment Practitioner |
| **EEZ** | Exclusive Economic Zone |
| **EIA** | Environmental Impact Assessment |
| **EIMS** | Environmental Impact Management Services (Pty) Ltd |
| **HIA** | Heritage Impact Assessment |
| **I&APs** | Interested and Affected Parties |
| **ka** | Thousand years |
| **Ma** | Million years ago |
| **MIS** | Marine Isotope Stage |
| **NEMA** | National Environmental Management Act |
| **NHRA** | National Heritage Resources Act |
| **ROV** | Remotely Operated Vehicle |
| **SAHRIS** | South African Heritage Resources Information System |
| **SAHRA** | South African Heritage Resources Agency |
| **UNESCO** | United Nations Educational, Scientific and Cultural Organization |

## Table of Contents

## 1 INTRODUCTION AND PROJECT DESCRIPTION

Africa Oil SA Corp, Ricocure (Pty) Ltd and Azinam Limited (a wholly owned subsidiary of Eco Atlantic) (hereafter jointly referred to as the Applicants) are applying for an Exploration Right in Block 3B/4B, and have appointed Environmental Impact Management Services (Pty) Ltd (EIMS) as the Environmental Assessment Practitioner (EAP) to undertake the required authorisation processes and to compile and submit the required documentation in support of an application for an Environmental Authorisation (EA), in accordance with the National Environmental Management Act (Act No. 107 of 1998) (NEMA).

Block 3B/4B extends from approximately 120 km west of St Helena Bay to approximately 145 km south-west of Hondeklip Bay off the West Coast of South Africa. The block covers a total area of approximately 17 581 km$^2$ and is located in in the Exclusive Economic Zone (EEZ), in water ranging from 200 m – 2000 m in depth (Figure 1).

The Applicants have identified two areas of interest (AOI) for exploration within Block 3B/4B. The primary AOI, ~1637 km$^2$ in extent, is located in the northern portion of the licence area in water depths between 1 000 m and 3 000 m. A second AOI lies near the centre of the block and extends over an area of ~3069 km$^2$ (Figure 1).

The project description below, as relevant to heritage resources, is summarised from the Scoping Report for the project.

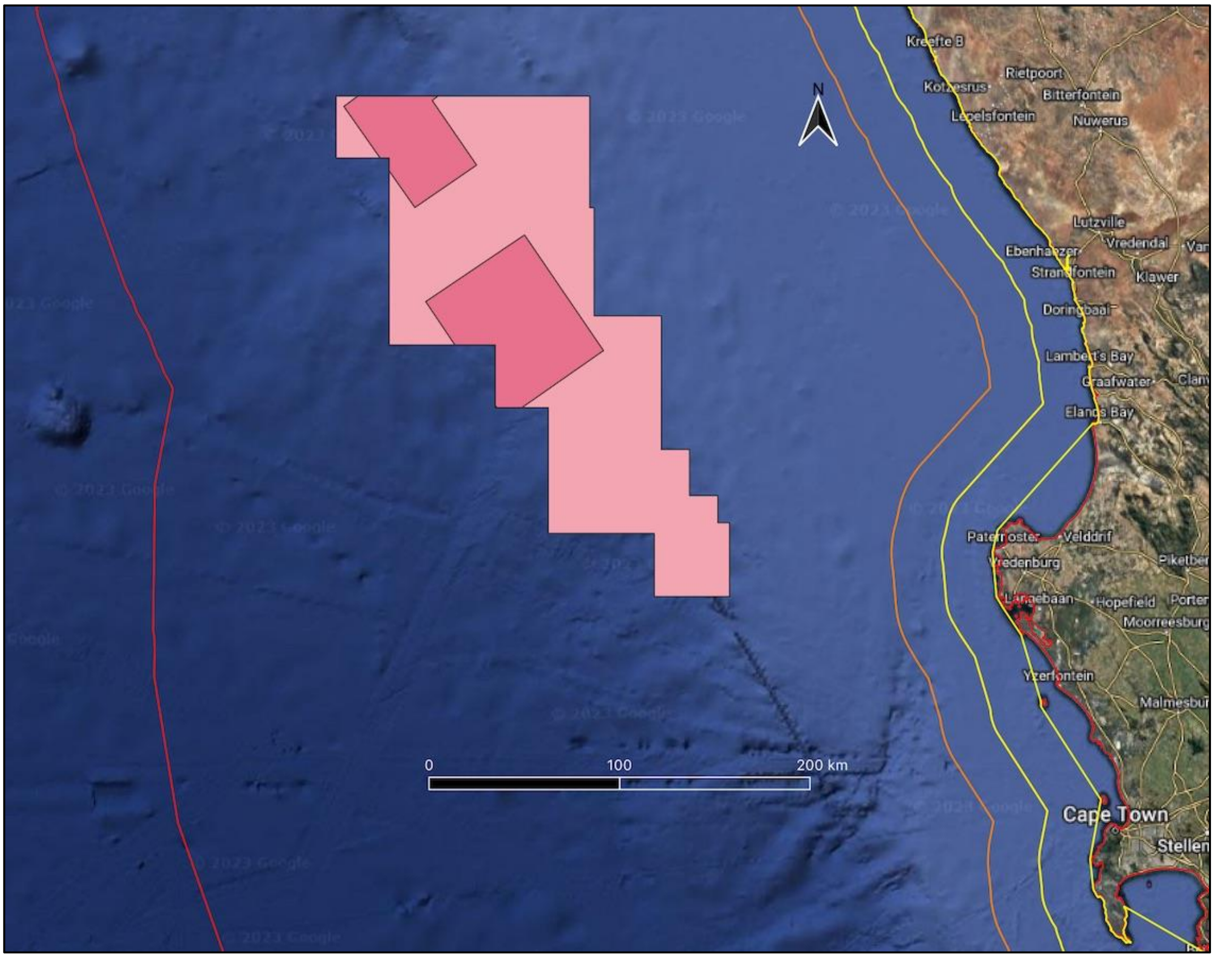


*Figure 1: Location and extent of Block 3B/4B (pale pink polygon) with the exploration areas of interest shown within it (dark pink polygons). The South African EEZ lies between the orange and red lines. The territorial waters are lie between the two yellow lines and the contiguous zone between the outer yellow and orange line (Source:*

*Google Earth).*

## 1.1 Pre-drill Surveys

Prior to exploration drilling, a number of non-intrusive geophysical surveys will be undertaken to develop digital terrain models of the seafloor and models of the sub-surface sediments within the AOIs. The objective of these surveys is to confirm baseline conditions at the proposed drill sites and to identify and delineate any seabed and sub-seabed geo-hazards that may impact the proposed exploration drilling operations.

The surveys are likely to involve a combination of multi- and single beam echo sounding and sub-bottom profiling. They will be of short duration, will cover a survey area of approximately 150 $km^2$ focussed on selected areas of interest within the block and will have no physical impact on the seabed or heritage resources in or on the seabed.

In addition to the geophysical surveys, pre-drill survey work is also likely to involve the collection of sediment samples in order to characterise the seafloor and for laboratory geochemical analyses in order to determine if there is any naturally occurring hydrocarbon seepage at the seabed or any other type of contamination, prior to the commencement of drilling.

No specific target areas have as yet been identified for the sediment sampling but it is anticipated that up to 20 grab samples could be taken across the entire area of interest, potentially removing a cumulative volume of ~ 35 $m^3$ of seabed sediment.

Two principal sampling techniques may be used, namely piston and box coring.

Piston coring is one of the more common methods used to collect seabed geochemical samples and is generally used in areas with soft sediment. A piston corer uses gravity to penetrate the seabed and consists of a weighted pipe that is allowed to free fall to the seabed. When the corer hits the bottom, a piston mechanism that is triggered which aids in the gravity-based penetration of the seabed (see Plate 1). Piston corer barrels are generally 6 - 9 m in lengths with a diameter of 10 cm.

Like piston corers, box corers are lowered vertically to the seabed from a survey vessel but collect larger, although shallower box-shaped sediment samples than piston corers. The recovered sample is completely enclosed which reduces the loss of finer materials during recovery (see Plate 1).

On recovery, the sample can be processed directly through the large access doors or via complete removal of the box and its associated cutting blade. The box corers being considered for this project will recover 50 cm x 50 cm core samples at a depth of less than 60 cm below the seabed surface.

As indicated above, both types of recovered cores will be visually examined at the surface for indications of hydrocarbons (gas hydrate, gas parting or oil staining) and sub-samples will be retained for further geochemical analysis in an onshore laboratory.

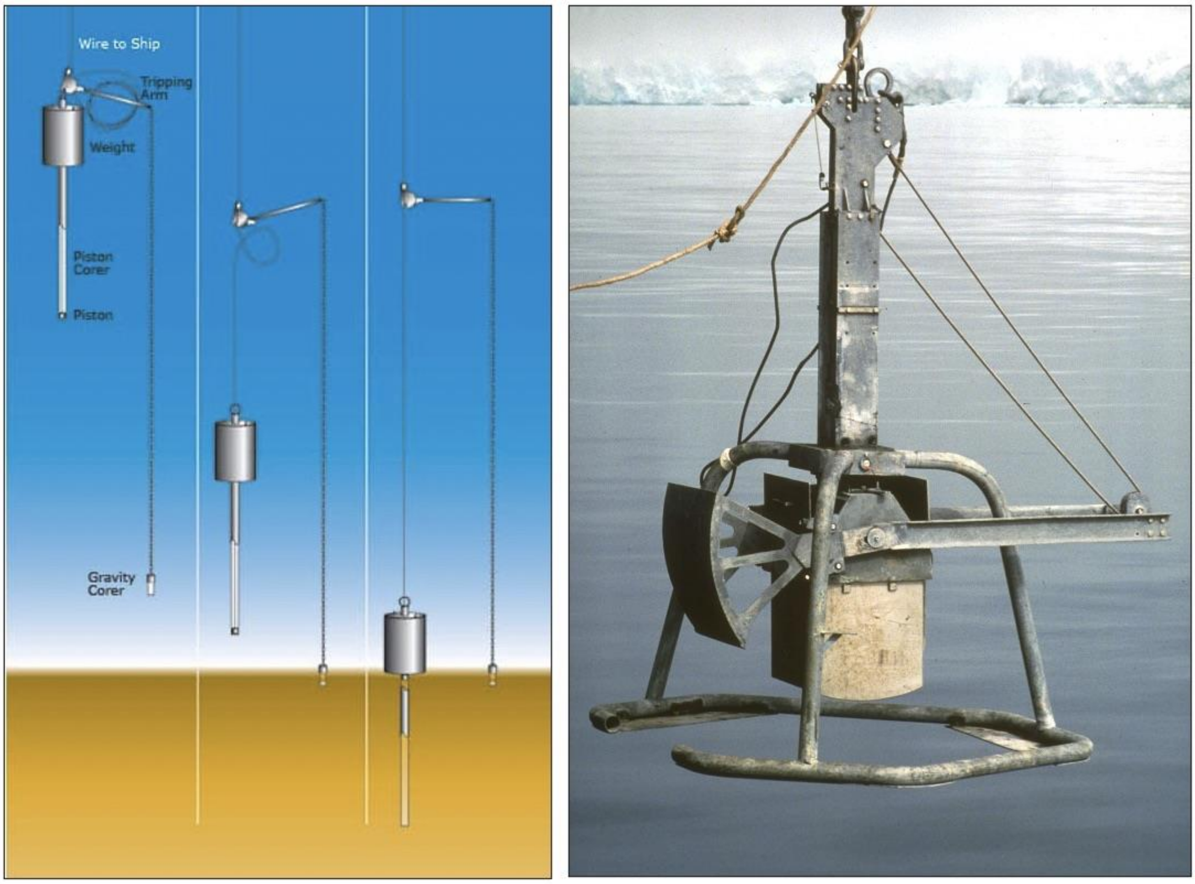


*Plate 1: Piston corer operation (left) and example of a box corer (right) (Sources: https://www.whoi.edu/ (left) and https://en.wikipedia.org/wiki/Box_corer#/media/File:Giant-box-corer_hg.jpg (right)).*

## 1.2 Well Drilling

The Applicants propose drilling up to five exploration wells within one of the identified AOIs within Block 3B/4B.

A number of types of drilling technology can be used to drill an exploration well, depending on, inter alia, the water depth and marine operating conditions experienced at the well site. Based on the anticipated sea conditions, the Applicants propose utilising either a semi-submersible drilling unit or a drill-ship, both with dynamic positioning systems suitable for expected environment.

A semi-submersible drilling unit (Plate 2) is essentially a drilling rig located on a floating structure of pontoons. When at the well location, the pontoons are partially flooded (or ballasted) with seawater and submerged to a pre-determined depth below the sea level where wave motion is minimised. This gives stability to the drilling platform, thereby facilitating drilling operations.

A drill-ship (Plate 2) is a purpose built vessel designed to operate in deep water conditions. The drilling "rig" is normally located towards the centre of the ship with support operations from both sides of the ship using fixed cranes. The advantages of a drill-ship over the majority of semi-submersible units are that a drill-ship has much greater storage capacity and is independently mobile, not requiring any towing and reduced requirement of supply vessels.

The final rig selection will be made depending upon availability and final design specifications.

*Plate 2: Example of a drill rig, the Noble Globetrotter II (left) and of a semi-submersible, the Deepwater Nautilus, being transported on a heavy-lift ship.*

The selection of the well locations will be based on a number of factors, including detailed analysis of the seismic and pre-drilling survey data and the geological samples. A Remote Operating Vehicle (ROV) will be used to finalise the well position based on inter alia the presence of any seafloor obstacles or the presence of any sensitive features that may become evident.

### *1.2.1 Well Drilling Operation*

A well will be created by drilling a hole into the seafloor with a drill bit attached to a rotating drill string, which crushes the rock into small particles or “cuttings”. After the hole is drilled, casings (sections of steel pipe), each slightly smaller in diameter, are placed in the hole and permanently cemented in place. The hole diameter therefore decreases with increasing depth.

Drilling is undertaken in two stages: namely an initial riserless stage and a risered stage deeper in the well (Plate 3).

The initial, riserless section of a well is often in soft sediments just below the seafloor and to keep the well from caving in and to allow it to carry the weight of the wellhead, a 30-inch (71 cm) or 36 inch (99 cm) diameter structural conductor pipe is first drilled and cemented into place.

When the conductor pipe and low-pressure wellhead are at the correct depth, approximately 70 m deep depending upon substrate strength, a new drilling assembly will be run inside the structural conductor pipe and the next hole section will be drilled by rotating the drill string and drill bit. Below the conductor pipe, the well will have a diameter of approximately 26 inches (66 cm).

At a planned depth the drilling is halted and the bit and drill string is withdrawn from the hole. A surface casing of 20-inch (51 cm) diameter is then placed into the well and cemented in place. The high-pressure wellhead for the remainder of the drilling process will be installed on the top of this 20-inch casing, which is also the connection point to the Blow-out Preventor (BOP).

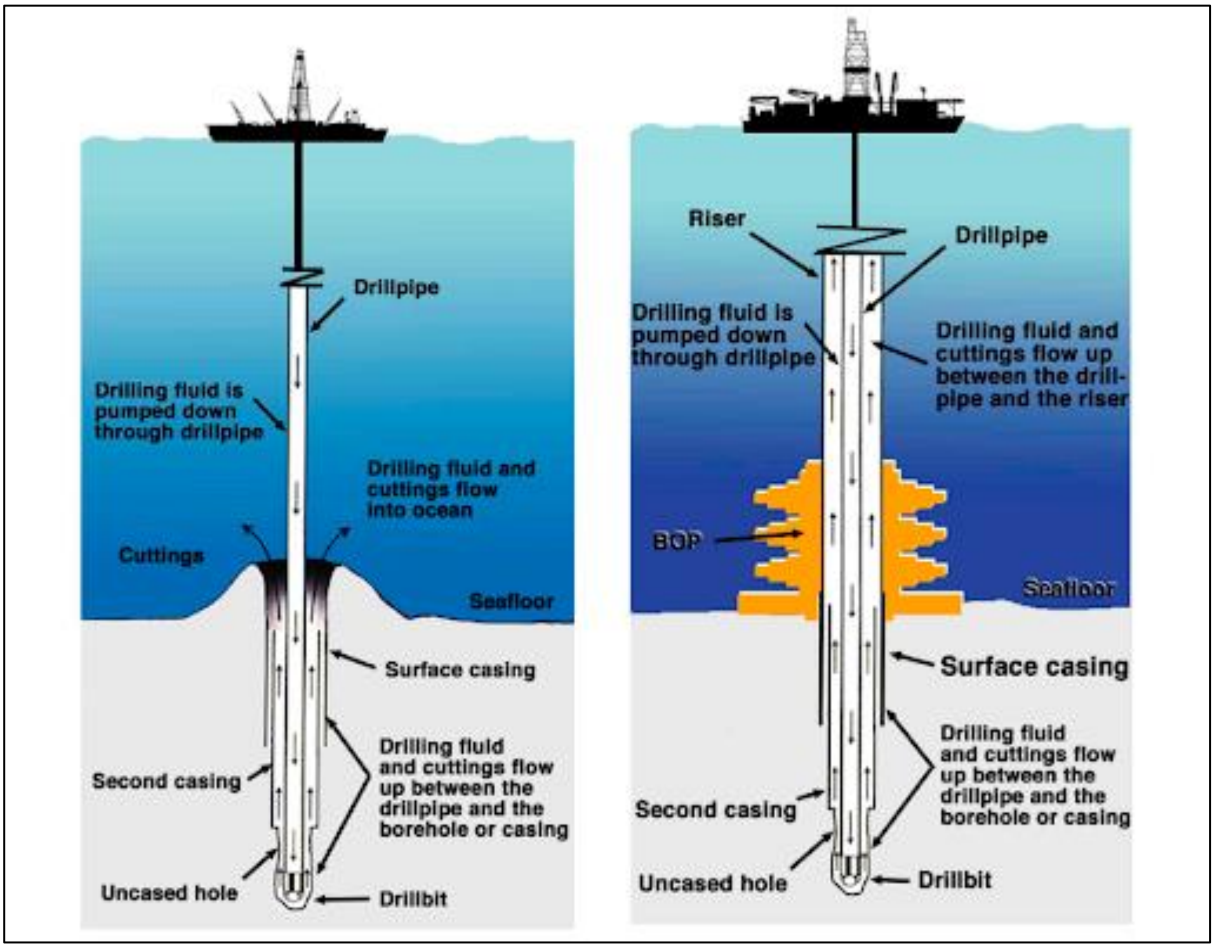


*Plate 3: Drilling stages: (a) Riserless Drilling Stage; and (b) Risered Drilling Stage.*

The risered drilling stage commences with the lowering of a BOP and installing it on the wellhead. The BOP is designed to seal the well and prevent any uncontrolled release of fluids from the well (a ‘blow-out’). A lower marine riser package is installed on top of the BOP and the entire unit is lowered on riser joints. The riser isolates the drilling fluid and cuttings from the external environment, thereby creating a “closed loop system”.

Drilling is continued by lowering the drill string through the riser, BOP and casing, and rotating the drill string. The hole diameter decreases in steps with depth as progressively smaller diameter casings are inserted into the hole at various stages and cemented into place.

The expected target drilling depth has not yet been confirmed but a notional well depth of 3,570 m below sea floor is assumed at this stage with a final hole diameter between of 8.5 (21 cm) and 12.25 inches (31 cm).

It is expected that it will take approximately three to four months to complete the physical drilling and testing of each well (excluding mobilisation and demobilisation).

Once drilling and logging have been completed, the exploration wells will be sealed with cement plugs, tested for integrity, and abandoned according to international best practices.

The intention is to remove the wellheads from the sea floor on non-productive wells. On productive wells, it may be decided to abandon the wellheads on the seafloor after installation of over trawlable protective equipment. Except for the over trawlable protective equipment over abandoned wellheads and drilling discharges deposited on the seabed, no further physical remnants of the drilling operation will be left on the seafloor.

# 2 TERMS OF REFERENCE

A Background Information Document and Scoping Report were submitted to the South African Heritage Resources Agency (SAHRA) for comment in June 2023 (SAHRIS Case 21617).

SAHRA's interim comment, dated 20 September 2023, stated that they required a maritime heritage impact assessment (HIA), to be conducted by a qualified maritime archaeologist. In addition, they requested a desktop "Palaeontological Study with a Fossil Chance Finds procedure [to] be drafted by a suitably qualified palaeontologist familiar with [the] continental shelf that must be used in the event that some fossiliferous rocks and fossils are identified".

Following correspondence between the EAP and SAHRA a further interim comment was issued by the latter on 1 December 2023 in which they reiterated their requirement that a "desktop study on potential tangible heritage that may occur must be undertaken as part of the EA application process. A maritime archaeologist must be appointed to undertake such a study and an assessment of known maritime heritage in the exploration area and what might occur along with management measures for such an event occurring. A palaeontologist must be appointed to assess [the] potential fossiliferous nature of the seabed geology and provide management measures for potential impacts".

SAHRA latterly also requested an assessment of intangible heritage in the form of the cultural heritage impact assessment be submitted along with the draft EIA report.

TerraMare Archaeology has been appointed to undertake the maritime HIA to inform the Environmental Impact Assessment (EIA) process.

Please note that this maritime HIA deals with tangible heritage only and is wholly separate from the requested Cultural Heritage Impact Assessment which is being undertaken by another specialist.

This HIA provides an assessment of the sensitivity and significance of the palaeontological potential of Block 3B/4B and a review of any recorded maritime casualties within Block 3B/4B and its vicinity. It evaluates the potential direct impacts on these resources arising from activities such as seabed sediment sampling and well drilling, potential indirect impacts from the dispersal of drill cuttings or oil spills, and makes recommendations for measures to mitigate the negative impacts of both planned and unplanned activities on palaeontological and maritime archaeological resources.

The assessment of the potential for the presence of submerged pre-colonial archaeological material in or on the seabed which ordinarily forms part of a maritime HIA has been excluded from this report because the water depth in Block 3B/4B is too great for pre-colonial archaeological material to be present.

This report meets the requirement of the SAHRA set out in their interim comments referred to above. The HIA will meet the requirements of SAHRA's minimum standards for HIAs and Appendix 6 of the EIA Regulations (2014 as amended).

This HIA must be submitted to SAHRA for their comment.

# 3 ASSUMPTIONS AND LIMITATIONS

The study is based on several assumptions and is subject to certain limitations, which should be borne in mind when considering information presented in this report. The validity of the findings of the study is not expected to be affected by these assumptions and limitations:

- South Africa's record of maritime and underwater cultural heritage resources is based on a mix of information derived in the main from historical documents and other secondary sources. Information from primary sources such as geophysical data and other field-based observations and site recordings is very limited and comprises only a small fraction of the available data.
- While every effort has been made to ensure the accuracy of the information presented in this report, the reliance on secondary data sources means that there are gaps and inaccuracies in this record and the locations of most of the wrecks referred to in the following sections are approximate. The potential also exists for currently unknown and/or unrecorded maritime heritage sites to be encountered Block 3B/4B in the course of exploration activities.
- In respect of palaeontology it has been assumed that the fossil potential of a formation in a study area will be typical of that found in the region and more specifically, similar to that already observed in the study area. A limitation on predictive capacity exists in that it is not possible to predict the fossil content of an area or formation other than in such general terms.

Any other assumptions made in the report are explicitly stated in the relevant sections.

# 4 METHODOLOGY

This HIA is an entirely desk-based assessment of the palaeontological and maritime and underwater cultural heritage potential of Block 3B/4B, within the study area defined in Section 4.1 below.

The baseline heritage resource assessment comprises descriptions of the known palaeontology of the continental shelf edge on the West Coast, the extent of South Africa's maritime and underwater cultural heritage and the maritime history of West Coast, and a discussion of the potential for both palaeontological and maritime heritage resources in Block 3B/4B within that wider context.

The HIA draws information from readily available documentary sources and databases, including SAHRA's Maritime and Underwater Cultural Heritage database, a database of underwater heritage resources maintained by TerraMare Archaeology, and from relevant primary and secondary sources and aims to identify as accurately as possible the maritime heritage resources within Block 3B/4B.

In respect of palaeontology, exploration for fossil fuels has been the main driver for determining the large-scale litho-, bio- and chrono-stratigraphy of continental shelves to depth. The palaeontology (fossil life forms and their evolution) of a variety of microscopic remains of both marine and terrestrial animals and plants provide the means to divide up long cores through kilometres of the offshore sediment pile into formations of different origins and ages. Mapping of the shelf bathymetry and the nature of seabed sediments in increasing detail is an ongoing endeavour, for both ecological and mineral resource purposes.

Sediment bodies on the shelf have been cored to access their sea-level change and palaeoclimatic records. This has generated a considerable marine geological literature by the collaborative efforts of scientists in employ of companies, the state and in academia. The contributions relevant to this assessment are cited in the normal manner as references in the text and are included in the References in Section 11.

An assessment of the potential impacts of the proposed prospecting on palaeontological and maritime and underwater cultural heritage resources is provided and this is supported by recommendations for measures to mitigate possible impacts arising from exploration activities in Block 3B/4B.

## 4.1 Study Area

The study area for this HIA is defined by the extents of Block 3B/4B and a buffer of 20 km that has been placed around it (Figure 2).

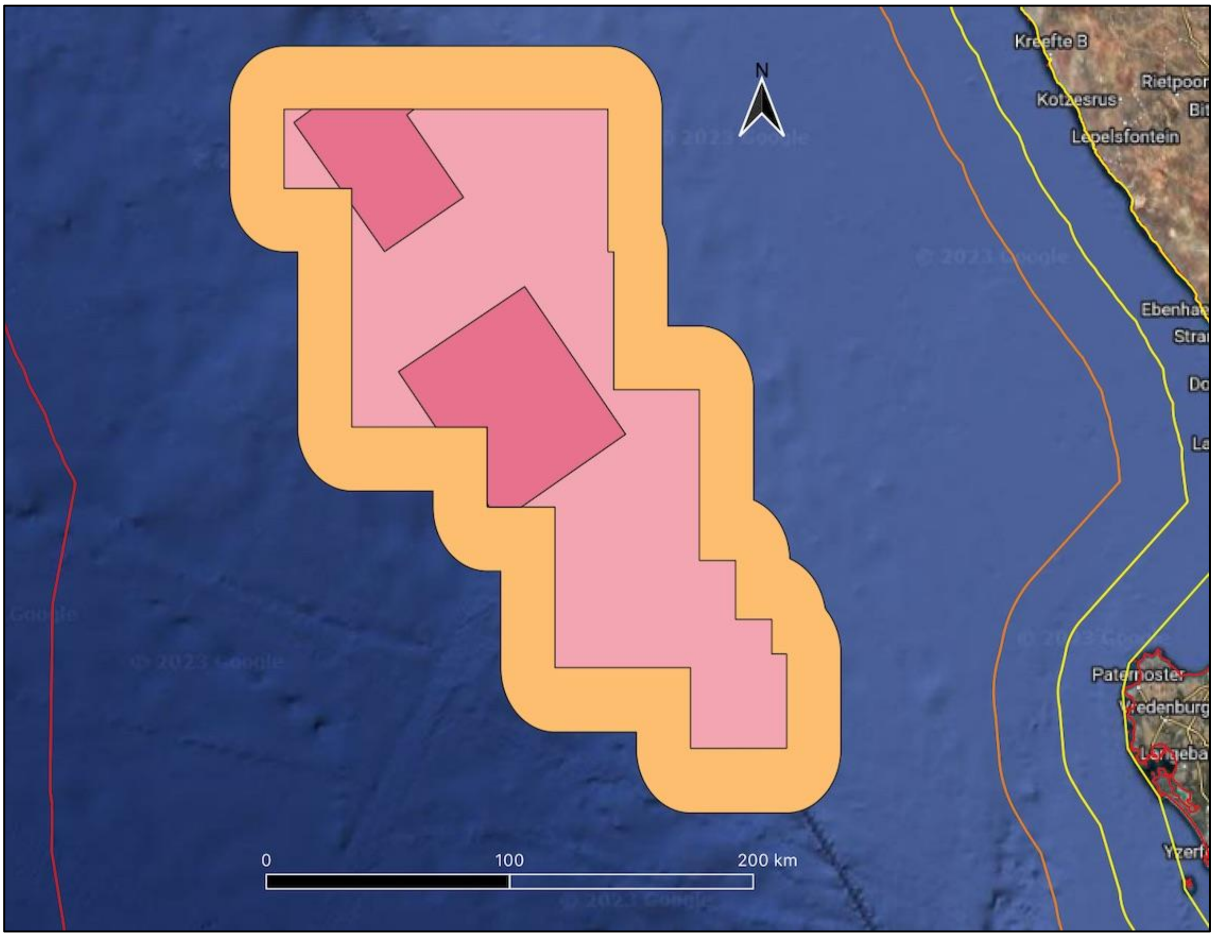


*Figure 2: Block 3B/4B (pale pink polygon) with a 20 km buffer (orange polygon) which together comprise the study area for this HIA (Source: Google Earth).*

## 4.2 Impact Assessment

Potential impacts of the proposed exploration were identified based on the baseline data, project description, review of other studies for similar projects and professional experience.

The significance of the impacts was assessed using the EIMS methodology used in the scoping assessment (see Section 8.1).

Practical mitigation and optimisation measures that can be implemented effectively to reduce or enhance the significance of impacts were identified. The impact significance was re-rated assuming the effective implementation of mitigation measures.

# 5 STAKEHOLDER CONSULTATION

A stakeholder consultation process was undertaken during August and September 2023 as part of the Scoping phase of the project in terms of the 2014 EIA Regulations, as amended.

According to the Comments and Responses Register from that process, comments related to tangible heritage were received only from SAHRA in the form of the tow interim comments referred to above. The remainder of heritage-related comments received addressed intangible cultural heritage and the CHIA report and process.

SAHRA commented on the Draft Scoping Report and indicated that a specific maritime HIA, undertaken by a suitably qualified maritime archaeologist, would be required as part of the EIA. This report fulfils that requirement from SAHRA as one of the commenting authorities on the EIA.

# 6 APPLICABLE LEGISLATION, GUIDELINES AND POLICIES

## 6.1 National Heritage Resources Act (No. 29 of 1999)

The NHRA came into force in April 2000 with the establishment of SAHRA, replacing the National Monuments Act (No. 28 of 1969 as amended) and the National Monuments Council as the national agency responsible for the management of South Africa's cultural heritage resources.

The NHRA reflects the tripartite (national/provincial/local) nature of public administration under the South African Constitution and makes provision for the devolution of cultural heritage management to the appropriate, competent level of government.

Because national government is responsible for the management of the seabed below the mean high water mark, however, the management of maritime and underwater cultural heritage resources under the NHRA does not devolve to provincial or local heritage resources authorities but remains the responsibility of the national agency, SAHRA.

The NHRA gives legal definition to the range and extent of what are considered to be South Africa's heritage resources. According to Section 2(xvi) of the Act a heritage resource is "any place or object of cultural significance". This means that the object or place has aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance.

In terms of the definitions provided in Section 2 of the NHRA, maritime and underwater cultural heritage can include the following sites and/or material relevant to this assessment:

- Material remains of human activity which are in a state of disuse and are in or on land [which includes land under water] and which are older than 100 years, including artefacts, human and hominid remains and artificial features and structures (Section 2(ii));
- Wrecks, being any vessel or aircraft, or any part thereof, which was wrecked in South Africa, whether on land, in the internal waters, the territorial waters or in the maritime

culture zone of the Republic, a defined respectively in sections 3, 4 and 6 of the Maritime Zones Act, 1994 (No. 15 of 1994), and any cargo, debris or artefacts found or associated therewith, which is older than 60 years or which SAHRA considers to be worthy of conservation (Section 2(ii)); and

- Any movable property of cultural significance which may be protected in terms of any provisions of the NHRA, including any archaeological artefact or palaeontological specimen (Section 2(xxix)).

Of the heritage resource types protected by the NHRA, the proposed exploration in Block 3B/4B has the potential to impact the following:

- Palaeontological features and material, which are defined by the NHRA as the fossilised remains or fossil trace of animals or plants which lived in the geological past;
- Maritime and underwater cultural heritage sites and material, which are principally historical shipwrecks; and possibly.

As indicated already, there is no potential for pre-colonial archaeology in Block 3B/4B and it has been scoped out of this assessment.

As per the definitions provided above, these cultural heritage resources are protected by the NHRA and a permit from SAHRA is required to destroy, damage, excavate, alter, deface or otherwise disturb any such site or material.

It is also important to be aware that in terms of Section 35(2) of the NHRA, all archaeological objects and material are the property of the State and must, where recovered from a site, be lodged with an appropriate museum or other public institution.

## 6.2 Maritime Zones Act (No. 15 of 1994)

South Africa's Maritime Zones Act of 1994 is the national legislative embodiment of the international maritime zones set out in the United Nations Convention on the Law of the Sea (UNCLOS). The Act defines the extent of the territorial waters, contiguous zone (also known as the maritime cultural zone), EEZ and continental shelf (which together comprises of some 4.34 million square kilometres of seabed) and sets out South Africa's rights and responsibilities in respect of these various maritime zones.

Under the terms of Sections 4(2) and 6(2) of the Maritime Zones Act respectively, "any law in force in the Republic, including the common law, shall also apply in its territorial waters" and "subject to any other law the Republic shall have, in respect of objects of an archaeological or historical nature found in the maritime cultural zone, the same rights and powers as it has in respect of its territorial waters". The NHRA applies, therefore, within South Africa's territorial waters (12 nautical miles seaward of the baseline) and to the outer limit of the maritime cultural zone / contiguous zone (24 nautical miles seaward of the baseline) (see Figure 1).

Any offshore activity that has the potential to disturb or damage cultural heritage resources located in or on the seabed within the territorial waters and maritime cultural zone requires the involvement of SAHRA, as a commenting body in respect of the NEMA environmental assessment process (see below) and as permitting authority where impacts to sites or material cannot be avoided and damage or destruction will occur.

Block 3B/4B lies outside both the territorial waters and contiguous zone in the EEZ and thus falls outside the direct application of the NHRA. However, Section 9 of the Maritime Zones Act states that activities undertaken from installations operating within the EEZ may be subject to the requirements of any law in force in the Republic. Included in the definition of "installation" set out in Section 1(ii) of the Act, is "any exploration or production platform used in prospecting for or the mining of any substance" (S1(ii)(b)).

In terms of the Maritime Zones Act, therefore, the NHRA will apply to exploration activities carried out within Block 3B/4B.

## 6.3 National Environmental Management Act (No. 107 of 1998)

The NEMA provides a framework for the integration of environmental issues into the planning, design, decision-making and implementation of plans and development proposals that are likely to have a negative effect on the environment.

Regulations governing the environmental authorisation process have been promulgated in terms of NEMA and include the EIA Regulations (GNR 982 of 2014) and Listing Notices (LN) 1-3 (GNR 983, GNR 984 and GNR 985)[1] that list activities requiring an EA.

The proposed exploration activities in Block 3B/4B trigger activities listed in terms of LN 1 and LN 2 of the EIA Regulations, 2014, requiring an EIA.

The EIA process aims to identify and assess all potential environmental impacts (negative and positive) and the EIA/Environmental Management Programme (EMPr) report should recommend how potential negative impacts can be effectively mitigated and how benefits can be enhanced

## 6.4 Guidelines

If the scope of a development triggers the National Environmental Management Act (No. 107 of 1998) (NEMA) or the Minerals and Petroleum Resources Development Act (MPRDA) (No. 28 of 2002) then a HIA will form part of the specialist reports in the EA application process required in terms of the NEMA and the NEMA EIA Regulations, (2014 and 2017 as amended).

In terms of the NEMA regulations, every EA application should be accompanied by a HIA, which has been produced by (an) appropriate independent heritage specialist(s) and "must identify, assess and record current conditions and locations of all heritage resources in the area proposed for development and impact zone, the impact of the development on the identified heritage resources or landscapes and make recommendations for protection or mitigation to reduce the impact on the resources".

The *Minimum Standards for Heritage Specialist Studies in terms of Section 38 of the National Heritage Resources Act (No. 25 of 1999) (NHRA)* published by SAHRA are the relevant guidelines which govern the form and content of this HIA (see https://www.sahra.org.za/Wordpress/wp-content/uploads/2020/01/Minimum_Standards_for_Heritage_reports_For_Public_Review.pdf). Part II of that document sets out the minimum standards for and stipulates the information required by SAHRA to be included in a HIA. This includes:

[1] As amended by GNR 324, GNR 325, GNR 326 and GNR 327 of 2017, and GNR 517 of 2021.

- A declaration of independence and the CV(s) of the heritage specialist(s);
- An introduction and terms of reference for the assessment;
- A description of the proposed project;
- A description of the legislative framework governing the project and heritage resources;
- A statement of the assessment methodology used, including information about any assumptions, gaps, restrictions and limitations;
- A description of the heritage resources within the project area;
- An assessment of potential impacts and risks to heritage resources arising from the project; and
- Conclusions and recommendation with regard to measures to mitigate any impacts.

This report includes all of the above and thus meets the requirements set out in the SAHRA *Minimum Standards*.

# 7 BASELINE DESCRIPTION

South Africa has a rich and diverse underwater cultural heritage. Strategically located on the historical trade route between Europe and the East, South Africa's rugged and dangerous coastline has witnessed more than its fair share of shipwrecks and maritime dramas in the last 500 years. According to SAHRA's records, at least 2,800 vessels are known to have sunk, grounded, or been wrecked, abandoned or scuttled in South African waters since the early 1500s.

This does not include the as yet unproven potential for shipwrecks and other sites that relate to pre-European, Indian Ocean maritime exploration, trade and interactions along the South African east coast, or the potential for wrecks of vessels which simply disappeared between Europe and the East to be present in our waters.

Although not applicable to Block 3B/4B, our coastal maritime heritage also includes a largely unexplored, but increasingly acknowledged submerged prehistoric element, consisting of prehistoric terrestrial archaeological sites and palaeolandscapes which are now inundated by the sea.

This assessment considers the potential for palaeontological resources and historical shipwrecks in Block 3B/4B.

## 7.1 Geological Setting

The basic composition of the surficial sediments on the shelf and slope (Figure 3) shows that the seabed of the AOIs is largely composed of the shells of planktonic foraminifera microfossils, generally referred to as "foram ooze".

The wider context in terms of shelf edge processes (Figure 4) shows the AOIs situated along the fissured zone of upper slope collapse, with large-scale downslope slumping and sliding and accumulation of turbidite lobes forming the continental rise. The latest slumping appears to be of early Quaternary age. Seismic profiles reveal preceding slumping along the palaeo-shelve edges of early and late Upper Cretaceous ages and of Palaeogene age (Dingle, 1980).

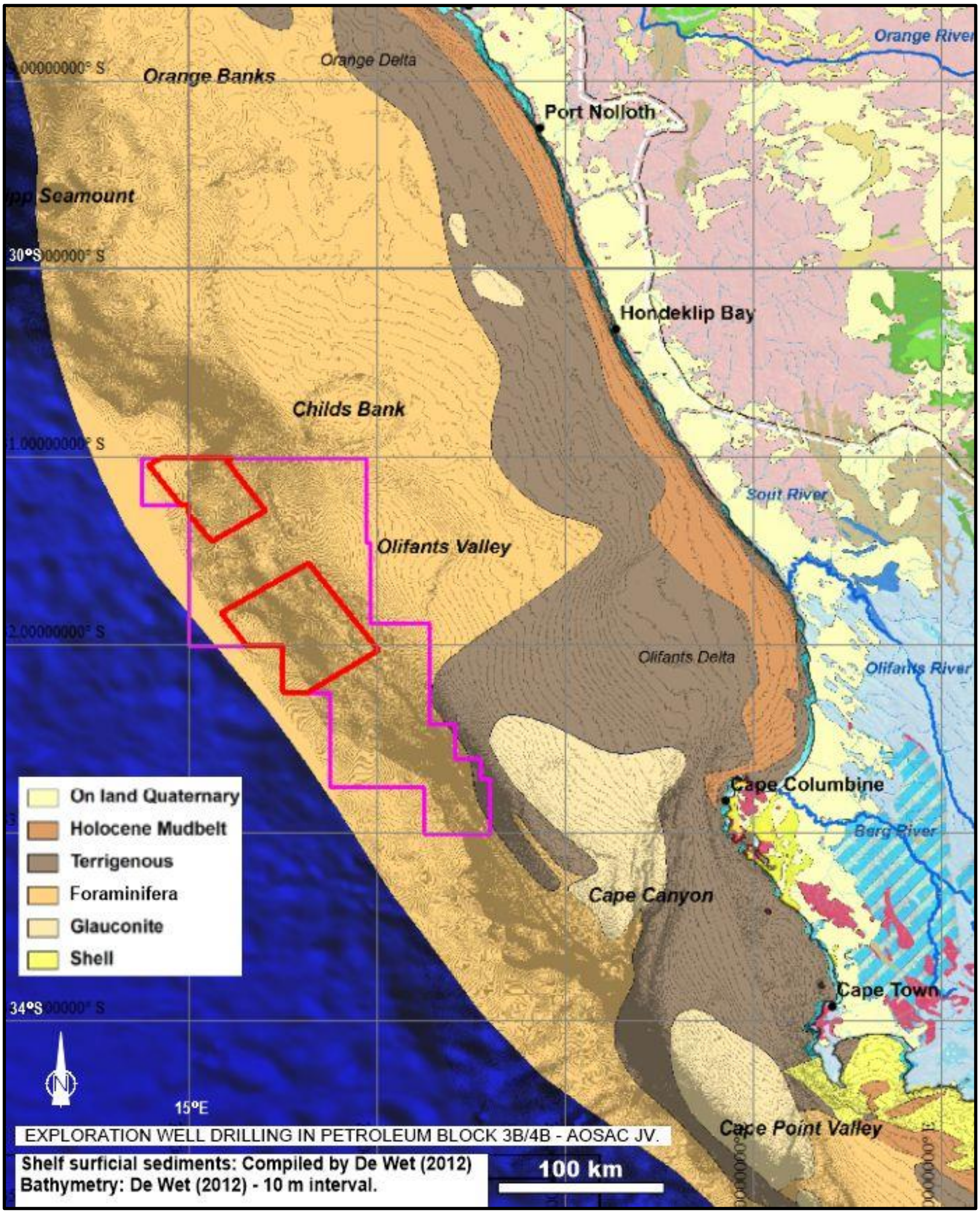


*Figure 3: Shaded bathymetry and shelf sediment cover. Block 3B/4B and the AOIs are the pink and red coloured polygons respectively (After De Wet, 2012).*

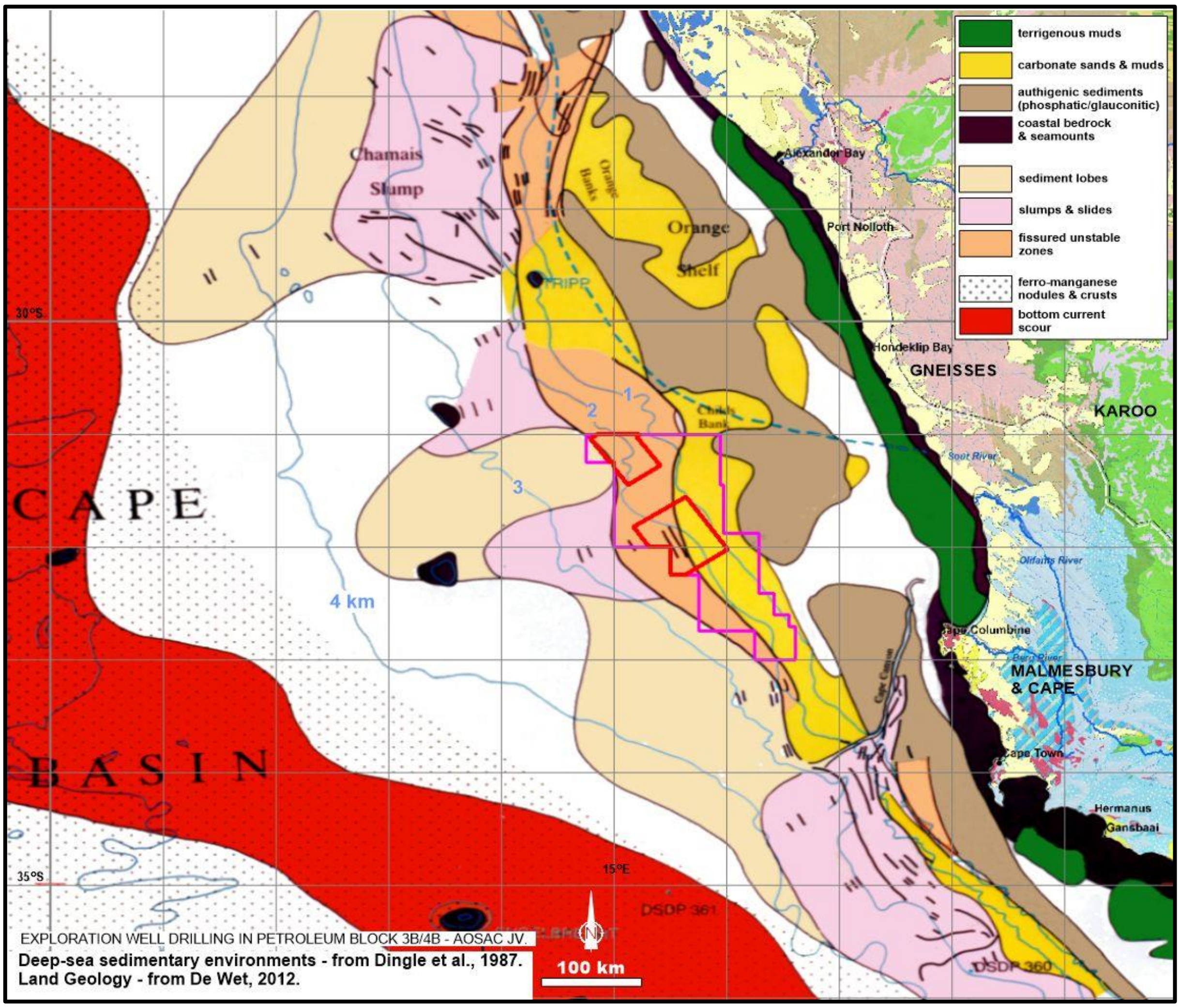


*Figure 4: Slumps, slides and turbidite fans on the West Coast margin Block 3B/4B and the AOIs are the pink and red coloured polygons respectively (after De Wet, 2012).*

The seabed geology beneath the Quaternary surficial sediment cover is shown in Figure 5. Based on old and very incomplete data (Dingle & Siesser, 1977) this map is very rudimentary, as has been shown further north off Namaqualand by diamond exploration geophysics, coring and drilling revealing greater complexity.

To briefly extrapolate what is not depicted in Figure 5, the Cretaceous formations underlying the middle shelf young seaward in coast-parallel sub-crops successively including the Albian-Cenomanian, Turonian and Coniacian formations and farther offshore there are windows of Santonian.  The overlying Paleogene sequence is mostly of Eocene age. Miocene carbonate deposits extend over the outer shelf, with the early Miocene (Burdigalian) overlain seawards by mid-Miocene (Langhian) carbonates, in turn succeeded by late Miocene and Pliocene carbonates accumulated on the slope, in the Block 3B/4B area.

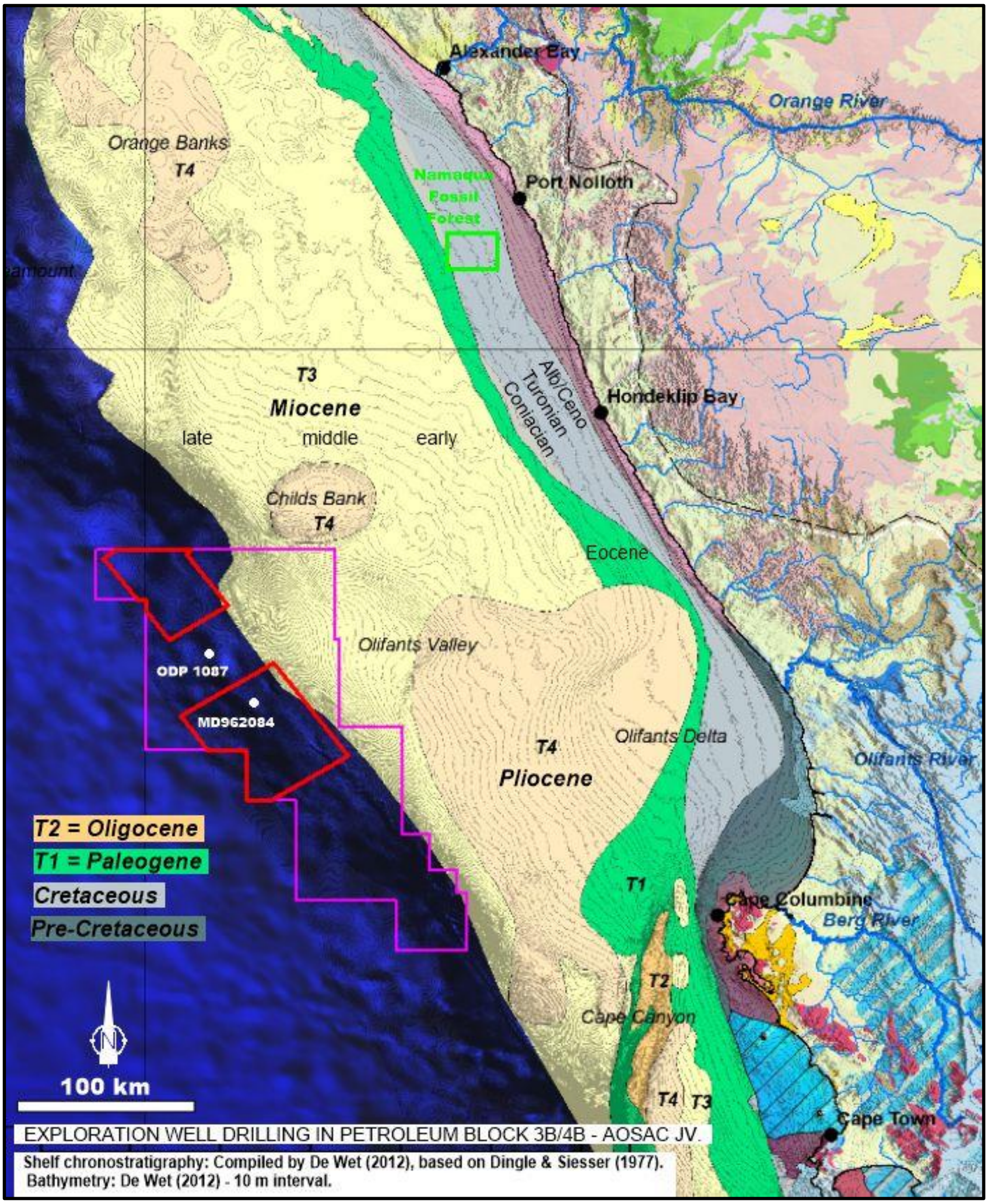


*Figure 5: Pre-Quaternary chronostratigraphy of the top of the continental shelf. Block 3B/4B and the AOIs are the pink and red coloured polygons respectively (after De Wet, 2012).*

## 7.2 The Orange Basin

The geology of Block 3B/4B from the technical hydrocarbon exploration point of view, based on geophysical seismic data and exploration well data, has been most adequately described in the Scoping Report. A general brief account is presented below.

The Cretaceous strata which comprise the bulk of the continental margin were deposited during and subsequent to the rifting of the Gondwana supercontinent and the opening of the Atlantic Ocean 134-120 million years ago (Ma) (Plate 4). The rifting phase involved down-faulting of the continental crust by extension, forming grabens in which the synrift terrestrial and lacustrine sediments were deposited, while massive outpourings of volcanic flood basalts accumulated in the main rift, the flows now represented by the Seaward Dipping reflectors (Plate 4).

After the rifting phase, from Barremian times, the subsiding rifted landscape was covered sediments delivered to the expanding Cretaceous South Atlantic Ocean during the Drift Phase. Wide coastal plains and deltas formed as many large rivers deposited large volumes of fluvial sediments eroded from the well-watered hinterland. These Albian-Coniacian proximal alluvial/fluvial coastal plain and deltaic formations form the sub-seabed along the inshore of the shelf.

In the offshore marine processes spread the finer sands and muds further to form the deeper shelves extending seawards and slumping at the shelf edges carried sediments downslope into deep water. Successive shelves built out and upwards as the underlying crust subsided. These now fill what is called the Orange Basin, which includes an accumulation of Cretaceous sediments 6 to 8 km thick.

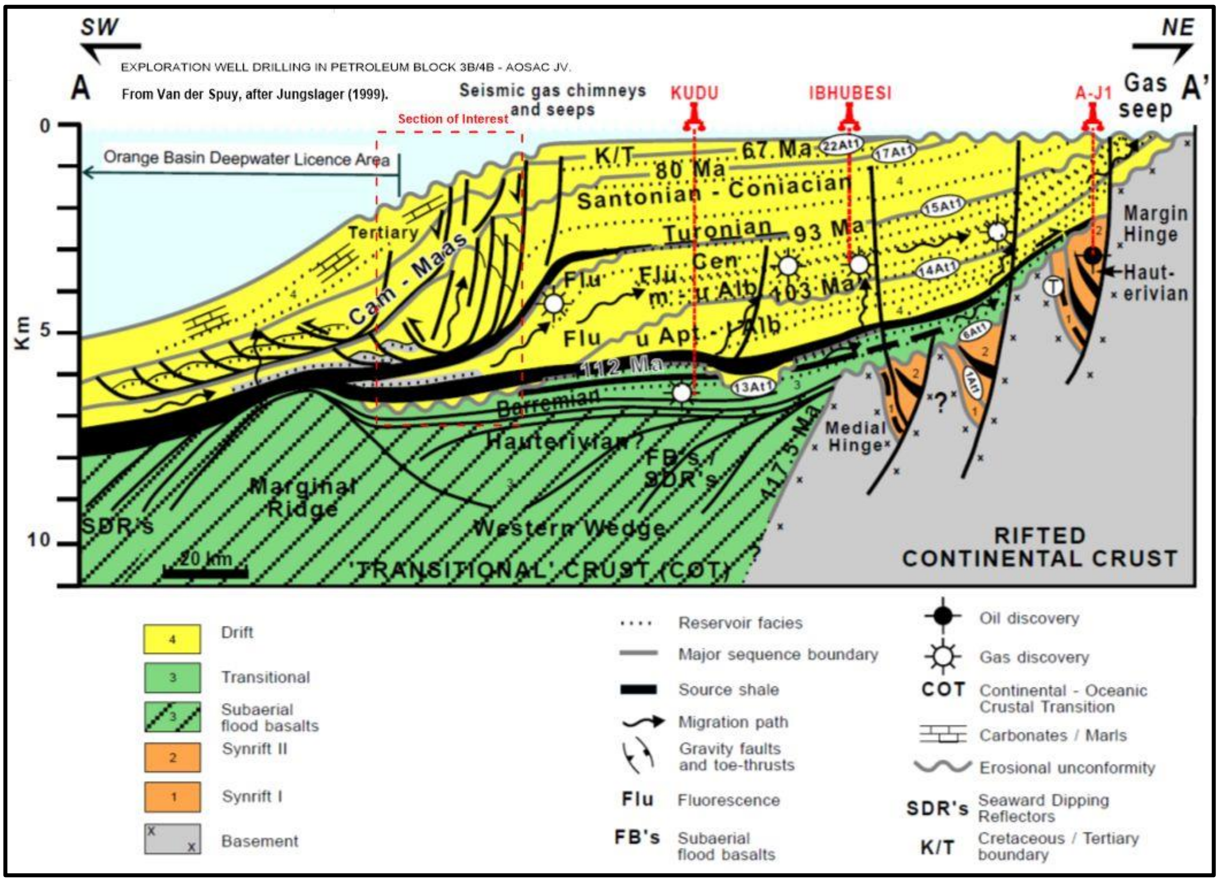


*Plate 4: Schematic chronostratigraphic section of the Orange Basin continental shelf.*

Overall, after the Cretaceous Period, the supply of land-derived terrigenous sediments to the margin and its rate of subsidence has decreased during the Tertiary/Cenozoic as the subcontinent became more arid, with a concomitant increase in the importance of carbonate biogenic sedimentation and authigenic mineralization (Dingle *et al*., 1983).

Weak upwelling developed since the middle Cenozoic and intensified from the late Miocene as global climatic deterioration progressed. The effect of late Cenozoic upwelling has been the widespread occurrence of phosphatic and glauconitic authigenic mineralization on the shelf and extensive phosphatization of Tertiary limestones exposed at the seabed (T3 and T4.)

On the shelf the Cenozoic formations, above the K/T contact (Plate 4) are relatively thin, but thicken seawards over the slope, beneath of which Paleocene and Eocene deep marine clays occur. The succeeding Miocene and Pliocene deposits offshore are pale carbonates comprised of forams, bryozoan debris and small molluscs such as scallops (*Pecten* spp.).

## 7.3 Palaeontological Heritage in Block 3B/4B

The fossils which are known to occur on the continental shelf have mainly been found at middle shelf depths where they come to light during diamond mining and sampling. These fossils include Cretaceous fossil wood, Cenozoic shelly macrofauna, the fossil bones and teeth of sharks and other fishes, the skulls of extinct whale species and the occasional remains of land-living animals that roamed the ice-age exposed shelf which have been phosphatized and reworked into the latest, loose Last Transgression Sequence sediments on the seabed, and “sub-fossil” marine shells dating from the Last Transgression Sequence.

Similar contexts do not pertain in the deep-water slope setting of Block 3B/4B. Instead, a research drill core and a giant piston core acquired on the slope in Block 3B/4B provide an indication of the sediments and the expected fossils within the block.

At site ODP 1087 cores were acquired to a depth of nearly 500 m below seabed and the entire sequence consists of an accumulation of microfossils, as a fine-grained foraminiferal-nannofossil ooze (Plate 5, see also Figure 5). Most of the microfossils accumulated since about 9 Ma at a rate of 2-7 cm/1000 yrs. The lowermost 60 m coring penetrated a condensed section with missing intervals ranging back to about 34 Ma.

The giant piston core (gravity drop-core) (Plate 6 see also Figure 5) penetrated to about 36 m below seabed and also consists of foraminiferal-nannofossil ooze (Plate 7 and Plate 8). The core was dated by analysis of the oxygen isotope content of the shells of planktonic microfossils sampled at 10 cm intervals, which mainly records global polar ice volumes (alternating ice ages and warm interglacial periods).

These cores illustrate the prime palaeontological value of the species of microfossils deposited in deep-sea environments: dating by the age ranges of species, palaeo-oceanographic information from the water masses they preferentially occupy, and a variety of oceanic parameter proxies from their geochemistry.

Other microfossils which are likely to occur are siliceous radiolarians and diatoms, and terrestrial pollen blown out to sea.

Macrofossils such as molluscs are not recorded from these cores, but certainly occur in the deep-sea environment. Notably, molluscs from deep dredging examined by Barnard (1963) comprised a host of new species, mostly small gastropods. However, to this day the deep-sea fauna is very poorly known. Giant benthic foraminifera may also occur.

Vertebrates will mainly be represented by shark and other fish teeth and bones. The remains of marine mammals such as cetaceans and seals are likely to be very sparsely distributed and are mainly brought up in bottom trawling swaths over a large area.

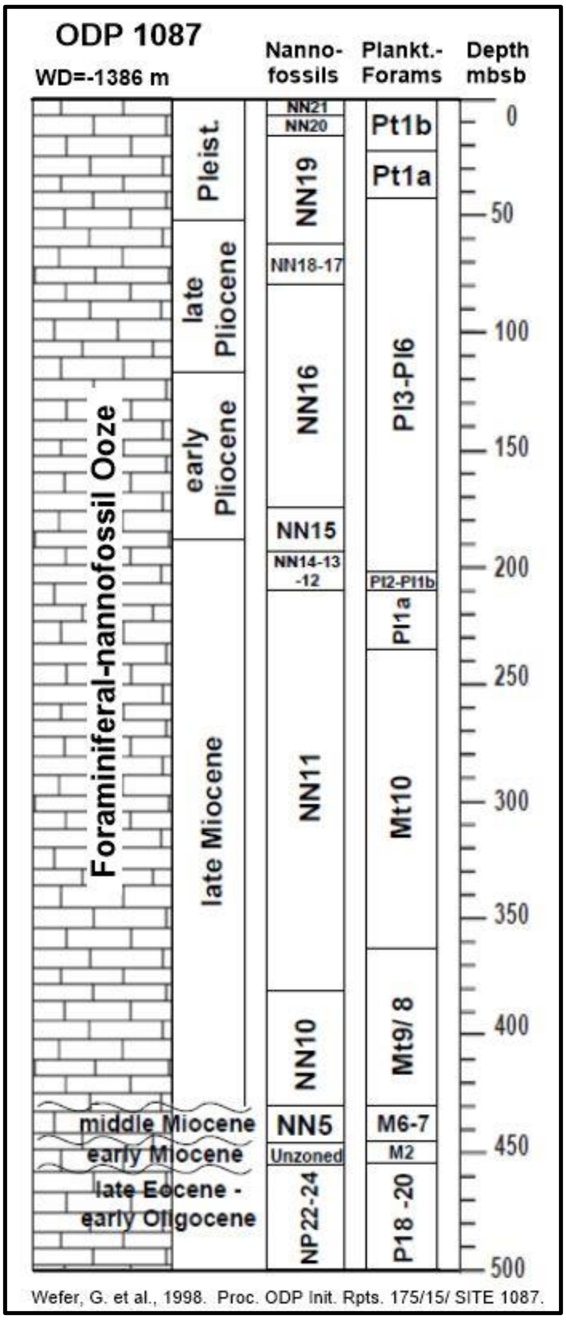


*Plate 5: Ocean Drilling Program core 1087 and its biostratigraphy (ages of strata downcore), based on the age ranges of microfossils. Location shown in Figure 5.*

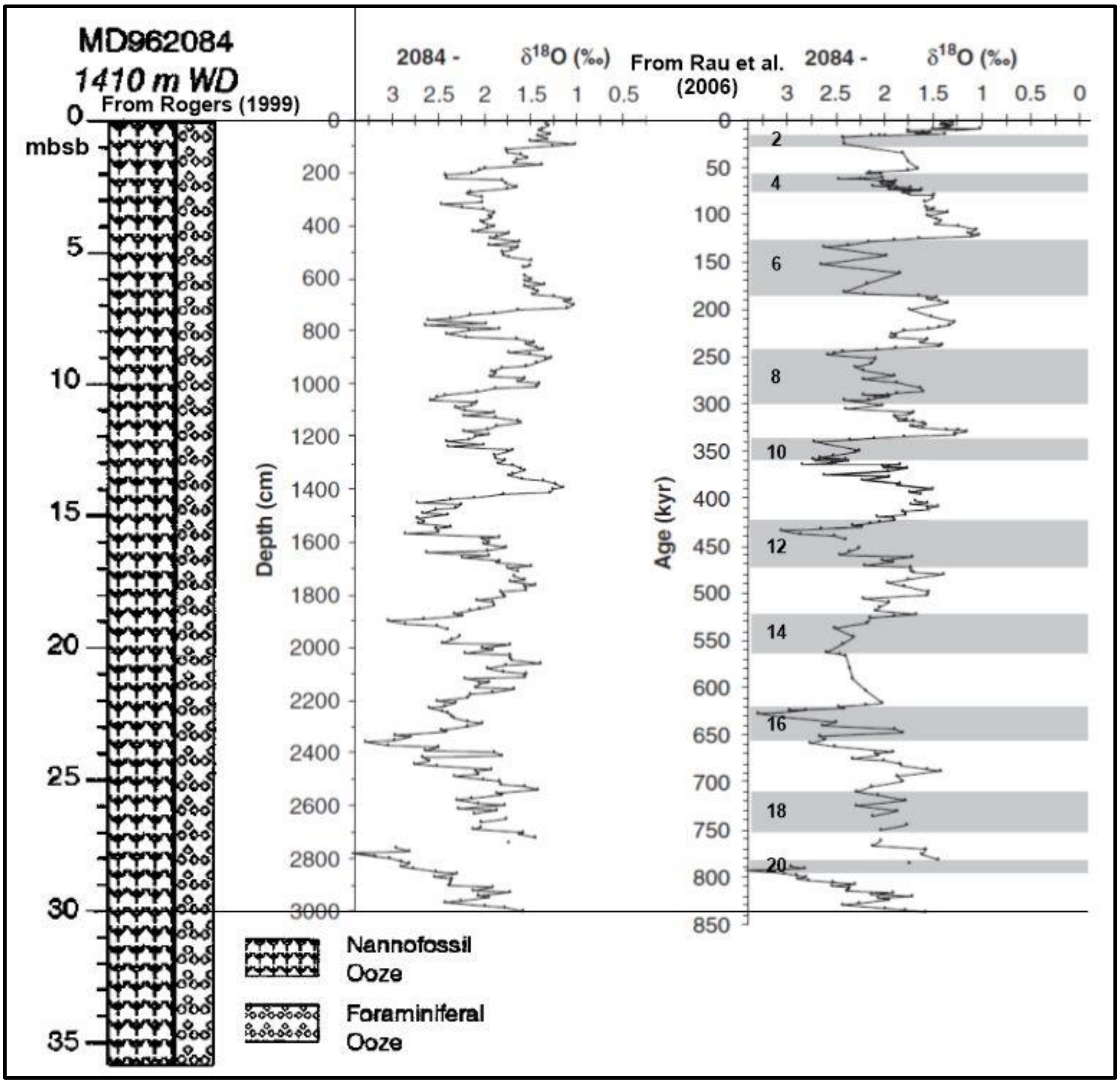


*Plate 6: Giant piston core MD96-2084 and its chronostratigraphy (age model downcore) based on the Oxygen-isotopes measured in samples of shells of planktonic microfossils. Grey bars mark ice-age (glacial) intervals labelled according to Marine Isotope Stages (MISs). Location shown in Figure 5.*

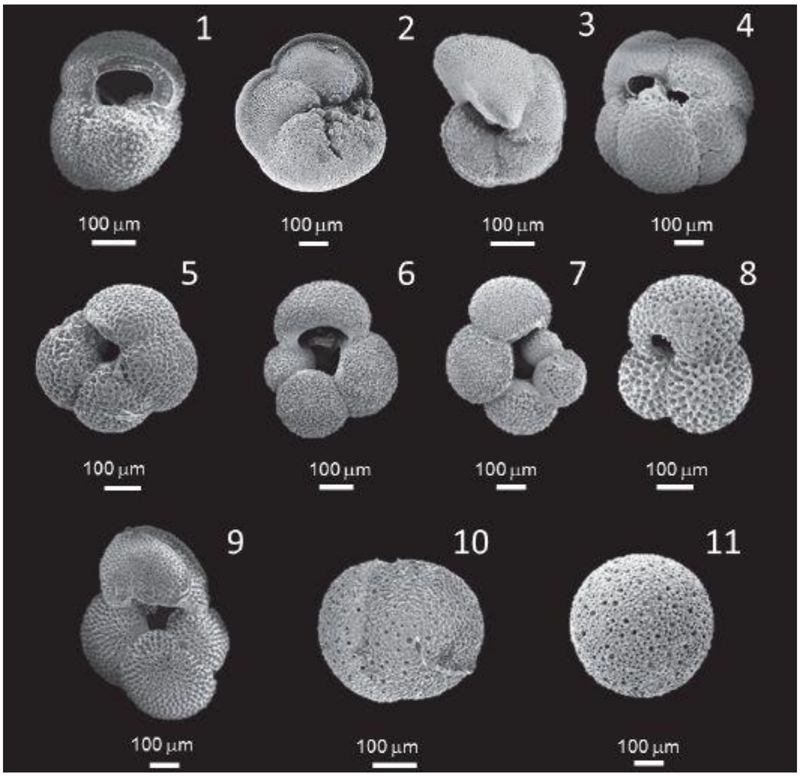


*Plate 7: Planktonic foraminifera. 1. Globoconella inflata. 2. Globorotalia menardii. 3. Globorotalia truncatulinoides. 4. Neogloboquadrina dutertrei. 5. Neogloboquadrina incompta. 6 Globigerina bulloides. 7. Globigerinella siphonifera. 8. Globigerinoides ruber. 9. Trilobatus sacculifer. 10. Orbulina bilobate. 11. Orbulina universa. (Image from Bergh & Compton, 2020).*

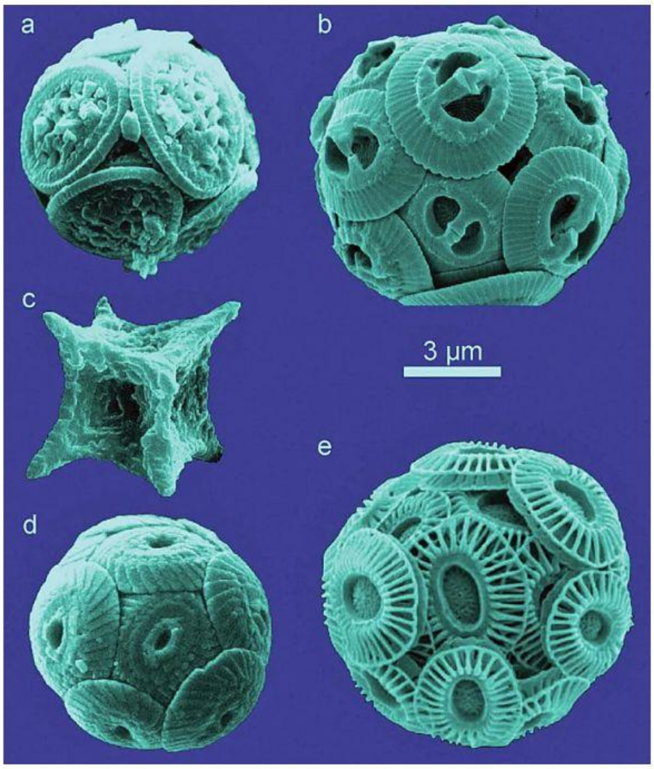


*Plate 8: Calcareous nannofossils. Note their mud particle size vs the sand grain size of the foraminifera. (Image from Sturm, 2016).*

## 7.4 Maritime History of the South African Coast

In 1498 the Portuguese captain Vasco da Gama pioneered the long-sought sea route around Africa from Europe to the East. Since then, the southern tip of the African continent has played a central and vital role in global economic and maritime affairs, and until the opening of the Suez Canal in 1869, represented the most viable route between Europe and the markets of the East (Figure 6) (Axelson, 1973; Turner, 1988; Gribble, 2002; Gribble and Sharfman, 2013).

The South African coast is rugged, and the long fetch and deep offshore waters mean that the force and size of seas around the South African coast are considerable, a situation exacerbated by prevailing seasonal winds. The geographical position of the South African coast on the historical route to the East and the physical conditions mariners could expect to encounter in these waters have, in the last five centuries, been responsible for the large number of maritime casualties which today form the bulk of South Africa's maritime and underwater cultural heritage (Gribble, 2002).

According to the SAHRA MUCH database and TerraMare Archaeology's own shipwreck database, at least 2,800 vessels are known to have sunk, grounded, or been wrecked, abandoned or scuttled in South African waters since the early 1500s. More than 1,900 of these wrecks are more than 60 years old and are thus protected by the NHRA as archaeological resources. This list is by no means complete and does not include the yet unproven potential for shipwrecks and other sites that relate to pre-European, Indian Ocean maritime exploration, trade and interactions along the South African east coast.

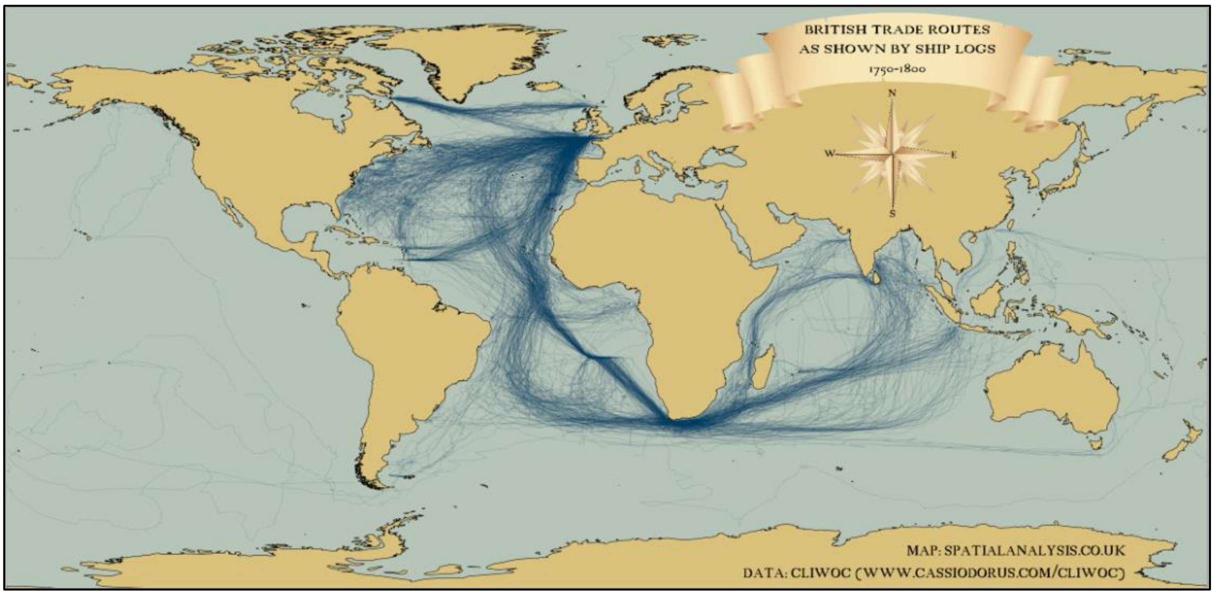


*Figure 6: Example of the density of British shipping around the South African coast between 1750 and 1800 (Source: https://www.theguardian.com/news/datablog/2012/apr/13/shipping-routes-history-map).*

The earliest known South African wrecks are Portuguese, dating to the sixteenth century when that country held sway over the route to the East. Due to the later, more prolonged ascendancy of first the Dutch and then the British in European trade with the East and control at the Cape, most wrecks along the South African coast are Dutch and British. However, at least 36 other nationalities are represented amongst the other wrecks that litter the coast.

Da Gama's maritime incursion into the Indian Ocean laid the foundation for more than 500 years of European maritime activity in the waters off the South African coast. The Portuguese and other European nations who followed their lead around the Cape and into the Indian Ocean, however, joined a maritime trade network that was thousands of years old and in which east and south-east Africa was an important partner.

This trade spanned the Indian Ocean and linked the Far East, South-East Asia, India, the Indian Ocean islands and Africa. Archaeological evidence from Africa points to an ancient trade in African products – gold, skins, ivory and slaves – in exchange for beads, cloth, porcelain, iron and copper. The physical evidence for this trade includes Persian and Chinese ceramics excavated sites on African Iron Age like Khami, Mapungubwe and Great Zimbabwe (see Garlake, 1968, Huffman, 1972, Chirikure, 2014), glass trade beads found in huge numbers on archaeological sites across eastern and southern Africa (Wood, 2012).

There is shipwreck evidence on the East African coast for this pre-European Indian Ocean trade (see for example Pollard et al 2016) and clear archaeological and documentary evidence that this trade network extended at least as far south as Maputo in Mozambique. This suggests that there is the potential for shipwrecks and other sites that relate to pre-European, Indian Ocean maritime exploration, trade and interactions to exist along the South African east coast and offshore waters.

The more than 2,800 historical shipwrecks that form part of South Africa's underwater cultural heritage are, thus, a huge, cosmopolitan, repository of information about mainly global maritime trade during the last five centuries, and potentially much further back into the past. These sites contain a wealth of cultural material associated with that trade and clues to the political, economic, social and cultural changes that accompanied this trade, and which contributed to the creation of the modern world.

## 7.5 Maritime Heritage of Block 3B/4B

The recorded maritime history of the South African west coast dates from the first transit of these waters by Bartholemeu Dias in 1488. The Cape Route was, for centuries thereafter, the only viable maritime way of reaching the East and as indicated by Figure 6 above, was heavily used (Knox-Johnston, 1989). The historical importance of the anchorage in Table Bay, located to the south-east of Block 3B/4B, (and its relative unsuitability as an anchorage) is reflected in the fact that it contains the greatest concentration of historical wrecks in South African waters: more than 400.

North of Table Bay, the early Dutch settlers at the Cape were quick to recognise and exploit the rich marine resources of the West Coast and from almost the first days of the colonial settlement, fishing and sealing flourished, with the catches transported down the coast to supply Cape Town.

This industry led to the development of fishing villages at Saldanha Bay and Lamberts Bay, the former, together with places like Elands Bay, also later becoming ports for the export of grain and other produce from the Swartland and Cederberg (Ingpen, 1979).

During the early nineteenth century the West Coast islands became the focus of an international 'white gold' rush to exploit their rich guano resources (Watson, 1930) (Snyders, 2011). The guano was soon depleted but the discovery of rich copper deposits in Namaqualand and the Richtersveld led to the use of Alexander Bay, Robbe Bay (now Port

Nolloth) and Hondeklip Bay by the early 1850s and the development of local, coasting shipping services to support this new industry (Ingpen, 1979)

Except for Saldanha Bay, the West Coast historically lacked good harbours and this, combined with the regular coastal fogs, a largely rocky shoreline and dangerous inset currents, meant that there were numerous shipping casualties along the coast adjacent to Block 3B/4B, especially since particularly much of the maritime traffic, tended to stay close to the coast rather than sailing large and out into deeper offshore waters, within which Block 3B/4B is located.

According to) the shipwreck database maintained by TerraMare Archaeology and records held by SAHRA and curated on the South African Heritage Resources Information System (SAHRIS) (http://www.sahra.org.za/sahris), there are numerous wrecks recorded between the Saldanha Bay at the southern end of Block 3B/4B and Kreefte Baai at the northern end of the block.

The bulk of these vessels were lost while involved in coastal trade and fishing and most are known to be on or close to the shore along the stretch of coastline landward of Block 3B/4B as indicated on Figure 7.

These wrecks are well outside of Block 3B/4B and the study area for this assessment and will not interfere with or be impacted by the proposed exploration activities in the block.

The records consulted for this study do contain records of shipping casualties further offshore, in the vicinity of Block 3B/4B, but none of these are within the block. Potentially the closest to the block is the *Kalewa*, a British freighter which sank after a collision with the *Boringia* in August 1942 approximately 300 miles north of Cape Town, placing the wreck just north of Block 3B/4B (see Figure 8). There are conflicting records of this loss, however, and there is a suggestion that the vessel may have been lost 300 miles south of Cape Town instead.

German U-boat activity around the South African coats during World War II accounts for many of the deep water wrecks in the shipwreck record, one of which is the *Columbine*, a steamship torpedoed and sunk by U-198 approximately 72 km east of the southern end of Block 3B/4B in June 1944.

Lastly, it must be stated that although unlikely, the possibility does exist for the remains of currently unknown and unrecorded wrecks to be present in Block 3B/4B.

The historical record contains many references to vessels that were lost without trace between their points of departure and arrival. Where survivors of such events were subsequently rescued, the loss was recorded, but in many cases, vessels simply never arrived at their destination and could thus lie anywhere along their intended route.

The potential for the occurrence of such unrecorded wrecks was illustrated in 2008 when a 16th century Portuguese wreck, since identified as the *Bom Jesus*, was unexpectedly found during the diamond mining south of Oranjemund in Namibia (see Alves 2011).

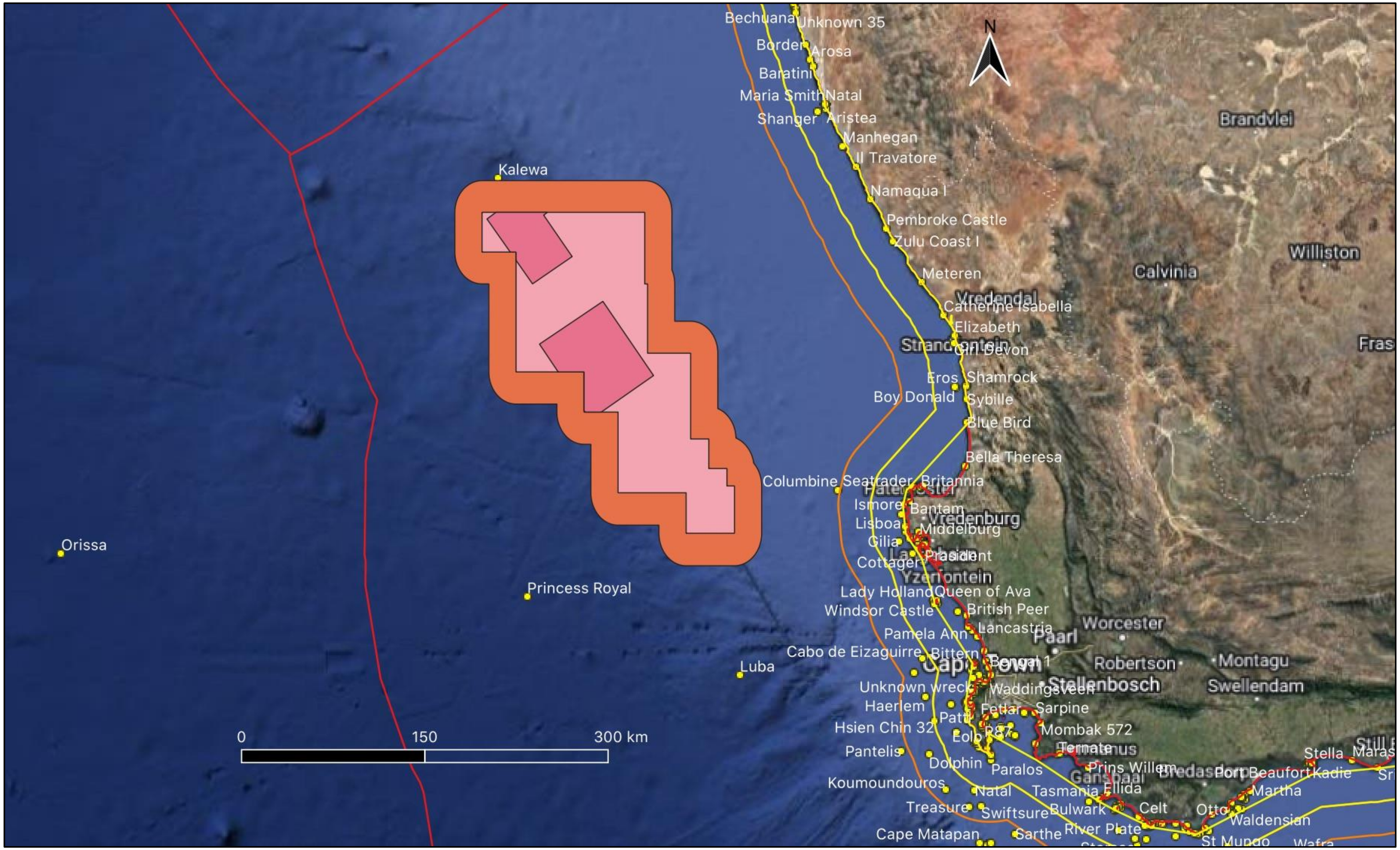


*Figure 7: Indication of the number of recorded shipwrecks between Cape Agulhas in the south and Hondeklip Bay in the north. Note the Kelewa north of block 3B/4B and the Columbine to the east (Source: TerraMare Archaeology Shipwreck Database).*


*Figure 8: Approximate position of the Kalewa north of Block 3B/4B (Source: TerraMare Archaeology Shipwreck Database).*

# 8 IMPACT ASSESSMENT

## 8.1 Impact Assessment Methodology

The impact assessment process is broken down as follows:

- Identification of proposed activities including their nature and duration: Impacts were identified through various methods including a desktop analysis; specialist studies (Heritage and Palaeontological and Wetlands) and the public participation process;
- Screening of activities likely to result in impacts or risks;
- Utilisation of the above mentioned EIMS methodology to assess and score preliminary impacts and risks identified. Refer to section 6.11 above for the full methodology used;
- Inclusion of I&AP comments received through the public participation process regarding impact identification and assessment; and
- Finalisation of impact identification and scoring.

The impact significance rating methodology, as provided by EIMS, is guided by the requirements of the NEMA EIA Regulations, 2014. The broad approach to the significance rating methodology is to determine the environmental risk (ER) by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and

Reversibility) and relate this to the probability/ likelihood (P) of the impact occurring. This determines the environmental risk. In addition, other factors, including cumulative impacts, public concern, and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the ER to determine the overall significance (S).

The significance (S) of an impact is determined by applying a prioritisation factor (PF) to the environmental risk (ER). The environmental risk is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and reversibility (R) applicable to the specific impact.

## 8.2 Determination of Environmental Risk

The significance (S) of an impact is determined by applying a prioritisation factor (PF) to the environmental risk (ER). The environmental risk is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and reversibility (R) applicable to the specific impact.

For the purpose of this methodology the consequence of the impact is represented by:

$$\frac{C = (E + D + M + R) * N}{4}$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in Table 1 below.

*Table 1: Criteria for Determining Impact Consequence*

| Aspect | Score | Definition |
|---|---|---|
| **Nature** | -1 | Likely to result in a negative/ detrimental impact |
| | 1 | Likely to result in a positive/ beneficial impact |
| **Extent** | 1 | Activity (i.e. limited to the area applicable to the specific activity) |
| | 2 | Site (i.e. within the development property boundary) |
| | 3 | Local (i.e. the area within 5 km of the site) |
| | 4 | Regional (i.e. extends between 5 and 50 km from the site |
| | 5 | Provincial / National (i.e. extends beyond 50 km from the site) |
| **Duration** | 1 | Immediate (<1 year) |
| | 2 | Short term (1-5 years) |
| | 3 | Medium term (6-15 years) |
| | 4 | Long term (the impact will cease after the operational life span of the project) |
| | 5 | Permanent (no mitigation measure of natural process will reduce the impact after construction) |

| | | |
|---|---|---|
| **Magnitude / Intensity** | 1 | Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected) |
| | 2 | Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected) |
| | 3 | Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way) |
| | 4 | High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease) |
| | 5 | Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease) |
| **Reversibility** | 1 | Impact is reversible without any time and cost |
| | 2 | Impact is reversible without incurring significant time and cost |
| | 3 | Impact is reversible only by incurring significant time and cost |
| | 4 | Impact is reversible only by incurring prohibitively high time and cost |
| | 5 | Irreversible Impact |

Once the C has been determined the ER is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/ scored as per Table 2.

*Table 2: Probability Scoring*

| **Probability** | |
|---|---|
| **1** | Improbable (the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <25%) |
| **2** | Low probability (there is a possibility that the impact will occur; >25% and <50%) |
| **3** | Medium probability (the impact may occur; >50% and <75%) |
| **4** | High probability (it is most likely that the impact will occur- > 75% probability) |
| **5** | Definite (the impact will occur) |

The result is a qualitative representation of relative ER associated with the impact. ER is therefore calculated as follows:

**ER= C x P**

*Table 3: Determination of Environmental Risk*

| **Consequence** | 5 | 5 | 10 | 15 | 20 | 25 |
|---|---|---|---|---|---|---|
| | 4 | 4 | 8 | 12 | 16 | 20 |
| | 3 | 3 | 6 | 9 | 12 | 15 |
| | 2 | 2 | 4 | 6 | 8 | 10 |
| | 1 | 1 | 2 | 3 | 4 | 5 |
| | | 1 | 2 | 3 | 4 | 5 |
| | **Probability** | | | | | |

The outcome of the environmental risk assessment will result in a range of scores, ranging from 1 through to 25. These ER scores are then grouped into respective classes as described in Table 4.

*Table 4: Significance Classes*

| Risk Score | Description |
|---|---|
| **<9** | Low (i.e. where this impact is unlikely to be a significant environmental risk) |
| **≥ 9; < 17** | Medium (i.e. where the impact could have a significant environmental risk) |
| **≥ 17** | High (i.e. where the impact will have a significant environmental risk) |

The impact ER will be determined for each impact without relevant management and mitigation measures (pre-mitigation), as well as post implementation of relevant management and mitigation measures (post-mitigation). This allows for a prediction in the degree to which the impact can be managed/mitigated.

## 8.3 Impact Prioritisation

Further to the assessment criteria presented in the section above, it is necessary to assess each potentially significant impact in terms of:

1. Cumulative impacts; and
2. The degree to which the impact may cause irreplaceable loss of resources.

To ensure that these factors are considered, an impact prioritisation factor (PF) will be applied to each impact ER (post-mitigation). This prioritisation factor does not aim to detract from the risk ratings but rather to focus the attention of the decision-making authority on the higher priority/significance issues and impacts. The PF will be applied to the ER score based on the assumption that relevant suggested management/mitigation impacts are implemented.

*Table 5: Criteria for Determining Prioritisation*

| | | |
|---|---|---|
| **Cumulative Impact** | Low (1) | Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it |

| | | |
|---|---|---|
| **(CI)** | | is unlikely that the impact will result in spatial and temporal cumulative change |
| | Medium (2) | Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change |
| | High (3) | Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/ definite that the impact will result in spatial and temporal cumulative change |
| **Irreplaceable Loss of Resources (LR)** | Low (1) | Where the impact is unlikely to result in irreplaceable loss of resources |
| | Medium (2) | Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited |
| | High (3) | Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions) |

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented in Table 36. The impact priority is therefore determined as follows:

Priority = CI + LR

The result is a priority score which ranges from 2 to 6 and a consequent PF ranging from 1 to 1.5 (Refer to Table 6)

*Table 6: Determination of Prioritisation Factor*

| Priority | Ranking | Prioritisation Factor |
|---|---|---|
| 2 | Low | **1** |
| 3 | Medium | **1.125** |
| 4 | Medium | **1.25** |
| 5 | Medium | **1.375** |
| 6 | High | **1.5** |

In order to determine the final impact significance, the PF is multiplied by the ER of the post mitigation scoring. The ultimate aim of the PF is an attempt to increase the post mitigation environmental risk rating by a full ranking class, if all the priority attributes are high (i.e. if an impact comes out with a medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a high significance).

*Table 7: Environmental Significance Rating*

| Value | Description |
| --- | --- |
| **< -9** | Low negative (i.e. where this impact would not have a direct influence on the decision to develop in the area). |
| **≥ -9 < -17** | Medium negative (i.e. where the impact could influence the decision to develop in the area). |
| **≥ -17** | High negative (i.e. where the impact must have an influence on the decision process to develop in the area). |
| **0** | No impact |
| **< 9** | Low positive (i.e. where this impact would not have a direct influence on the decision to develop in the area). |
| **≥ 9 < 17** | Medium positive (i.e. where the impact could influence the decision to develop in the area). |
| **≥ 17** | High positive (i.e. where the impact must have an influence on the decision process to develop in the area). |

The significance ratings and additional considerations applied to each impact will be used to provide a quantitative comparative assessment of the alternatives being considered. In addition, professional expertise and opinion of the specialists and the environmental consultants will be applied to provide a qualitative comparison of the alternatives under consideration. This process will identify the best alternative for the proposed project.

## 8.4 Potential Impacts: Exploration Activities

Of the activities to be undertaken as part of the proposed exploration in Block 3B/4B, only the seabed sampling and well drilling have potential impacts on cultural heritage resources.

The potential impacts of seabed sampling and well drilling on palaeontological and maritime archaeological resources are assessed in the following sections.

### *8.4.1 Potential Direct Impacts: Damage to or Loss of Palaeontological Materials*

The physical extent of impacts on potential palaeontological resources is site specific and relates directly to the extents of subsurface disturbance involved in the activities.

However, unlike an impact that has a defined spatial extent (*e.g.* loss of a portion of a habitat), the scientific findings from the analysis of deep-sea geophysical surveys and well drilling have impacts that are of international extent.

The destruction of fossils that will be a consequence of well-drilling in particular means that the duration of any impact is permanent. This is why it is important that any found fossils are preserved for posterity.

The intensity of the potential impact of sampling and drilling on fossil resources is determined by the palaeontological sensitivity of the affected formations - the potential scientific value of the fossils which are included in it, together with the volume of the formation which is excavated.

Overall, the palaeontological sensitivity of marine deposits is high (Almond & Pether, 2009) due to a few, crucial fossil bone finds of high scientific importance that provided the age constraints for the formations. However, there are complications as marine formations usually contain more than one type of fossil of differing importance, *e.g.* common shells and rare bones as discrete objects, and formations entirely composed of fossils, as in biogenic limestones such as the foram-nannofossil formation beneath Block 3B/4B, wherein a small piece contains thousands of microfossils.

The proposed baseline environmental sampling and exploration well drilling activities have a very small footprint in the continental shelf environment and a relatively small subsurface volume of excavation of ~2000 $m^3$. This may be compared with a small bulk sample for diamond exploration of 50x20x5 m = 5000 $m^3$.

The approximate depth of the exploration wells of 3570 m is equivalent to drilling through 3.5 stacked Table Mountains, into a huge volume of sediments up to 8 km thick in places. Due to the small affected volume the impact of the proposed sampling and drilling activities on the palaeontological heritage of the continental shelf deposits may be considered to be negligible or low, at most.

Within the site specific extents the potential loss of fossils in the drill operation is irreversible. Realistically, the nature of the loss at depth in the drill hole, below the upper biogenic ooze unit cored in ODP 1087, is unknown, but is insubstantial on scale considerations.

An impact will occur, but as above, the minute affected volume relative to the preserved volume in the Orange Basin renders the probability of an actual impact from drilling insubstantial.

Mostly palaeontological resources are unique and their loss is irreversible. This is perfectly appreciated in the case of discrete fossils such as petrified bones, shells, wood *etc*. For micro-fossiliferous formations only accessible by costly drilling to acquire cores, it is the core itself with its palaeo-oceanographic record which is the irreplaceable fossil. The extent to which deep-sea cores are irreplaceable is evident in the extent of efforts to preserve them, to eke out analyses involving destruction, and increasing employ non-destructive analytical techniques. Similarly, the cuttings from non-cored hydrocarbon well drilling are archived (or should be).

Thus, although not readily replaced, replacement cores can theoretically be acquired and the proposed exploration activities in Block 3B/4B will not result in an Irreplaceable loss of resources.

Based on the assessment above, a significant rating of Low Positive is found to apply to palaeontological resources in the context of the proposed exploration activities. Palaeontological concerns do not impede the proposed the Applicant’s baseline sampling and hydrocarbon exploration well drilling activities in Block 3B/4B.

The impact assessment for palaeontological resources is set out in Table 8. below:

*Table 8: Palaeontological Impact Assessment for Block 3B/4B Exploration Activites*

| IMPACT | RATING |
|---|---|
| Nature | 1 |
| Extent | 1 |
| Duration | 5 |
| Magnitude | 1 |
| Reversibility | 5 |
| Probability | 1 |
| **Consequence** | **3** |
| Environmental Risk | 3 |
| Environmental Risk Ranking | LOW |
| Cumulative Impact | 1 |
| Irreplaceable Loss | 1 |
| Priority | 2 |
| Priority Ranking | LOW |
| Prioritization Factor | 1 |
| Significance | 3 |
| **Significance Rating (with mitigation)** | **LOW POSITIVE** |

#### *8.4.2 Potential Direct Impacts: Damage to or Loss of Maritime Archaeological Sites or Material*

The discussion above of the maritime heritage resources in and around Block 3B/4B indicates that there are no historical shipwrecks recorded within the block.

The nearest recorded wreck, that of the *Kalewa*, appears to be well outside Block 3B/4B, but its position is very approximate and there is a possibility, albeit extremely low, that this wreck could be present within the block.

The possibility also exists that currently unknown historical wrecks or maritime debris are present on the seabed in Block 3B/4B, but this is so low that it can probably be discounted.

There is thus unlikely to be any impact arising from exploration activities on maritime heritage resources within Block 3B/4B and they are scoped out of this impact assessment.

#### *8.4.3 Potential Indirect Impacts: Damage to or Loss of Palaeontological Resources and/or Maritime Archaeological Sites or Material*

Cuttings discharge and sediment plume arising from well drilling may indirectly impact palaeontological and/or maritime archaeological resources on the seabed by smothering or burying such sites or material.

Such an impact, should it occur is unlikely to be negative, with the introduced sediment providing a protective covering to any heritage resources present.

### 8.5 Cumulative Impacts

Cumulative effects are the combined potential impacts from different actions that result in a significant change larger than the sum of all the impacts.

Consideration of ‘cumulative impact’ should include “past, present and reasonably foreseeable future developments or impacts". This requires a holistic view, interpretation and analysis of the biophysical, social and economic systems (DEAT 2004).

For the most part, cumulative effects, or aspects thereof, are too uncertain to be quantifiable, due mainly to a lack of data availability and accuracy. This is particularly true of cumulative effects arising from potential or future projects, the design or details of which may not be finalised or available and the direct and indirect impacts of which have not yet been assessed.

For practical reasons, the identification and management of cumulative impacts are limited to those effects generally recognised as important on the basis of scientific concerns and/or concerns of affected communities.

### *8.5.1 Cumulative Impact Analysis*

Given the nature of palaeontological and maritime archaeological heritage resources and the extent of our knowledge about their occurrence and distribution, an assessment of the cumulative impact of current and future seabed activities on these resources in the area surrounding Block 3B/4B, can only be qualitative and descriptive.

#### *8.5.1.1 Palaeontological Resources*

The presence of palaeontological resources within the seabed of the block is proven. While current and future seabed activities in the area which will disturb the seabed and bedrock, including mineral and oil and gas prospecting or mining, have the potential to impact palaeontological resources, the scale of these impacts, relative to the scale of the seabed means that such impacts will be of low cumulative significance and will not deplete the palaeontological resources of the Orange Basin.

#### *8.5.1.2 Maritime Archaeological Resources*

With respect to potential cumulative impacts on historical shipwrecks, the discussion above indicates that this area of South Africa's West Coast has relatively few wrecks, when compared to places like Table Bay which alone contains more than 400 wrecks. The majority of West Coast wrecks are also located close to the coast, and cumulative impacts arising from offshore mining, prospecting and exploration are thus potentially more of a risk in areas close to the coast.

Generally, historical wrecks and related maritime archaeological debris are avoidable (through the prior collection and analysis of geophysical data) and actively avoided (because of potential damage they can cause to mining plant and machinery) by seabed activities such as mining or prospecting.

Impacts on historical shipwrecks arising from seabed activities are likely to be accidental where they do occur, and once a site has been encountered on the seabed it is likely to be excluded from the area of activities as an operational obstruction or risk.

There is thus a very low potential for cumulative impacts on maritime archaeological resources, principally historical shipwrecks, arising out of current and future seabed activities in the area surrounding Block 3B/4B.

# 9 MITIGATION AND RECOMMENDATIONS

## 9.1 Palaeontological Mitigation

The scientific research cores acquired and their analysis may be regarded as mitigation of exploration drilling activities which has already been accomplished in Block3B/4B. Importantly, core ODP 1087 has captured the palaeo-oceanographic record which will be lost during the spudding in of the hydrocarbon wells.

#### *9.1.1 Pre-drilling Box & Piston Coring*

It is presumed that the box cores and piston cores will be handed over to consultant marine biologists for analysis for the baseline environmental inventory. This intended analysis for baseline purposes constitutes mitigation.

As mentioned above, the modern deep-sea shell fauna is hardly sampled and poorly known. New samples from any deep-water location have the potential to discover unknown species, or at least add to the very small existing museum collections of specimens. In this respect the concerns of palaeontology and marine biology coincide.

It is expected that the molluscs shells and any other fossil material (fish teeth, otoliths *etc*.) will be sieved out at some stage. Fine sieves must be used as some deep-sea molluscs are tiny. All shells and other material of interest must have the details of context recorded and be kept for identification by an appropriate specialist, and ultimately be deposited in a curatorial institution such as the IZIKO Museum. The best outcome for piston cores is that core splits, or site duplicate cores, are the subject of a detailed study, such as for a B.Sc. Honours or M.Sc. project.

#### *9.1.2 Well Drilling*

As mentioned, the sampling of drill cuttings for various standard industry analyses, most notably micro-palaeontological and palaeo-environmental, constitutes prescribed or “built-in” mitigation, the main aspects of which are very likely to be written up by the consulting experts and published in the longer term.

The sizes of typical drill cuttings are in the range of 0.1 mm (100 µm - very fine sand) to 3-4 mm (granules) (Kern *et al*., 2022). Macrofossils are destroyed and not delivered to the “shale shaker” screen and only very small fossils will be enclosed in the coarse cuttings, such as larval mollusc shells, micro-molluscs, barnacle fragments and opercula, polychaete worm mouthparts, tiny fish teeth *etc*. from marine deposits and small aquatic molluscs and plant material from terrestrial deposits. Such will be in the cuttings samples and inform palaeo-environmental interpretations. There is therefore no special requirement for additional observations and a Fossil Finds Procedure at the “shale shaker” on the vessel.

### 9.2 Maritime Archaeological Mitigation

From the available information is It is unlikely that there will be maritime archaeological sites or materials within Block 3B/4B.

Should unrecorded wreck material be present in the project area, however, it may be subject to accidental impact, and it is recommended, therefore, that:

- The interpretation of any future seabed bathymetric data / review of ROV video footage must include the requirement to flag any shipwreck or related material;
- Any such finds must be reported to SAHRA; and

- Any shipwreck finds must be excluded from areas subject to seabed sampling or well drilling by the implementation of a buffer of at least 50 m around the site or material.

## 10 CONCLUSION AND AUTHORISATION OPINION

It is our reasoned opinion that the proposed exploration activities in Block 3B/4B are likely to have a very low impact on palaeontological resources, and no impact on maritime archaeological sites and materials.

Provided the recommendations to mitigate and offset potential impacts are implemented, the proposed exploration activities can be considered to be palaeontologically and archaeologically acceptable.

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## APPENDIX A: KNOWN WRECKS IN THE VICINITY OF BLOCK 3B/4B

| Ship Name | Place | Latitude/Longitude (estimated)* (WGS84) | Event Type | Vessel Category | Type | Date Lost |
|---|---|---|---|---|---|---|
| *Kalewa* | 300 miles north **OR** south of Table Bay | -30.7861S / 14.8687E | Foundered | Steamship | Freighter | 1942-08-01 |
| *Columbine* | 25 miles from Cape Columbine lighthouse | -32.7333 S / 17.3666 E | Sunk | Steamship | Freighter | 1944-06-16 |

*** PLEASE NOTE**: The shipwreck positions provided above are estimated positions based on descriptions of loss in the historical record. Confidence in the accuracy of these positions is thus very low and it is unlikely that the vessels concerned will be found at the given co-ordinates

## APPENDIX B: PALAEONTOLOGICAL IMPACT ASSESSMENT

(See separate PDF file)

**SAHRA CASE ID 21617**

# PALAEONTOLOGICAL IMPACT ASSESSMENT

**(DESKTOP STUDY)**

**EXPLORATION RIGHT APPLICATION FOR WELL DRILLING IN PETROLEUM BLOCK 3B/4B**

**CONTINENTAL SHELF SLOPE OFFSHORE THE WEST COAST OF THE WESTERN CAPE**

**AFRICA OIL SA CORP, RICOCURE (PTY) LTD & AZINAM LTD JOINT VENTURE**

By

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Tel: 011 789 7170
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**18 DECEMBER 2023**

## SUMMARY

### Site Name

Exploration Right Application for hydrocarbon exploration well drilling in Petroleum Block 3b/4b

### Location

Block 3B/4B is located offshore of the coast of the Western Cape and generally straddles the continental shelf break and steeping offshore slope, *i.e.* the edge of the continental shelf (Figure 1). Within Block 3B/4B (17 581 km$^2$) two Areas of Interest (AoI) are identified, a northern AoI of approx. 1637 km$^2$ of prime interest and a central AoI of approx. 3069 km$^2$, situated over a depth range of approx. -1000 to -2000 m.

### Proposed Activities

The holders of the Exploration Right for the offshore Petroleum Exploration Block 3B/4B (Figure 1), namely the Joint Venture (JV) comprising Africa Oil SA Corp., Ricocure (Pty) Ltd. and Azinam Ltd., propose to drill up to 5 exploration wells into hydrocarbon prospects identified in geophysical data.

The proposed exploration drilling is to be accomplished in phases:

- Pre-drilling Geophysical Survey – Target well sites to be surveyed to establish the baseline natural conditions and to identify potential seabed and sub-seabed geo-hazards.
- Pre-drilling Sampling - Box coring to sample the uppermost ~0.5 m of the seabed for baseline studies of sediment textures, composition, geochemistry, organics and fauna. Piston coring penetrating 6-9 m into the seabed to ground-truth sub-bottom profiles
- Riserless spudding in - Cementing conductor pipes in the drill hole to ~320 m depth below seabed to avoid hole collapse. Drilled cuttings ejected onto seabed.
- Risered drilling – Installing a Blowout Preventer on the wellhead and a riser pipe to convey drill cuttings to the drill vessel. Expected drilling depth about 3570 m below the seabed.
- Well logging with various downhole instrument packages

### Impacted Palaeontological Resources

Research core logs (*e.g.* Ocean Drilling Program) show that to a depth of at least ~500 m below seabed the entire sequence consists of an accumulation of microfossils, as a fine-grained foraminiferal-nannofossil ooze (Figure 11). Most of the drill holes will penetrate strata of Cretaceous age.

### Anticipated Impacts

The intensity of the potential impact of sampling and drilling on fossil resources is determined by the palaeontological sensitivity of the affected formations - the potential scientific value of the fossils which are included in it, together with the volume of the formation which is excavated.

The purpose of the pre-drilling box and piston cores is for determining the baseline conditions at the drill sites and they are destined for analysis, in which the shelly macrofauna and other skeletal material will be revealed and will require identification by a specialist, with a positive scientific outcome.

The riserless, spudding-in process of the upper drill holes does not provide any opportunities for observing and collecting fossils as drilled material is ejected onto the seabed.

The proposed baseline environmental sampling and 5 exploration well drilling activities have a very small footprint in the continental shelf environment and a relatively small subsurface volume of excavation of ~2000 m3. This may be compared with a small bulk sample for diamond exploration of 50x20x5 m = 5000 m3. The approximate depth of the exploration wells of 3570 m is equivalent to drilling through 3 ½ stacked Table Mountains (~1 km high), into a huge volume of sediments in the Orange Basin up to 8 km thick in places. Due to the small affected volume the impact of the proposed sampling and drilling activities on the palaeontological heritage of the continental shelf deposits may be considered to be negligible or at most LOW.

**Mitigation**

The scientific research cores acquired and their analysis may be regarded as mitigation of exploration drilling activities which has already been accomplished in Block3B/4B (Figures 11 & 12). Importantly, core ODP 1087 has captured the palaeo-oceanographic record which will be lost during the spudding in of the hydrocarbon wells.

It is presumed that the box cores and piston cores will be handed over to consultant marine biologists for analysis for the baseline environmental inventory. This intended analysis for baseline purposes constitutes mitigation. The modern deep-sea shell fauna is hardly sampled and poorly known. New samples from any deep-water location have the potential to discover unknown species, or at least add to the very small existing museum collections of specimens. In this respect the concerns of palaeontology and marine biology coincide. All shells and other material of interest from the baseline sampling must have the details of context recorded and be kept for identification by an appropriate specialist, and ultimately be deposited in a curatorial institution such as the IZIKO SA Natural History Museum. The best outcome for piston cores is that core splits, or site duplicate cores, are the subject of a detailed study, such as for a B.Sc. Honours or M.Sc. project.

During exploration well drilling the sampling of drill cuttings for various standard industry analyses, most notably micro-palaeontological and palaeo-environmental, constitutes prescribed or “built-in” mitigation, the main aspects of which are very likely to be written up by the consulting experts and published in the longer term, constituting a positive outcome.

The sizes of typical drill cuttings are in the range of 0.1 mm (100 µm - very fine sand) to 3-4 mm (granules) (Kern *et al.*, 2022). Macrofossils are destroyed and not delivered to the “shale shaker” screen and only very small fossils will be enclosed in the coarse cuttings, such as larval mollusc shells, micro-molluscs, barnacle fragments and opercula, polychaete worm mouthparts, tiny fish teeth *etc*. from marine deposits and small aquatic molluscs and plant material from terrestrial deposits. Such will be in the cuttings samples and inform palaeo-environmental interpretations. There is therefore no special requirement for additional observations and a Fossil Finds Procedure at the “shale shaker” on the vessel.

**Conclusions**

The Significance Rating by the EIMS methodology is accordingly LOW POSITIVE.

Palaeontological concerns do not impede the proposed AOSAC JV baseline sampling and hydrocarbon exploration well drilling activities in Block 3B/4B.

**CONTENTS**

## SPECIALIST DETAILS, EXPERTISE AND DECLARATION

### CURRICULUM VITAE

**John Pether, M.Sc., Pr. Sci. Nat. (Earth Sci.)**

Independent Consultant/Researcher recognized as an authority with 37 years' experience in the field of coastal-plain and continental-shelf palaeoenvironments, fossils and stratigraphy, mainly involving the West Coast/Shelf of southern Africa. Has been previously employed in academia (South African Museum) and industry (Trans Hex, De Beers Marine). At present an important involvement is in Palaeontological Impact Assessments (PIAs) and mitigation projects in terms of the National Heritage Resources Act 25 (1999) (~350 PIA reports to date) and is an accredited member of the Association of Professional Heritage Practitioners (APHP). Continues to be involved as consultant to offshore and onshore marine diamond exploration ventures. Expertise includes:

- Coastal plain and shelf stratigraphy (interpretation of open-pit exposures, on/offshore cores and exploration drilling).
- Sedimentology and palaeoenvironmental interpretation of shallow marine, aeolian and other terrestrial surficial deposits.
- Marine macrofossil taxonomy (molluscs, barnacles, brachiopods) and biostratigraphy.
- Marine macrofossil taphonomy.
- Sedimentological and palaeontological field techniques in open-cast mines (including finding and excavation of vertebrate fossils (bones).

**Membership of Professional Bodies**

- South African Council of Natural Scientific Professions. Earth Science. Reg. No. 400094/95.
- Geological Society of South Africa.
- Palaeontological Society of Southern Africa.
- Southern African Society for Quaternary Research.
- Association of Professional Heritage Practitioners (APHP), Western Cape. Accredited Member No. 48.

**Past Clients Palaeontological Assessments**

| | |
|---|---|
| AECOM SA (Pty) Ltd. | Guillaume Nel Environmental Management Consultants. |
| Agency for Cultural Resource Management (ACRM). | Klomp Group. |
| AMATHEMBA Environmental. | Megan Anderson, Landscape Architect. |
| Anél Blignaut Environmental Consultants. | Ninham Shand (Pty) Ltd. |
| Arcus Gibb (Pty) Ltd. | PD Naidoo & Associates (Pty) Ltd. |
| ASHA Consulting (Pty) Ltd. | Perception Environmental Planning. |
| Aurecon SA (Pty) Ltd. | PHS Consulting. |
| BKS (Pty) Ltd. Engineering and Management. | Resource Management Services. |
| Bridgette O'Donoghue Heritage Consultant. | Robin Ellis, Heritage Impact Assessor. |
| Cape Archaeology, Dr Mary Patrick. | Savannah Environmental (Pty) Ltd. |
| Cape EAPrac (Cape Environmental Assessment Practitioners). | Sharples Environmental Services cc |
| CCA Environmental (Pty) Ltd. | Site Plan Consulting (Pty) Ltd. |
| Centre for Heritage & Archaeological Resource Management (CHARM). | SRK Consulting (South Africa) (Pty) Ltd. |
| Chand Environmental Consultants. | Strategic Environmental Focus (Pty) Ltd. |
| CK Rumboll & Partners. | UCT Archaeology Contracts Office (ACO). |
| CNdV Africa | UCT Environmental Evaluation Unit |
| CSIR - Environmental Management Services. | Urban Dynamics. |
| Digby Wells & Associates (Pty) Ltd. | Van Zyl Environmental Consultants |
| Enviro Logic | Western Cape Environmental Consultants (Pty) Ltd, t/a ENVIRO DINAMIK. |
| Environmental Resources Management SA (ERM). | Wethu Investment Group Ltd. |
| Greenmined Environmental | Withers Environmental Consultants. |

**Stratigraphic consulting including palaeontology**

| | |
|---|---|
| Afri-Can Marine Minerals Corp | Council for Geoscience |
| De Beers Marine (SA) Pty Ltd. | De Beers Namaqualand Mines. |
| Geological Survey Namibia | IZIKO South African Museum. |
| Namakwa Sands (Pty) Ltd | NAMDEB |

**DECLARATION OF INDEPENDENCE**

PALAEONTOLOGICAL IMPACT ASSESSMENT

(DESKTOP STUDY)

EXPLORATION RIGHT APPLICATION FOR WELL DRILLING IN PETROLEUM BLOCK 3B/4B

CONTINENTAL SHELF SLOPE OFFSHORE THE WEST COAST OF THE WESTERN CAPE

AFRICA OIL SA CORP, RICOCURE (PTY) LTD & AZINAM LTD JOINT VENTURE

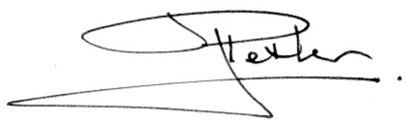
**Terms of Reference**

This assessment forms part of the Heritage Assessment and it assesses the overall palaeontological (fossil) sensitivities of formations underlying the Project Area in terms of the proposed development.

**Declaration**

I …**John Pether**……, as the appointed independent specialist hereby declare that I:

- act/ed as the independent specialist in the compilation of the above report;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- have and will not have any vested interest in the proposed activity proceeding;
- have disclosed to the EAP any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management act;
- have provided the EAP with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not; and
- am aware that a false declaration is an offence in terms of regulation 48 of the 2014 NEMA EIA Regulations.



Signature of the specialist.

Date: 18 DECEMBER 2023.

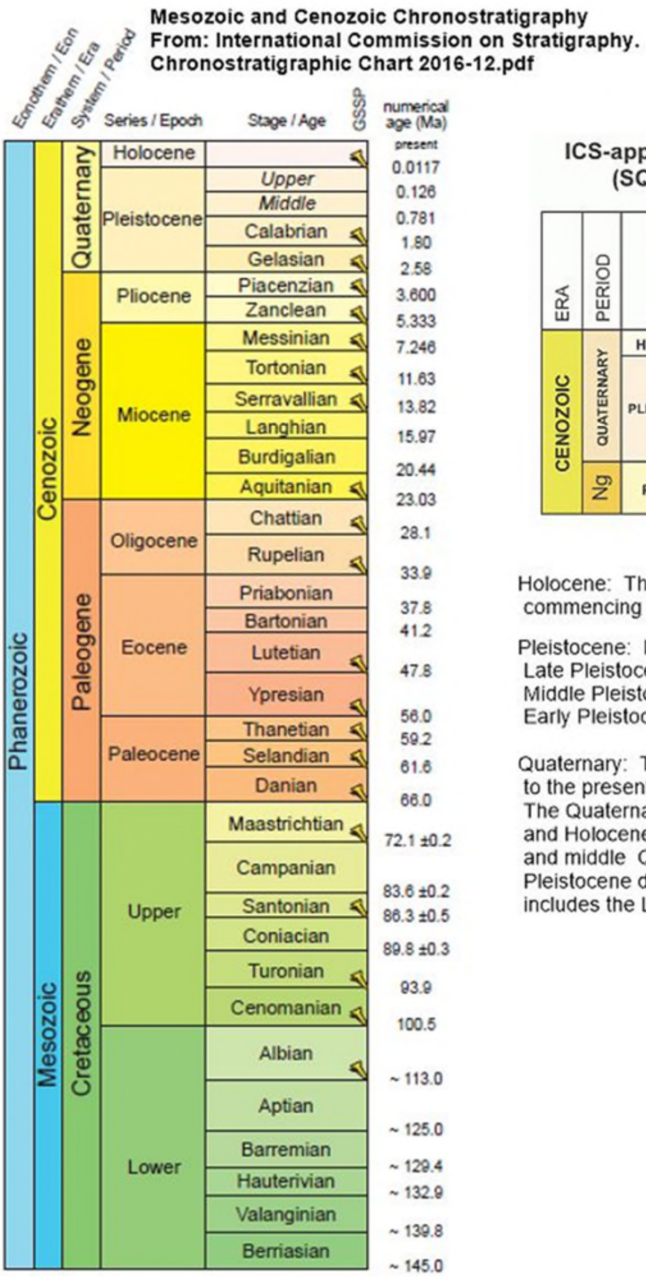
## GEOLOGICAL TIME SCALE TERMS

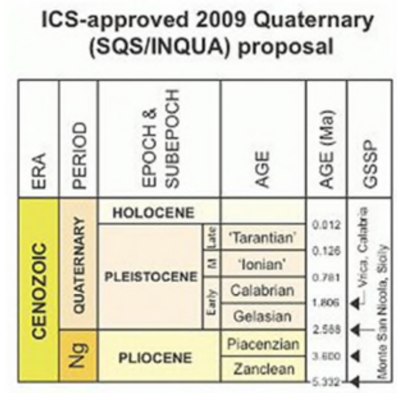
For more detail see www.stratigraphy.org.

ka: Thousand years or kilo-annum ($10^3$ years). Implicitly means "ka ago" *i.e*. duration from the present, but "ago" is omitted. The "Present" refers to 1950 AD. Not used for durations not extending from the Present. For a duration only "kyr" is used.

Ma: Millions years, mega-annum ($10^6$ years). Implicitly means "Ma ago" *i.e.* duration from the present, but "ago" is omitted. The "Present" refers to 1950 AD. Not used for durations not extending from the Present. For a duration only "Myr" is used.

Tertiary Period: Refers to the Palaeogene and Neogene Periods together. Supposed to be obsolete, but still widely in use.




Holocene: The most recent geological epoch commencing 11.7 ka till the present.

Pleistocene: Epoch from 2.6 Ma to 11.7 ka.
Late Pleistocene 11.7–126 ka.
Middle Pleistocene 135–781 ka.
Early Pleistocene 781–2588 ka.

Quaternary: The current Period, from 2.6 Ma to the present, in the Cenozoic Era.
The Quaternary includes both the Pleistocene and Holocene epochs. As used herein, early and middle Quaternary correspond with the Pleistocene divisions, but late Quaternary includes the Late Pleistocene and the Holocene.

## 1 INTRODUCTION

The holders of the Exploration Right for the offshore Petroleum Exploration Block 3B/4B (Figure 1), namely the Joint Venture (JV) comprising Africa Oil SA Corp., Ricocure (Pty) Ltd. and Azinam Ltd., propose to drill an exploration well into a hydrocarbon prospect identified in seismic geophysical data, with the option to drill up to 4 additional wells.

The Africa Oil SA Corp. JV (AOSAC-JV) have appointed Environmental Impact Management Services (EIMS) to undertake a Scoping & Environmental Impact Assessment (EIA) for the application for an Environmental Authorization. Maritime Archaeologist Dr John Gribble (TerraMare Archaeology) has been appointed to undertake the Heritage Impact Assessment (HIA) study to inform the application process. This report is a contribution to the HIA and it describes the potential palaeontological heritage which may be affected by the proposed activities.

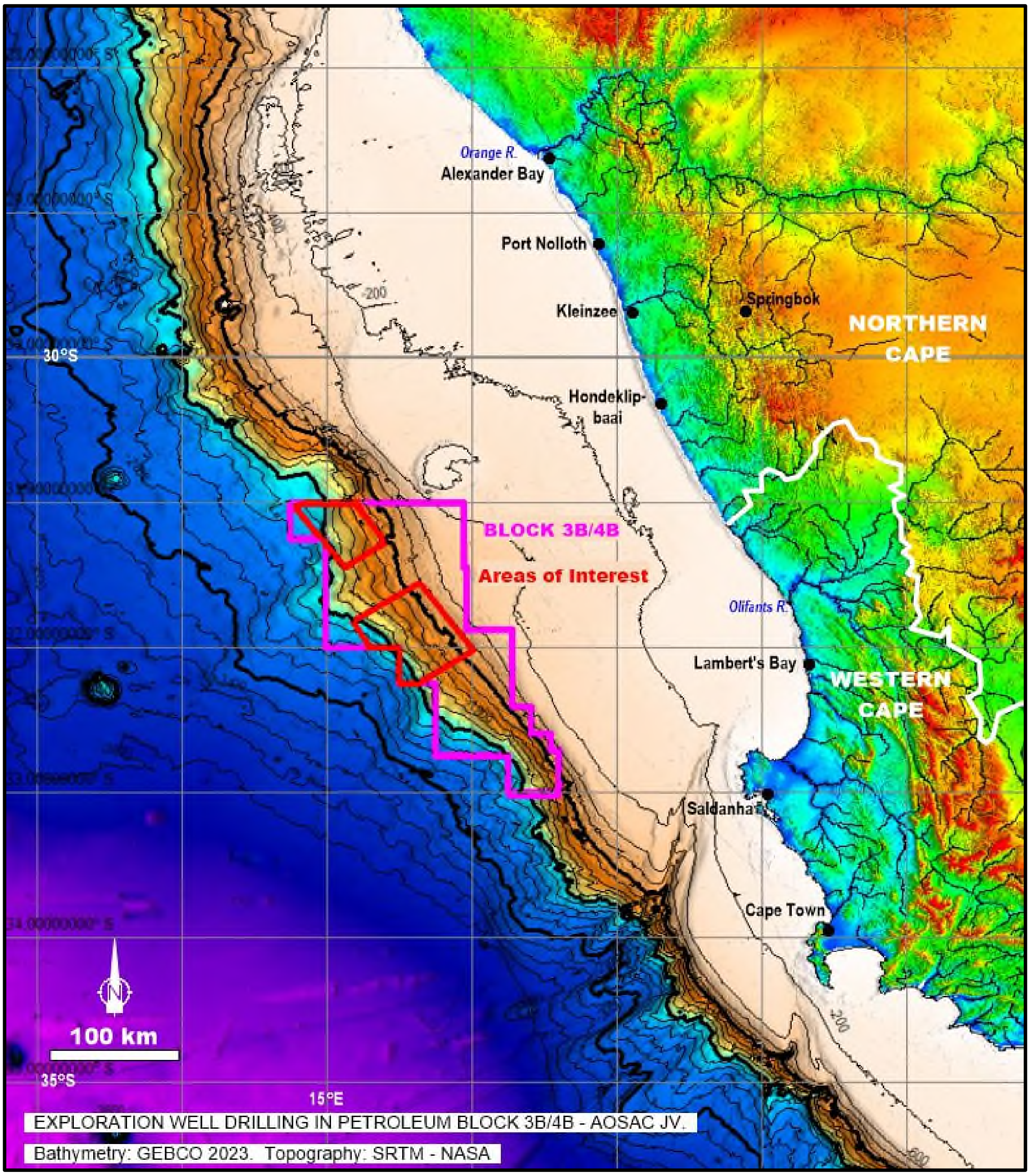



**Figure 1. Location and bathymetric setting of Block 3B/4B and the Areas of Interest.**

The Basic Information Document and Scoping Report was submitted to the South African Heritage Resources Agency (SAHRA) by EIMS. The SAHRA has insisted that a suitably qualified palaeontologist familiar with continental shelf must be appointed to assess potential fossiliferous nature of the seabed geology and provide management measures for potential impacts.

# 2 LOCATION

Block 3B/4B is located offshore of the coast of the Western Cape, with its southern boundary west of Saldanha Bay (33°S), its northern boundary approximately west of the NW coastal corner of the W. Cape (31°S), and generally straddles the continental shelf break and steeping offshore slope, *i.e*. the edge of the continental shelf (Figure 1). Within Block 3B/4B (17 581 $km^2$) two Areas of Interest (AoI) are identified, a northern AoI of approx. 1637 $km^2$ of prime interest and a central AoI of approx. 3069 $km^2$, situated over a depth range of approx. -1000 to -2000 m (Figure 1).

# 3 APPLICABLE LEGISLATION

The National Heritage Resources Act (NHRA No. 25 of 1999) protects archaeological and palaeontological sites and materials, as well as graves/cemeteries, battlefield sites, buildings, structures and features over 60 years old, and shipwrecks. According to the Act (Sect. 35), it is an offence to destroy, damage, excavate, alter of remove from its original place, or collect, any archaeological, palaeontological and historical material or object, without a permit issued by the South African Heritage Resources Agency (SAHRA) or the applicable Provincial Heritage Resources Agency, *viz*. Heritage Western Cape (HWC).

# 4 PROPOSED ACTIVITIES

The initial phase of evaluating the prospects of Block 3B/4B has involved the acquisition of digital seismic data, well data and reports from previous exploration, the reprocessing of the digital seismic data and its analysis and interpretation, well log interpretation, regional mapping and basin modelling studies, in order to rank prospects for exploratory well drilling.

## 4.1 PRE-DRILLING GEOPHYSICAL SURVEYS

Prior to drilling the target well site the area is to be surveyed to establish the baseline natural conditions at the drill site and to identify potential seabed and sub-seabed geo-hazards that may impact the proposed exploration drilling operations. A geophysical survey vessel will undertake acquisition of Multibeam Swath Bathymetry to derive a high-resolution map of the topography of the seabed. Side-scan Sonar provides detail of features and objects on the seabed. Sub-bottom profiles are acquired using a shallow seismic system (e.g. CHIRP) to reveal several metres of the sub-seabed sedimentary structures and presence of cemented layers. A Remotely Operated Vehicle (ROV) could be deployed to investigate and video features of interest.

## 4.2 PRE-DRILLING SAMPLING

Seabed sediment sampling involves the collection of “ground-truth” sediment samples in order to establish the baseline composition and fauna of the seabed. For example, there may be naturally occurring hydrocarbon seepage or some other type of contamination prior to the commencement of drilling. It is currently anticipated that up to 20 samples could be taken across the entire area of interest, amounting to ~35 $m^3$ of material.

Box corers and grabs sample the uppermost ~0.5 m of the seabed and are usually deployed for baseline studies of sediment textures, composition, geochemistry, organics and fauna. Piston corers penetrating 6-9 m into the seabed ground-truth the structure seen in the sub-bottom profiles and the cores provide geotechnical data, in addition to signs of hydrocarbon seepage. The analysis of cores several metres in length provides insights into the conditions at the site over the longer term, such as several thousand years or even >50 ka (ka – thousand years ago).

## 4.3 WELL DRILLING

AOSAC-JV is proposing to drill up to five exploration wells within the Areas of Interest in Block 3B/4B, with initial sites in the northern AoI. The expected water depth is in the range of -500 to -1700 metres with the expected drilling depth being about 3570 m below the seabed.

The drilling is to be undertaken by either a drill ship or a semi-submersible drill rig platform on pontoons, depending on availability, drilling specifications and costs. Both have dynamic positioning by satellite GPS linked to thrusters to stay on site. A drill ship has the advantage of independent mobility, while a drill rig must be towed to site and has greater support vessel needs.

The well is drilled with a cutting drill bit attached to a rotating tube called the drill string. As the hole is drilled it is cased with sections of steel pipe, each slightly smaller in diameter, which are permanently cemented in place, with the hole diameter decreasing with depth. The casings isolate dangerous high-pressure zones from each other and from the surface. The well design depends upon factors such as planned depths, expected pore pressures and anticipated hydrocarbon-bearing formations. Several types of drilling fluids with different compositions and densities would be used for drilling operations, according to the conditions.

During drilling the material from the hole is removed by viscous drilling fluids which are pumped down the inside of the drill pipe, pass through holes in the drill bit and transport sediments and rock cuttings upwards through the space between the drill string and the walls of the hole.

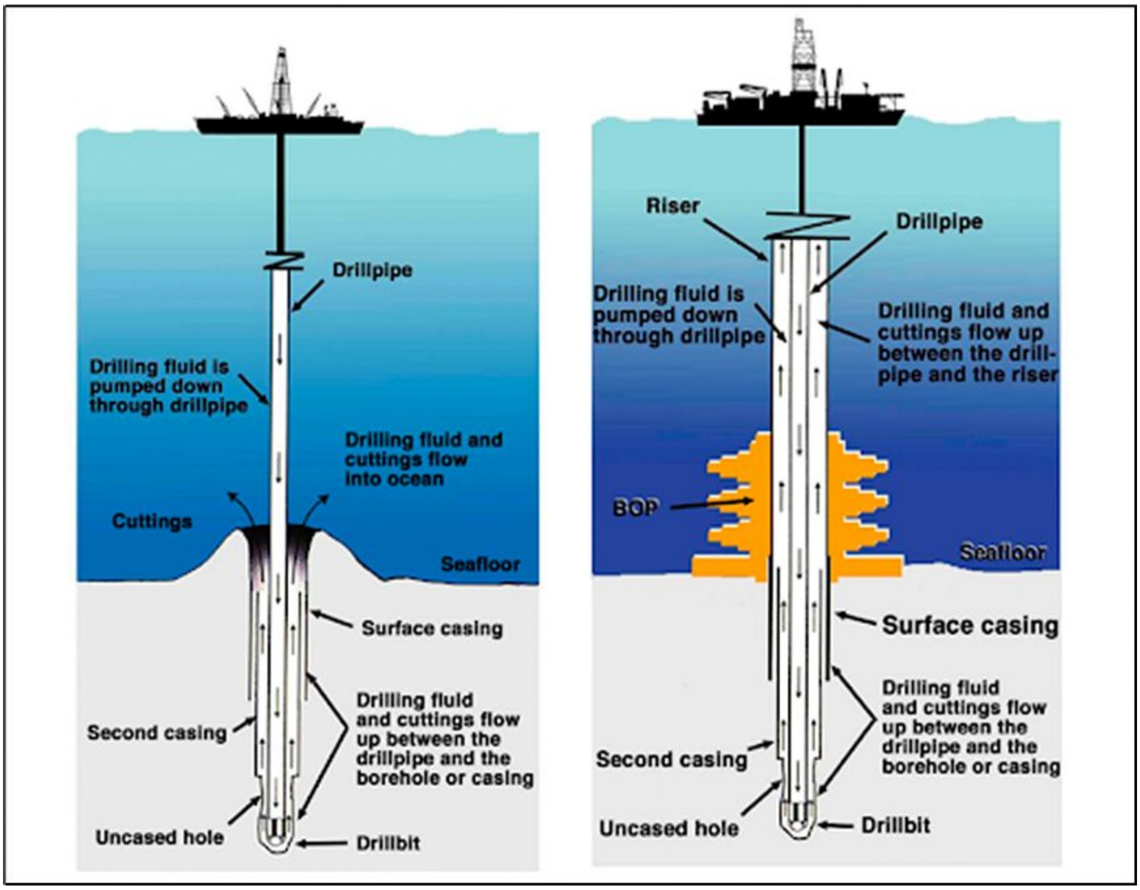



**Figure 2. The riserless drilling, spudding-in stage (L) and the risered drilling stage (R). Figure from Scoping Report.**

The drilling is undertaken in two stages, namely the riserless or spudding-in stage and risered drilling stage (Figure 2).

#### 4.3.1 Riserless Spudding-in

Due to the soft nature of the seabed sub-surface the upper part of the drill hole must be cased by a large diameter pipe (~0.8 m diam.) to prevent hole collapse and to support the wellhead on the seabed. This conductor pipe is drilled and cemented in position, with the cement pumped downhole and returning upwards to fill the annular space between the conductor pipe and the hole. The conductor pipe is inserted to a typical hole depth of ~70 m. A new drilling assembly of smaller diameter will be run inside the conductor pipe and the next hole section will be drilled to a depth of approximately 320 m and its casing cemented in place. This ~50 cm casing will have a high-pressure wellhead on top which provides the entry point and is the connection point to the Blow-Out Preventor (BOP) (Figure 2).

These initial hole sections will be drilled using seawater and Water-Based Mud (WBM). All cuttings (~131 $m^3$) and WBM from this initial drilling stage will be discharged directly onto the seafloor adjacent to the wellbore.

#### 4.3.2 Risered Drilling

The risered drilling stage commences with the lowering of a BOP and installing it on the wellhead. The BOP is designed to seal the well and prevent any uncontrolled release of fluids from the well (a ‘blow-out’). A riser is installed on top of the BOP to convey the drilling fluid and cuttings to the vessel. In a “closed loop system” the ~257 $m^3$ of cuttings are sieved out from the drilling fluid on a “shale shaker” and the drilling fluid is returned to the circuit (Figure 3). The cuttings are sampled for analysis and discharged overboard.

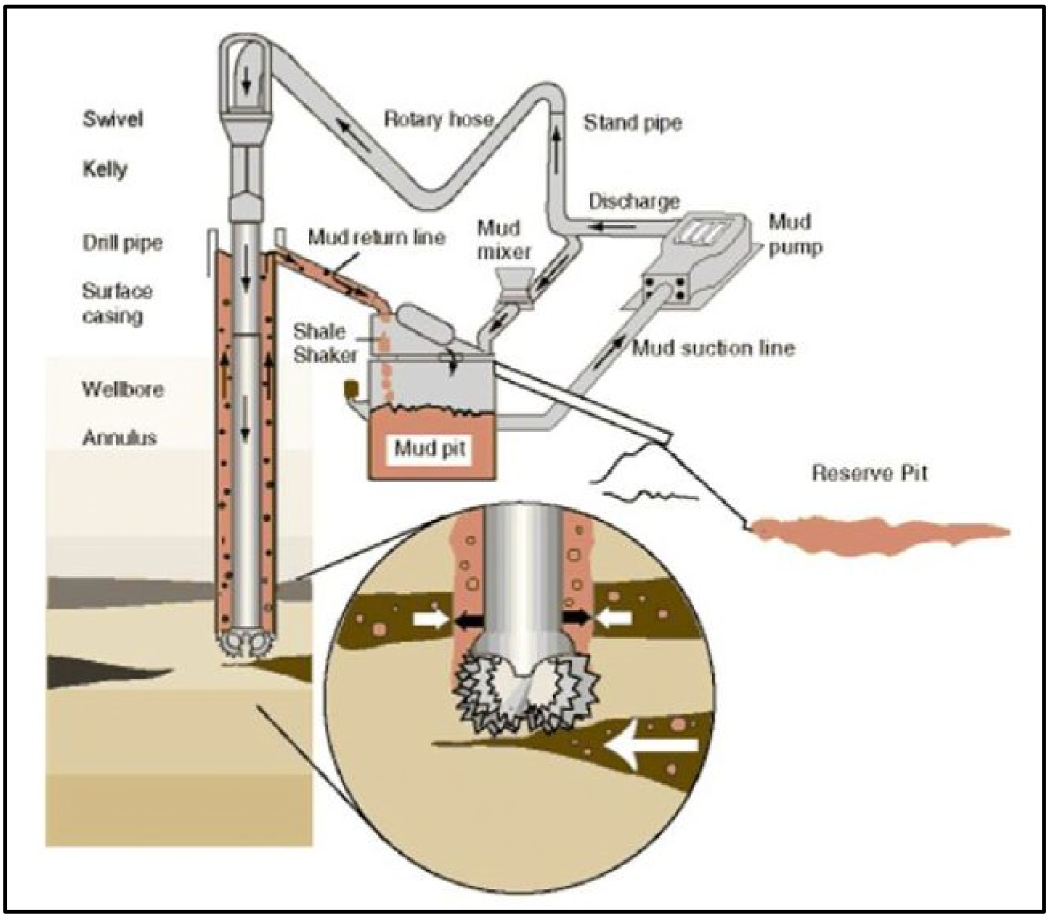



**Figure 3. The Closed Loop System for capture of cuttings and drill fluid recycling.**

Once the target depth is reached, the well would be logged and could be tested dependent on the drilling results. Well logging involves the evaluation of the physical and chemical properties of the sub-surface rocks, and their component minerals, including water, oil and gas to confirm the presence of hydrocarbons and the petrophysical characteristics of rocks. It is undertaken during the drilling operation using Wireline Logging or Logging While Drilling instrument packages to measure and log downhole data. Vertical Seismic Profiling (VSP) involves airgun shots which are recorded by receivers inside the drill hole and the images are used for correlation with surface seismic images and for forward planning of the drill bit during drilling.

# 5 METHODOLOGY

## 5.1 THE LITERATURE

Exploration for fossil fuels has been the main driver for determining the large-scale litho-, bio- and chrono-stratigraphy of continental shelves to depth. The palaeontology (fossil life forms and their evolution) of a variety of microscopic remains of both marine and terrestrial animals and plants provide the means to divide up long cores through kilometres of the offshore sediment pile into formations of different origins and ages. Mapping of the shelf bathymetry and the nature of seabed sediments in increasing detail is an ongoing endeavour, for both ecological and mineral resource purposes. Sediment bodies on the shelf have been cored to access their sea-level change and palaeoclimatic records. This has generated a considerable marine geological literature by the collaborative efforts of scientists in employ of companies, the state and in academia. The contributions relevant to this assessment are cited in the normal manner as references in the text and are included in the References section.

## 5.2 ASSUMPTIONS AND LIMITATIONS

The main assumption is that the fossil potential of a formation in a study area will be typical of that found in the region and more specifically, similar to that already observed in the study area. A limitation on predictive capacity exists in that it is not possible to predict the fossil content of an area or formation other than in such general terms.

# 6 GEOLOGICAL SETTING

## 6.1 REGIONAL CONTEXT

The basic composition of the surficial sediments on the shelf and slope (Figure 4) shows that the seabed of the AoIs is largely composed of the shells of planktonic foraminifera microfossils, generally referred to as “foram ooze”.

The wider context in terms of shelf edge processes (Figure 5) shows the AoIs situated along the fissured zone of upper slope collapse, with large-scale downslope slumping and sliding and accumulation of turbidite lobes forming the continental rise. The latest slumping appears to be of early Quaternary age. Seismic profiles reveal preceding slumping along the palaeo-shelve edges of early and late Upper Cretaceous ages and of Palaeogene age (Dingle, 1980).

The seabed geology beneath the Quaternary surficial sediment cover is shown in Figure 6. Based on old and very incomplete data (Dingle & Siesser, 1977) this map is very rudimentary, as has been shown further north off Namaqualand by diamond exploration geophysics, coring and drilling revealing greater complexity. To briefly extrapolate what is not depicted in Figure 6, the Cretaceous formations underlying the middle shelf young seaward in coast-parallel sub-crops successively including the Albian-Cenomanian, Turonian and Coniacian formations and farther offshore there are windows of Santonian. The overlying Paleogene sequence is mostly of Eocene age. Miocene carbonate deposits extend over the outer shelf, with the early Miocene (Burdigalian) overlain seawards by mid-Miocene (Langhian) carbonates, in turn succeeded by late Miocene and Pliocene carbonates accumulated on the slope, in the Block 3B/4B area (see more below).

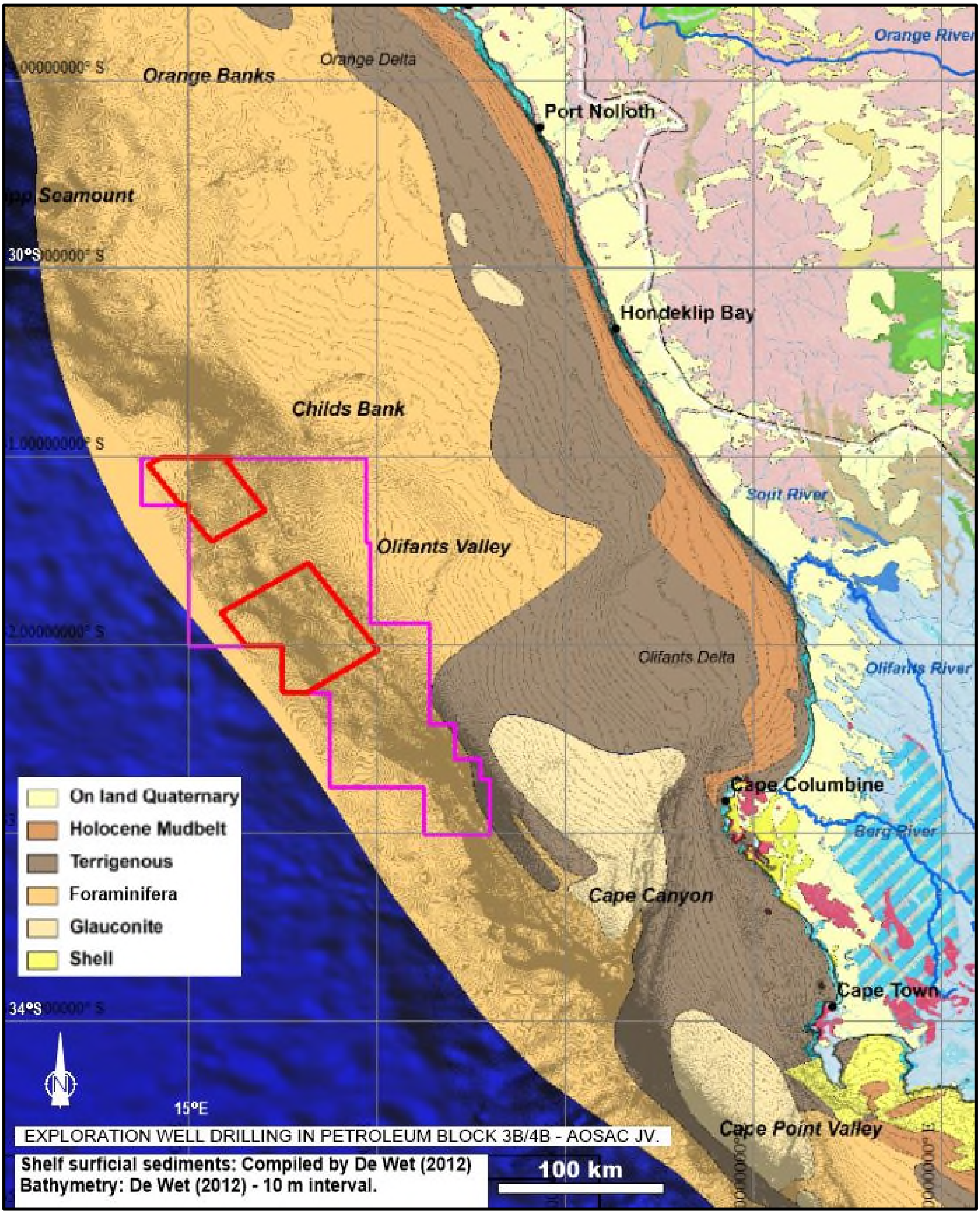



**Figure 4. Shaded bathymetry and shelf sediment cover.**

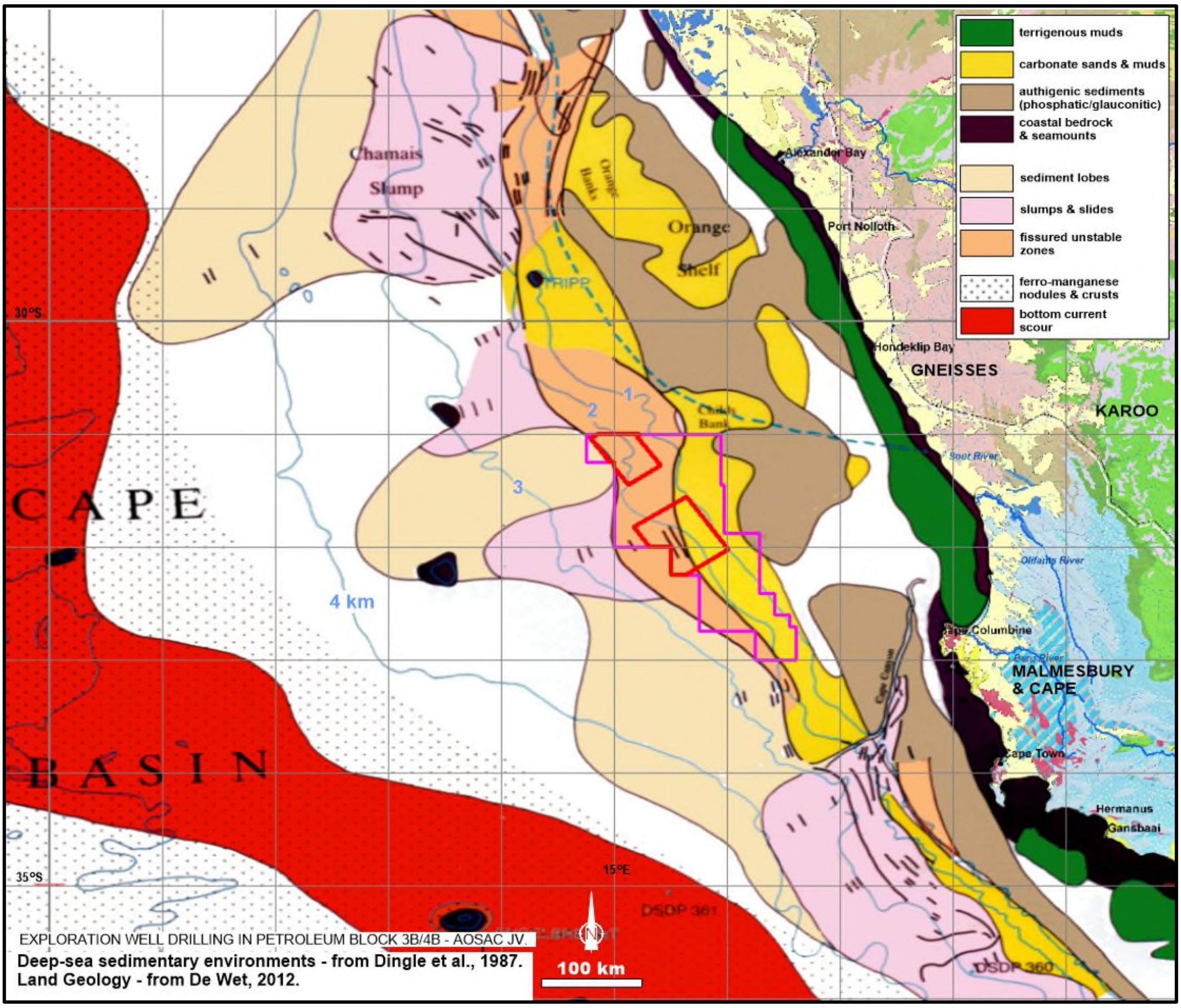



**Figure 5. Slumps, slides and turbidite fans on the West Coast margin.**

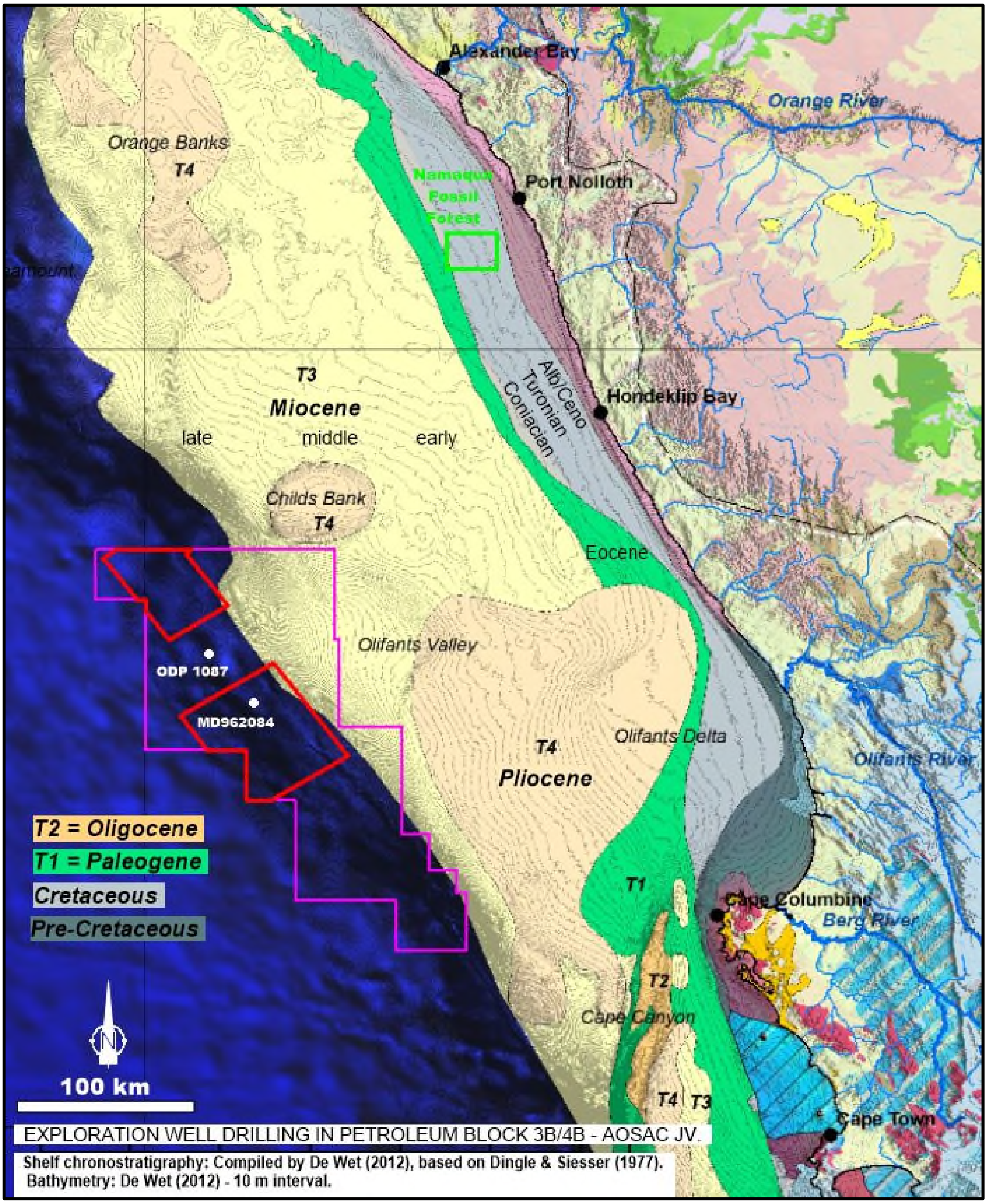



**Figure 6. Pre-Quaternary chronostratigraphy of the top of the continental shelf.**

## 6.2 THE ORANGE BASIN

The geology of Block 3B/4B from the technical hydrocarbon exploration point of view, based on geophysical seismic data and exploration well data, has been most adequately described in the Scoping Report. A general brief account is presented below.

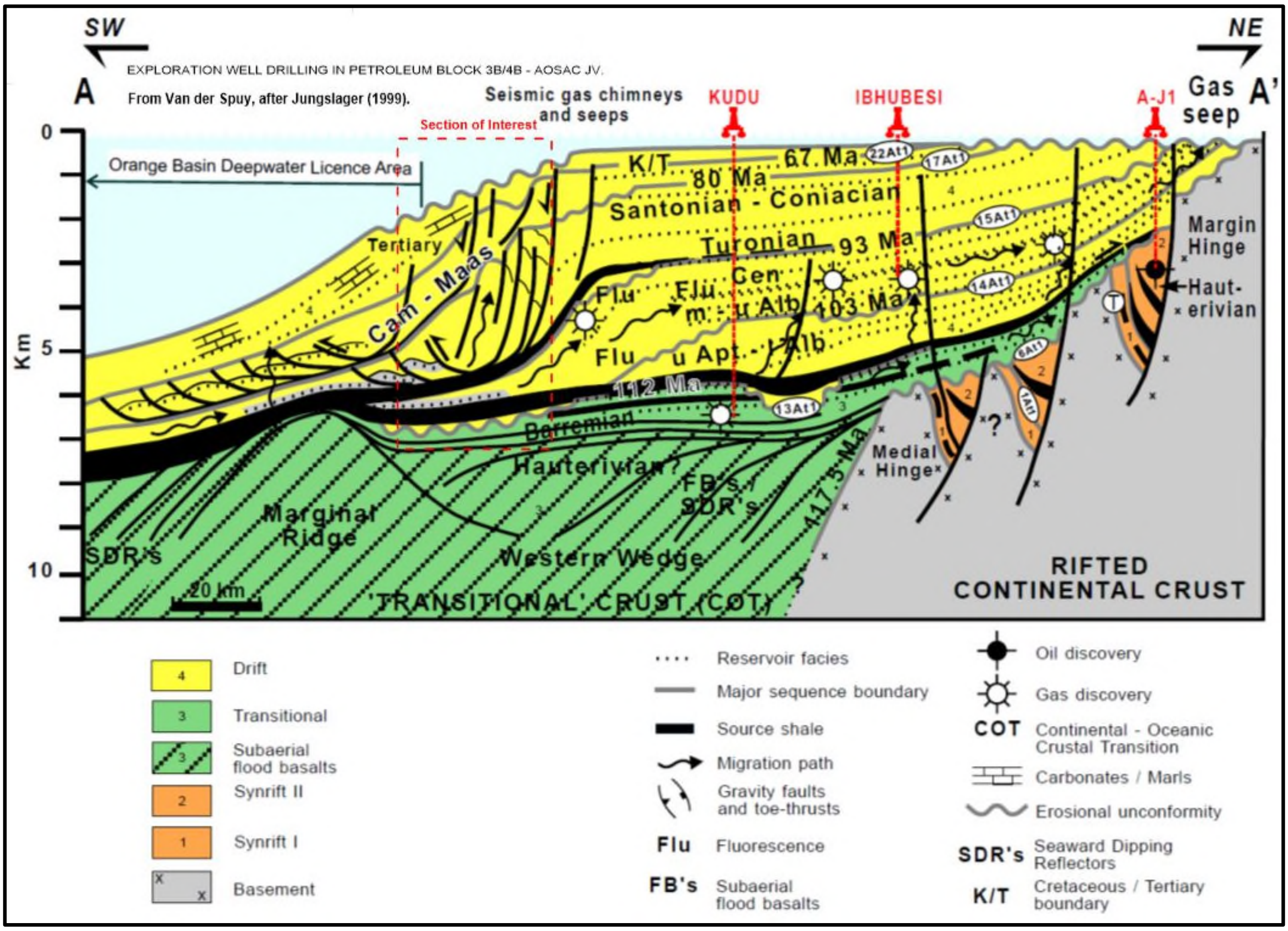



**Figure 7. Schematic chronostratigraphic section of the Orange Basin continental shelf.**

The Cretaceous strata which comprise the bulk of the continental margin were deposited during and subsequent to the rifting of the Gondwana supercontinent and the opening of the Atlantic Ocean 134-120 Ma (Ma=million years ago) (Figure 7). The rifting phase involved down-faulting of the continental crust by extension, forming grabens in which the synrift terrestrial and lacustrine sediments were deposited, while massive outpourings of volcanic flood basalts accumulated in the main rift, the flows now represented by the Seaward Dipping reflectors (SDRs) (Figure 7).

After the rifting phase, from Barremian times, the subsiding rifted landscape was covered sediments delivered to the expanding Cretaceous South Atlantic Ocean during the Drift Phase. Wide coastal plains and deltas formed as many large rivers deposited large volumes of fluvial sediments eroded from the well-watered hinterland (Figure 8). These Albian-Coniacian proximal alluvial/fluvial coastal plain and deltaic formations form the sub-seabed along the inshore of the shelf. In the offshore marine processes spread the finer sands and muds further to form the deeper shelves extending seawards and slumping at the shelf edges carried sediments downslope into deep water. Successive shelves built out and upwards as the underlying crust subsided. These now fill what is called the Orange Basin, which includes an accumulation of Cretaceous sediments 6 to 8 km thick.

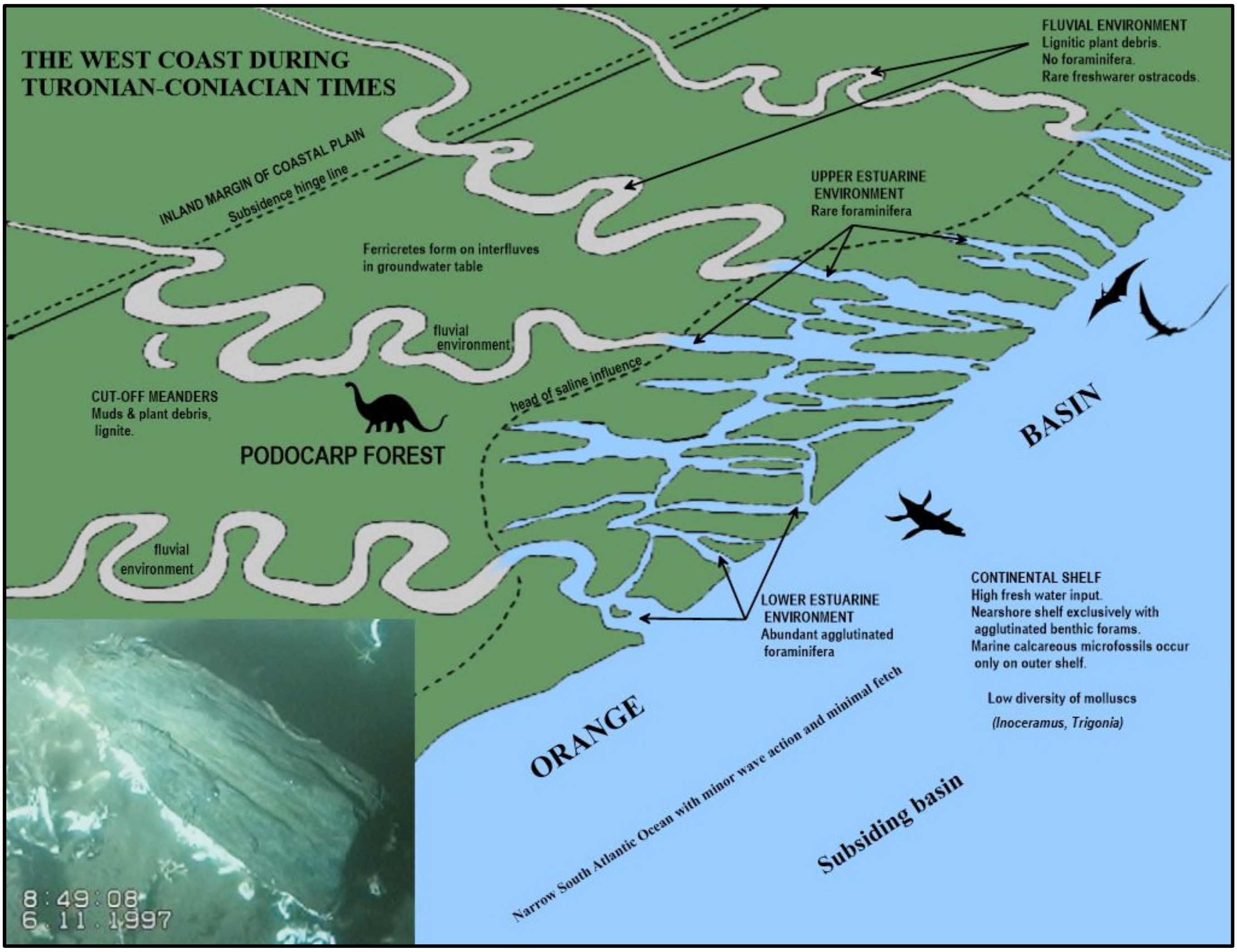



**Figure 8. The Coniacian coastal plain (adapted from Stevenson & McMillan, 2004). Inset: Fossil log (from Stevenson & Bamford, 2003).**

Overall, after the Cretaceous Period, the supply of land-derived terrigenous sediments to the margin and its rate of subsidence has decreased during the Tertiary/Cenozoic as the subcontinent became more arid, with a concomitant increase in the importance of carbonate biogenic sedimentation and authigenic mineralization (Dingle *et al*., 1983). Weak upwelling developed since the middle Cenozoic and intensified from the late Miocene as global climatic deterioration progressed. The effect of late Cenozoic upwelling has been the widespread occurrence of phosphatic and glauconitic authigenic mineralization on the shelf and extensive phosphatization of Tertiary limestones exposed at the sea-bed (T3 and T4.)

On the shelf the Cenozoic formations, above the K/T contact (Figure 7) are relatively thin, but thicken seawards over the slope, beneath of which Paleocene and Eocene deep marine clays occur. The succeeding Miocene and Pliocene deposits offshore are pale carbonates comprised of forams, bryozoan debris and small molluscs such as scallops (*Pecten* spp.).

## 7 PALAEONTOLOGICAL HERITAGE ON THE SHELF

The fossils which occur on the shelf have mainly been found at middle shelf depths where they come to light during diamond mining and sampling and appear on the vibrating screens which sieve out oversize gravel and sand, which are over-boarded. Observation, logging and sampling of the gravel stream occurs at the screens, where fossils can also be collected (Figure 9). As examples the types and contexts of fossils are summarised below, although similar contexts do not pertain in the deep-water slope setting.

**Figure 9. The oversize screen on diamond sampling and mining vessels., where fossils are spotted and rescued from being over-boarded.**

**Cretaceous fossil wood** occurs primarily in the gravels on the flat middle shelf which directly overlie the source Cretaceous formations. Petrified wood is common and includes areas where petrified logs litter the seabed, the "fossil forests". Specimens obtained via diamond exploration are providing valuable insights into the palaeo climates of the Cretaceous West Coast, when wide, well-watered coastal plains were covered by forests of primitive yellow wood (podocarp) trees (Figure 8) (Bamford & Corbett, 1994; Bamford & Stevenson, 2002; Stevenson & Bamford, 2003). The ***Namaqua Fossil Forest*** is an area southwest of Port Nolloth (Figure 6) which has been declared a Marine Protected Area. *Fossil wood is not expected in Block 3B/4B due to the lack of Cretaceous formations directly underlying the seabed and the more offshore, distal setting of the buried Cretaceous formations beneath the slope.*

The **Cenozoic shelly macrofauna** comprises phosphatic shell casts and more rare intact shells of various ages. During later Neogene and Quaternary times the shelf was dominated by upwelling processes, with high organic productivity and authigenic mineralization of seabed rocks, clays and biogenic particles by phosphatization and glauconization. Extensive cemented crusts or "hardgrounds" formed on formations exposed at the seabed, *e.g*. Miocene beds. Sea level oscillated repeatedly, dropping to ice-age palaeoshorelines as much as 140 m below present sea level. The hardgrounds were eroded during the ice-age/glacial shallowing episodes, releasing these fossils for incorporation into the Quaternary gravels. *Non-depositional and erosional conditions concomitant with shallow-shelf depths and glacial/interglacial sea-level fluctuations do not pertain at slope depths and reworked fossils are not expected.*

**Fossil bones and teeth** include the bones and teeth of sharks and other fishes, the skulls of extinct whale species and the occasional remains of land-living animals that roamed the ice-age exposed shelf are also phosphatized and reworked into the latest, loose Last Transgression Sequence sediments on the seabed. A sample of this reworked material turns up in bottom-trawl fishnets, scientific dredging and during diamond-mining operations and the specimens which have been donated to scientific institutions have been invaluable contributions (*e.g*. Bianucci, Lambert & Post, 2007; Bianucci, Post & Lambert, 2007). All such material should be collected.

**Shells from the Last Transgression Sequence (LTS)** refers to the "sub-fossil" shells that occur abundantly in the sediments accumulated on the shelf during the last 20 thousand years as it was submerged to increasing depths. The marine shell fossils which occur in the LTS are predominantly the species expected on the West Coast Shelf, in a deepening-water faunal succession with littoral epifaunal species in the basal gravels, succeeded by infaunal bivalves in clean sands, succeeded by bivalves adapted to dwelling in the capping sulphidic muds. However, unexpected species and “extralimitals” (species beyond their normal home range) are actually quite common.

For instance, the Last Ice Age palaeoshoreline gravels are dominated by a “Venus shell” clam, *Tawera philomela* (Figure 10). This cold-water species, along with others, reached the Cape coast from the mid-Atlantic islands of Tristan da Cunha and Gough, apparently thrived here and then became extinct locally during the last deglaciation (Pether, 1993). During the subsequent deglaciation/warming, several warm-water species from the south and east coasts “invaded” the western shelf temporarily (Figure 10).

This shows a more marked influence of Agulhas water rounding the Cape and affecting the Benguela System during the global-warming steps of the last deglaciation (Pether, 1994). These Agulhas extralimitals have mainly been found during diamond sampling/mining off northern Namaqualand – one may expect them to be more abundant further south such as in 12C, as well as more species occurring. It is important to obtain a comprehensive sample of these occurrences for future study. In addition to dating the incursions on Agulhas influence, the individual shells are snapshot archives of the palaeoceanographic conditions at the time, as revealed by incremental analyses of stable isotopes and trace elements by “spot trails” across the growth lines of shells.

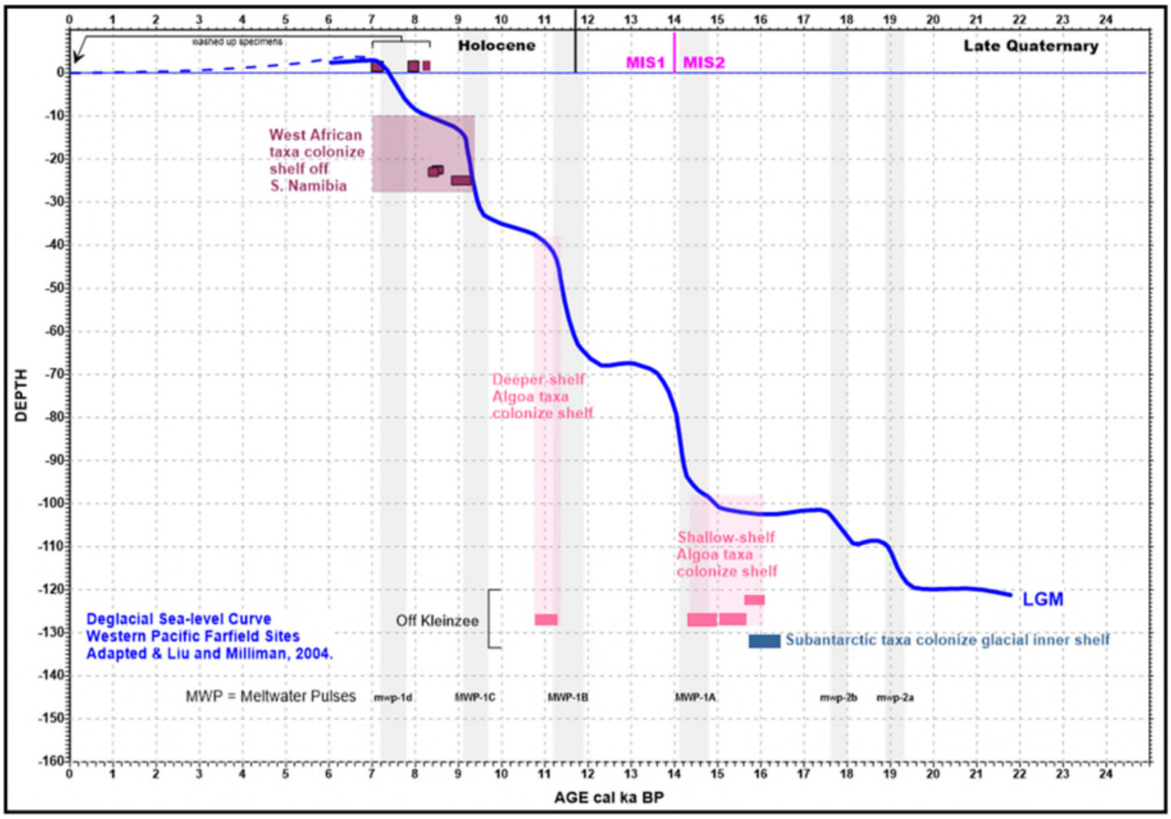



**Figure 10. Sea-level curve for the last deglaciation, showing contexts of dated shells from the West Coast Shelf.**

*At the depths of Block 3B/4B the seabed has not been subjected to marked shallowing and deepening during glacial and interglacials and these sea-level fluctuations are not expected to influence the sedimentological regime and the benthic faunas.*

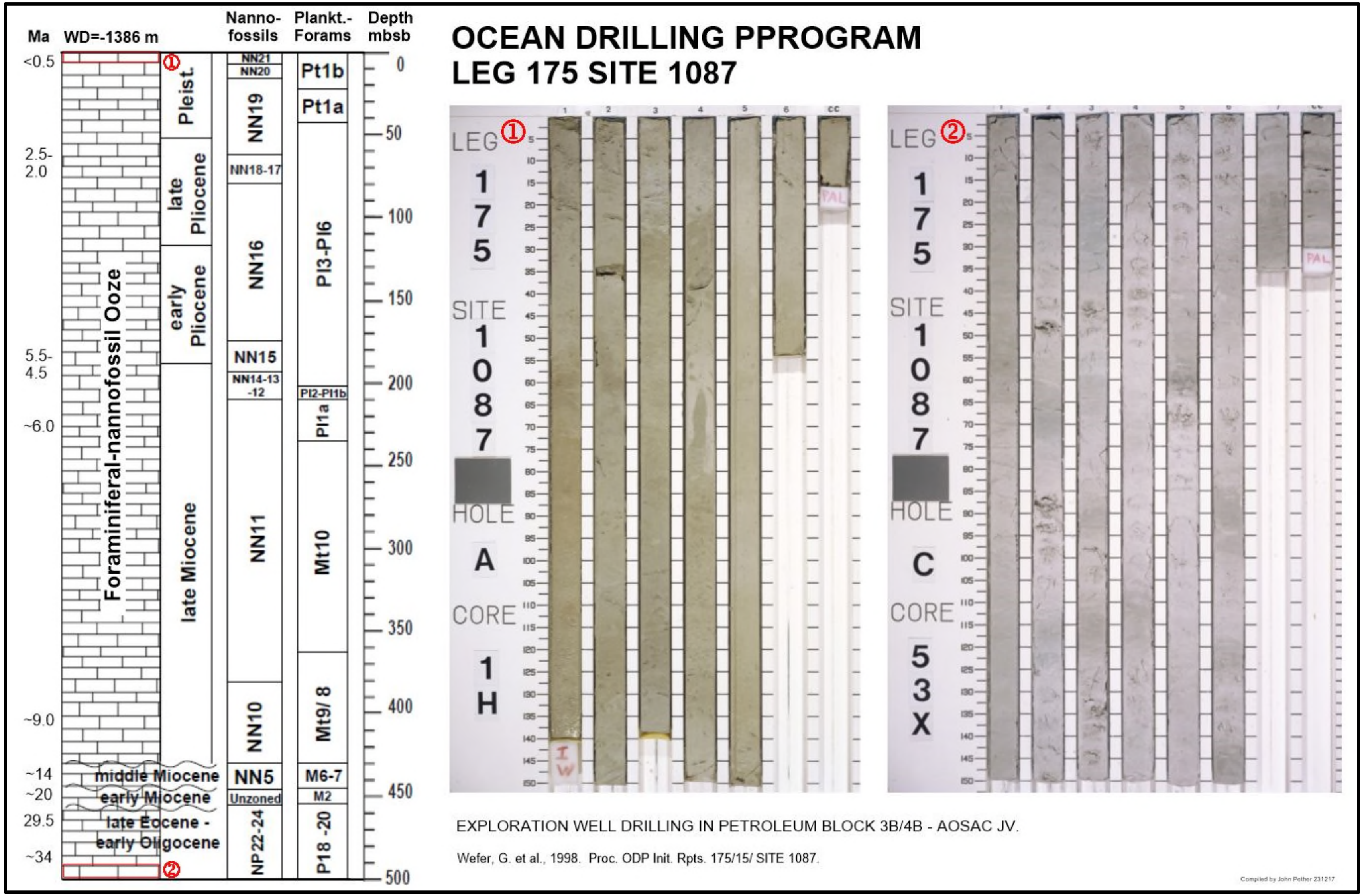



**Figure 11. Ocean Drilling Program core 1087 and its biostratigraphy (ages of strata downcore), based on the age ranges of microfossils. Location shown in Figure 6.**

## 8 PALAEONTOLOGICAL ASPECTS OF THE CONTINENTAL SLOPE

Two palaeo-oceanographic scientific research drill cores acquired in Block 3B/4B inform of the nature of the expected sediments and fossils – an Ocean Drilling Programme core at Site 175/1087 and a giant piston core acquired on the 2nd voyage of the French RV Marion Dufresne.

At site ODP 1087 cores were acquired to a depth of nearly 500 m below seabed and the entire sequence consists of an accumulation of microfossils, as a fine-grained foraminiferal-nannofossil ooze (Figure 11). Most of the microfossils accumulated since about 10 Ma at a rate of 2-7 cm/1000 yrs. The lowermost 60 m coring penetrated a condensed section with missing intervals ranging back to about 34 Ma.

The giant piston core (gravity drop-core) (Figure 12) penetrated to about 36 m bsb and also consists of foraminiferal-nannofossil ooze. The core was dated by analysis of the oxygen isotope content of the shells of planktonic microfossils sampled at 10 cm intervals, which mainly records global polar ice volumes (alternating ice ages and warm interglacial periods).

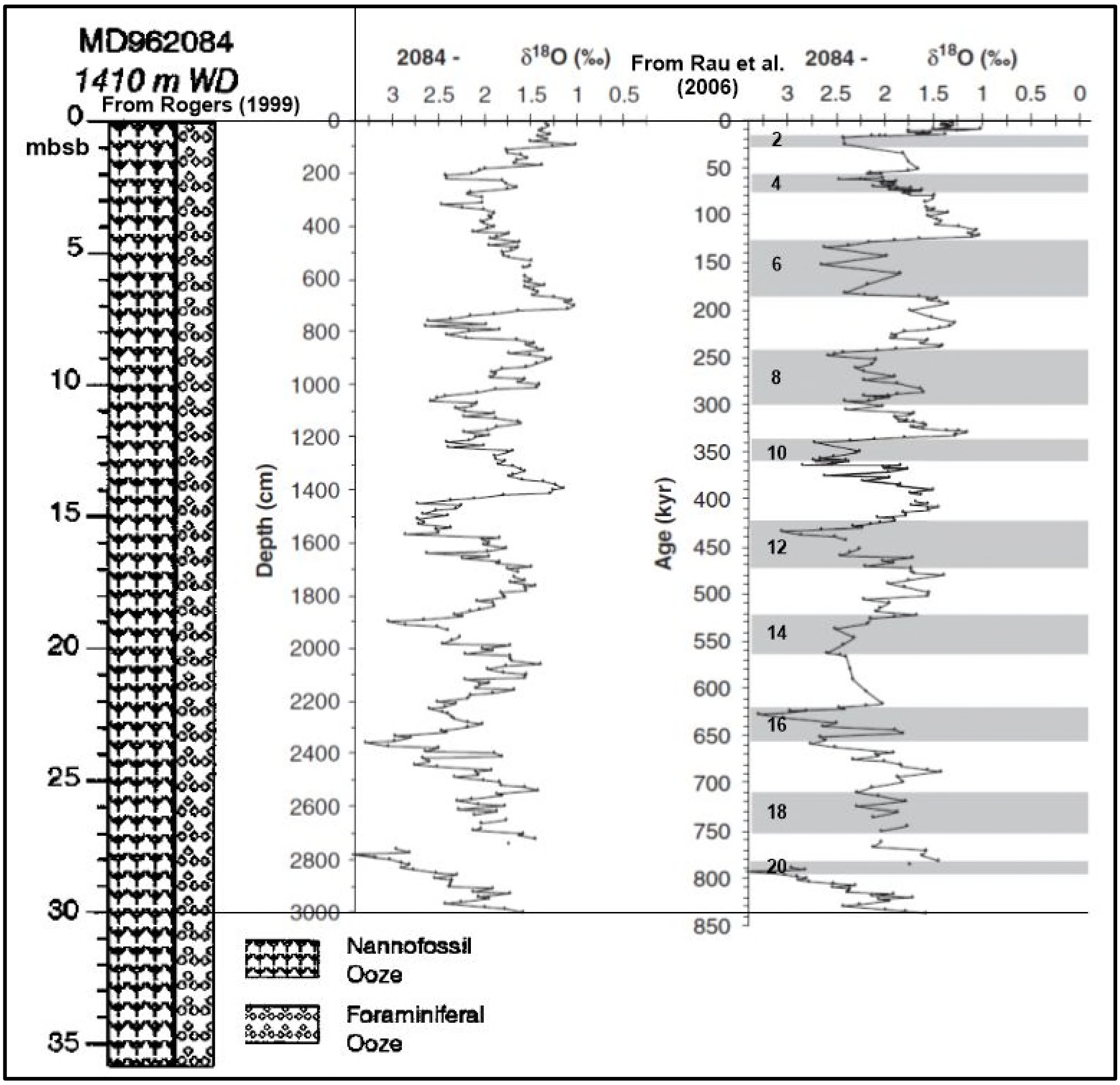



**Figure 12. Giant piston core MD96-2084 and it chronostratigraphy (age model downcore) based on the Oxygen-isotopes measured in samples of shells of planktonic microfossils. Grey bars mark ice-age (glacial) intervals labelled according to Marine Isotope Stages (MISs). Location shown in Figure 6.**

The ODP 1087 core images of the uppermost and lowermost core sections show the homogenous nature of the bioturbated (burrow-mottled) foraminiferal-nannofossil ooze (Figure 11), composed of covarying proportions of planktonic foraminifera (forams) (Figure 13 and calcareous nannofossils (Figure 14), otherwise referred to as coccoliths. The cores are basically a gritty lime mud which with depth is being transformed into a gritty chalky limestone (Figure 11, bottom cores). Other planktonic microfossils which are likely to occur are siliceous radiolarians and diatoms, and terrestrial pollen and dust blown out to sea.

Planktonic foraminifera are single-celled protists which secrete quite complex sand-grain size shells full of little holes (fora) from which they stream filaments to catch little snacks in the water column. A whole variety of species preferentially occupy different water masses, at different depths and temperatures, most basically tropical, subtropical, temperate, subpolar, polar. When dead the shells sink to the seabed and the mix of species at a site reflects the influences of different water masses. An important research topic is the changes in the influence of Agulhas water in the Benguela Upwelling System through time, which is recorded in the microfossils in cores. A variety of ocean water mass geochemical properties are incorporated in the geochemistry of the microfossil shells, such as the proportions of isotopes of elements, which change with changes in past oceanographic conditions. Furthermore, different foram species have evolved, changed and become extinct through time, and the extinct species time ranges have been painstakingly established, so that the presence of an extinct species in a new core provides age constraints.

Nannofossils are the remains of calcifying phytoplankton, the Coccolithophores - photosynthesizing single-cell algae which produce elements of distinct shapes. As with forams, there are extinct species whose time ranges have been established and are used to provide age constraints for marine cores.

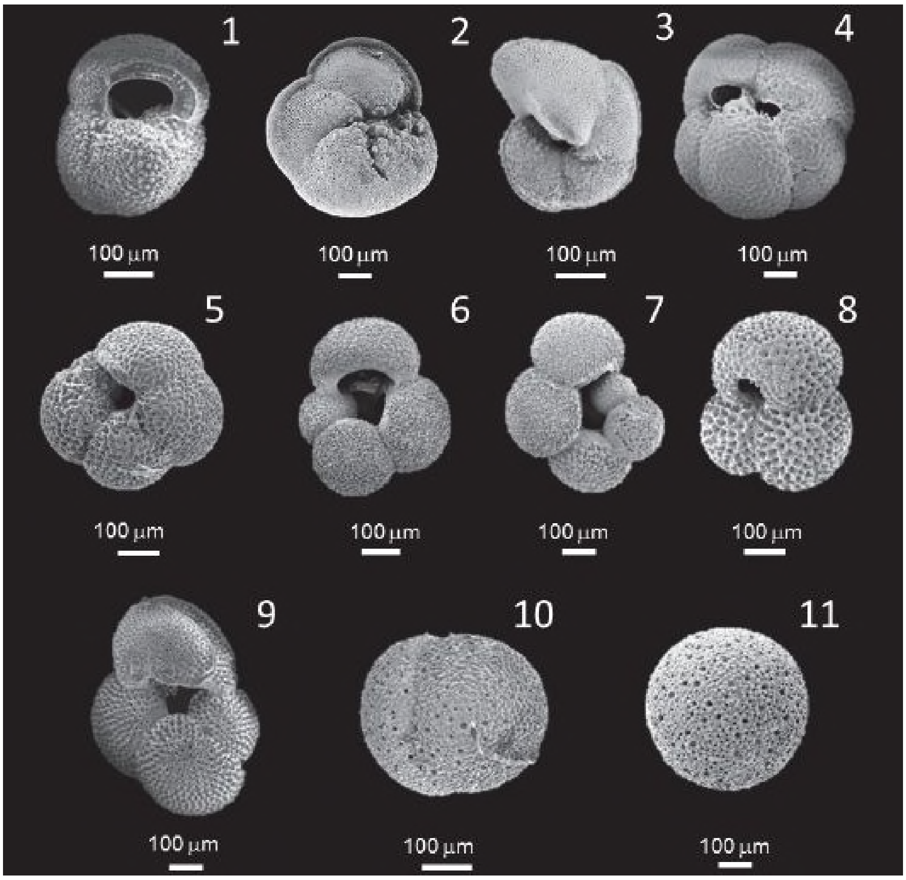



**Figure 13. Planktonic foraminifera. 1. Globoconella inflata. 2. Globorotalia menardii. 3. Globorotalia truncatulinoides. 4. Neogloboquadrina dutertrei. 5. Neogloboquadrina incompta. 6 Globigerina bulloides. 7. Globigerinella siphonifera. 8. Globigerinoides ruber. 9. Trilobatus sacculifer. 10. Orbulina bilobate. 11. Orbulina universa. Image from Bergh & Compton, 2020.**

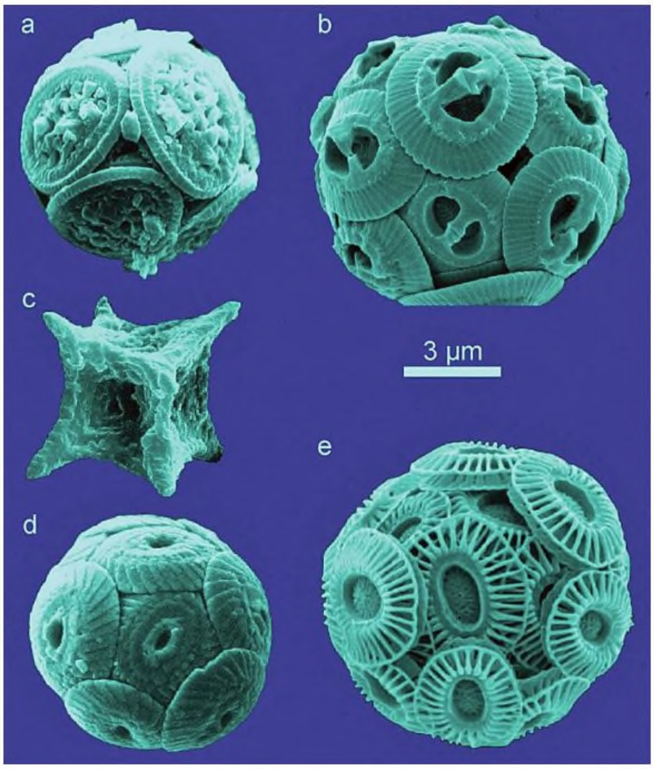



**Figure 14. Calcareous nannofossils. Note their mud particle size *vs* the sand grain size of the foraminifera. Image from Sturm, 2016.**

Macrofossils such as molluscs are not recorded from these cores, but certainly occur in the deep-sea environment. The bioturbated cores show that the seabed hosted an infauna, but the soft upper part of the seabed often washes out the coretop.

Notably, molluscs from deep dredging examined by Barnard (1963) comprised a host of new species, mostly small predatory gastropods. However, to this day the deep-sea fauna is very poorly known.

Vertebrates will mainly be represented by shark and other fish teeth and bones. The remains of marine mammals such as cetaceans and seals are likely to be very sparsely distributed and are mainly brought up in bottom trawling swaths over a large area.

# 9 ANTICIPATED IMPACTS

## 9.1 PRE-DRILLING SURVEY

Palaeontological objects are very unlikely to be identified by the geophysical surveys, except perhaps for the large bones from "whale falls". Any such remote occurrence on the seabed is unlikely to be very old, given the appetites of the whale-bone eaters.

## 9.2 PRE-DRILLING SAMPLING

Box cores and piston cores from the slope depths are rare opportunities to sample the poorly-known modern deep-sea fauna. Box cores and grabs are designed to sample the soft seabed in which most of the seabed fauna resides and should capture some molluscs.

Although a 6 m or 9 m piston core may extend back in time to about 150 ka and 250 ka, resp. (*e.g.* Figure 12, Core 2084), due to the conservative nature of the deep-sea faunas, extinct taxa are not expected to occur in the late Quaternary. In the absence of detailed study of the pre-drilling cores the negative impact of the activities will be high. **However, the purpose of the box and piston cores is for determining the**

**baseline conditions at the drill sites and they are destined for analysis, in which the shelly macrofauna and other skeletal material will be revealed and will require identification by a specialist, with a positive scientific outcome.**

### 9.3 WELL DRILLING

The riserless, spudding-in process does not provide any opportunities for observing and collecting fossils as drilled material is ejected onto the seabed. The upper part of the drilled sequence is "lost" and, with ODP 1087 as an example, the risered drilling would commence at about -320 mbsb when the drillbit is well into the Miocene strata.

It is standard procedure to sample the cuttings separated on the "shale shaker" for the purposes of lithological and geotechnical analysis, and for micro-palaeontological analyses by consulting specialists in order to provide age, correlation and palaeo-environmental constraints. These very costly data and their interpretations often come to be published by exploration company geo-personnel and consultants, as is readily evident in the vast volume of scientific literature emanated from the hydrocarbon exploration industry. The data may also be archived for commercial intentions**. In this sense mitigation is built into the exploration drilling and sampling process and the anticipated impact is positive.**

## 10 IMPACT ASSESSMENT

The Impact Assessment Methodology employed is the provided by EIMS in the scoping Report.

### 10.1 RATINGS TABLE

| **IMPACT** | | |
|---|---|---|
| Nature | N | 1 |
| Extent | E | 1 |
| Duration | D | 5 |
| Magnitude | M | 1 |
| Reversibility | R | 5 |
| Probability | P | 1 |
| Consequence | C | 3 |
| Environmental Risk | ER | 3 |
| Environ. Risk Ranking | | LOW |
| Cumulative Impact | CI | 1 |
| Irreplaceable Loss | LR | 1 |
| Priority | PY | 2 |
| Priority Ranking | | LOW |
| Prioritization Factor | PF | 1 |
| Significance PFxER | S | 3 |
| **Significance Rating** | | **LOW POS** |

### 10.2 EXTENTS

The physical extent of impacts on potential palaeontological resources relates directly to the extents of subsurface disturbance involved in the activities, *i.e*. SITE SPECIFIC. (1).

However, unlike an impact that has a defined spatial extent (*e.g.* loss of a portion of a habitat), the scientific findings from the analysis of deep-sea geophysical surveys and well drilling have impacts that are of international extent.

### 10.3 DURATION

The impact of both the finding or the loss of fossils is permanent. The found fossils must be preserved "for posterity"; the lost, overlooked or destroyed fossils are lost to posterity. The duration of impact is therefore PERMANENT with or without mitigation. (5).

### 10.4 MAGNITUDE

The intensity of the potential impact of sampling and drilling on fossil resources is determined by the palaeontological sensitivity of the affected formations - the potential scientific value of the fossils which are included in it, together with the volume of the formation which is excavated. Overall, the palaeontological sensitivity of marine deposits is HIGH (Almond & Pether, 2009) due to a few, crucial fossil bone finds of high scientific importance that provided the age constraints for the formations. However, there are complications as marine formations usually contain more than one type of fossil of differing importance, *e.g*. common shells and rare bones as discrete objects, and formations entirely composed of fossils, as in biogenic limestones such as the foram-nannofossil formation beneath Block 3b/4B, wherein a small piece contains thousands of microfossils.

The proposed baseline environmental sampling and 5 exploration well drilling activities have a very small footprint in the continental shelf environment and a relatively small subsurface volume of excavation of ~2000 $m^3$. This may be compared with a small bulk sample for diamond exploration of 50x20x5 m = 5000 $m^3$.

The approximate depth of the exploration wells of 3570 m is equivalent to drilling through 3 ½ stacked Table Mountains (~1 km high), into a huge volume of sediments up to 8 km thick in places. Due to the small affected volume the impact of the proposed sampling and drilling activities on the palaeontological heritage of the continental shelf deposits may be considered to be negligible or at most LOW. (1).

### 10.5 REVERSIBILITY

Within the site-specific extents the potential loss of fossils in the drill operation is IRREVERSIBLE (5). Realistically, the nature of the loss at depth in the drill hole, below the upper biogenic ooze unit cored in ODP 1087, is unknown, but is insubstantial on scale considerations.

### 10.6 PROBABILITY OF OCCURRENCE

An impact will occur, but as above, the minute affected volume relative to the preserved volume in the Orange Basin renders the probability of an actual impact from drilling insubstantial. (1).

### 10.7 CUMULATIVE IMPACT

Onshore the cumulative impact of coastal developments and coastal mining is the inevitable and permanent loss of fossils and the associated scientific implications. As mentioned, the impact of both the finding or the loss of fossils is permanent. Most fossils exposed in coastal excavations are not seen and lost despite management actions to mitigate such loss. Diligent and successful mitigation contributes to a positive cumulative impact as the rescued fossils are preserved and accumulated for scientific study. Even though just a very minor portion of the bone fossils exposed in coastal excavations has been seen and saved, the rescued fossils have proved to be of fundamental scientific value.

The cumulative impact of offshore exploration drilling, given scale considerations, will not deplete the palaeontological resources of the Orange Basin. (1).

### 10.8 IRREPLACEABLE LOSS OF RESOURCES

Mostly palaeontological resources are unique and their loss is irreversible. This is perfectly appreciated in the case of discrete fossils such as petrified bones, shells, wood *etc*. For micro-fossiliferous formations only accessible by costly drilling to acquire cores, it is the core itself with its palaeo-oceanographic record which is the irreplaceable fossil. The extent to which deep-sea cores are irreplaceable is evident in the extent of efforts to preserve them, to eke out analyses involving destruction, and increasing employ non-destructive analytical techniques. Similarly, the cuttings from non-cored hydrocarbon well drilling are archived (or should be).

Although not readily replaced, replacement cores can theoretically be acquired. (1).

### 10.9 SIGNIFICANCE RATING

LOW POSITIVE. Palaeontological concerns do not impede the proposed AOSAC JV baseline sampling and hydrocarbon exploration well drilling activities in Block 3B/4B.

## 11 DISCUSSION & RECOMMENDATIONS

Due to the small affected volume the impact of the proposed activities on the palaeontological heritage of the Orange Basin continental shelf volume may be considered to be negligible or at most LOW.

### 11.1 MITIGATION

The scientific research cores acquired and their analysis may be regarded as mitigation of exploration drilling activities which has already been accomplished in Block3B/4B. Importantly, core ODP 1087 has captured the palaeo-oceanographic record which will be lost during the spudding in of the hydrocarbon wells.

#### 11.1.1 Pre-drilling Box & Piston Coring

It is presumed that the box cores and piston cores will be handed over to consultant marine biologists for analysis for the baseline environmental inventory. This intended analysis for baseline purposes constitutes mitigation.

As mentioned above, the modern deep-sea shell fauna is hardly sampled and poorly known. New samples from any deep-water location have the potential to discover unknown species, or at least add to the very small existing museum collections of specimens. In this respect the concerns of palaeontology and marine biology coincide.

It is expected that the molluscs shells and any other fossil material (fish teeth, otoliths *etc*.) will be sieved out at some stage. Fine sieves must be used as some deep-sea molluscs are tiny. All shells and other material of interest must have the details of context recorded and be kept for identification by an appropriate specialist, and ultimately be deposited in a curatorial institution such as the IZIKO SA Natural History Museum. The best outcome for piston cores is that core splits, or site duplicate cores, are the subject of a detailed study, such as for a B.Sc. Honours or M.Sc. project.

#### 11.1.2 Well Drilling

As mentioned, the sampling of drill cuttings for various standard industry analyses, most notably micro-palaeontological and palaeo-environmental, constitutes prescribed or “built-in” mitigation, the main aspects of which are very likely to be written up by the consulting experts and published in the longer term.

The sizes of typical drill cuttings are in the range of 0.1 mm (100 µm - very fine sand) to 3-4 mm (granules) (Kern *et al*., 2022). Macrofossils are destroyed and not delivered to the “shale shaker” screen and only very small fossils will be enclosed in the coarse cuttings, such as larval mollusc shells, micro-molluscs, barnacle fragments and opercula, polychaete worm mouthparts, tiny fish teeth *etc*. from marine deposits and small aquatic molluscs and plant material from terrestrial deposits. Such will be in the cuttings samples and inform palaeo-environmental interpretations. There is therefore no special requirement for additional observations and a Fossil Finds Procedure at the “shale shaker” on the vessel.

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## 13 APPENDIX 1. PALAEONTOLOGICAL SENSITIVITY RATING

Palaeontological Sensitivity refers to the likelihood of finding significant fossils within a geologic unit.

**VERY HIGH:** Formations/sites known or likely to include vertebrate fossils pertinent to human ancestry and palaeoenvironments and which are of international significance.

**HIGH:** Assigned to geological formations known to contain palaeontological resources that include rare, well-preserved fossil materials important to on-going palaeoclimatic, palaeobiological and/or evolutionary studies. Fossils of land-dwelling vertebrates are typically considered significant. Such formations have the potential to produce, or have produced, vertebrate remains that are the particular research focus of palaeontologists and can represent important educational resources as well.

**MODERATE:** Formations known to contain palaeontological localities and that have yielded fossils that are common elsewhere, and/or that are stratigraphically long-ranging, would be assigned a moderate rating. This evaluation can also be applied to strata that have an unproven, but strong potential to yield fossil remains based on its stratigraphy and/or geomorphologic setting.

**LOW:** Formations that are relatively recent or that represent a high-energy subaerial depositional environment where fossils are unlikely to be preserved, or are judged unlikely to produce unique fossil remains. A low abundance of invertebrate fossil remains can occur, but the palaeontological sensitivity would remain low due to their being relatively common and their lack of potential to serve as significant scientific resources. However, when fossils are found in these formations, they are often very significant additions to our geologic understanding of the area. Other examples include decalcified marine deposits that preserve casts of shells and marine trace fossils, and fossil soils with terrestrial trace fossils and plant remains (burrows and root fossils)

**MARGINAL:** Formations that are composed either of volcaniclastic or metasedimentary rocks, but that nevertheless have a limited probability for producing fossils from certain contexts at localized outcrops. Volcaniclastic rock can contain organisms that were fossilized by being covered by ash, dust, mud, or other debris from volcanoes. Sedimentary rocks that have been metamorphosed by the heat and pressure of deep burial are called metasedimentary. If the meta sedimentary rocks had fossils within them, they may have survived the metamorphism and still be identifiable. However, since the probability of this occurring is limited, these formations are considered marginally sensitive.

**NO POTENTIAL:** Assigned to geologic formations that are composed entirely of volcanic or plutonic igneous rock, such as basalt or granite, and therefore do not have any potential for producing fossil remains. These formations have no palaeontological resource potential.

*Adapted from Society of Vertebrate Paleontology. 1995. Assessment and Mitigation of Adverse Impacts to Nonrenewable Paleontologic Resources - Standard Guidelines. News Bulletin, Vol. 163, p. 22-27.*

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## APPENDIX C: SPECIALIST DECLARATION

(See separate PDF file)

## APPENDIX D: CURRICULUM VITAE – JOHN GRIBBLE

| | |
|---|---|
| **Name:** | John Gribble |
| **Profession:** | Archaeologist (Maritime) |
| **Date of Birth:** | 15 November 1965 |
| **Parent Firm:** | TerraMare Archaeology (Pty) Ltd |
| **Position in Firm:** | Director & Senior Archaeologist |
| **Years of experience:** | 33 |
| **Nationality:** | South African |

### Education:

- 1979-1983 Wynberg Boys' High School
- 1986 BA (Archaeology), University of Cape Town
- 1987 BA (Hons) (Archaeology), University of Cape Town
- 1990 Master of Arts, (Archaeology) University of Cape Town

### Employment:

- September 2023 – present: TerraMare Archaeology, Director and Senior Archaeologist
- September 2017 – August 2023: ACO Associates, Senior Archaeologist and Consultant
- 2014-2017: South African Heritage Resources Agency, Manager: Maritime and Underwater Cultural Heritage Unit
- 2012-2018: Sea Change Heritage Consultants Limited, Director
- 2011-2012: TUV SUD PMSS (Romsey, United Kingdom), Principal Consultant: Maritime Archaeology
- 2009-2011: EMU Limited (Southampton, United Kingdom), Principal Consultant: Maritime Archaeology
- 2005-2009: Wessex Archaeology (Salisbury, United Kingdom), Project Manager: Coastal and Marine
- 1996-2005: National Monuments Council / South African Heritage Resources Agency, Maritime Archaeologist
- 1994-1996: National Monuments Council, Professional Officer: Boland and West Coast, Western Cape Office

### Professional Qualifications and Accreditation:

- Member: Association of Southern African Professional Archaeologists (ASAPA) (No. 043)
- Principal Investigator: Maritime and Colonial Archaeology, ASAPA CRM Section
- Field Director: Stone Age Archaeology, ASAPA CRM Section
- Class III Diver (Surface Supply), Department of Labour (South Africa) / UK (HSE III)

### Experience:

I have more than 30 years of professional archaeological and heritage management experience. After completing my postgraduate studies and a period of freelance archaeological work in South Africa and aboard, I joined the National Monuments Council (NMC) (now the South African Heritage Resources Agency (SAHRA)) in 1994. In 1996 I become the NMC's first full-time maritime archaeologist and in this regulatory role was responsible for the management and protection of underwater cultural heritage in South Africa under the National Monuments Act, and subsequently under the National Heritage Resources Act.

In 2005 I moved to the UK to join Wessex Archaeology, one of the UK's biggest archaeological consultancies, as a project manager in its Coastal and Marine Section. In 2009 I joined Fugro EMU Limited, a marine geosurvey company to set up their maritime archaeological section. I then spent a year at TUV SUD PMSS, an international renewable energy consultancy, where I again provided maritime archaeological consultancy services to principally the offshore renewable and marine aggregate industries.

In August 2012 I established Sea Change Heritage Consultants Limited, a maritime archaeological consultancy. Sea Change traded until 2018, providing archaeological services to a range of UK maritime sectors, including marine aggregates and offshore renewable energy.

Relevant maritime experience includes specialist archaeological consultancy for more than two dozen offshore renewable energy projects and aggregate extraction licence areas in UK waters including:

- Lynn and Inner Dowsing OWF;
- Humber Gateway OWF;
- Sheringham Shoal OWF;
- Race Bank OWF;
- Docking Shoal OWF;
- Triton Knoll OWF;
- Neart na Gaoithe OWF;
- Dogger Bank OWF;
- Hornsea OWF;
- Navitus Bay OWF;
- Aggregate Area 392/393, Hilbre Swash;
- Area 478, East English Channel;
- Area 372/1, North Nab;
- Areas 401 & 2;
- Area 466, North West Rough; and
- Area 447, Cutline.

In the UK I was also involved in strategic projects which developed guidance and best practice for the UK offshore industry with respect to the marine historic environment. This included the principal authorship of two historic environment guidance documents for COWRIE and the UK renewable energy sector (*Historical Environment Guidance for the Offshore Renewable Energy Sector* (2007) and *Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector* (2010)). I was also manager and lead author in the development of the archaeological elements of the first Regional Environmental Assessments for the UK marine aggregates industry, and in the

2009 *UK Continental Shelf Offshore Oil and Gas and Wind Energy Strategic Environmental Assessment* for Department of Energy and Climate Change. In 2013-14 I was lead author and project co-ordinator on *The UNESCO Convention on the Protection of the Underwater Cultural Heritage 2001: An Impact Review for the United Kingdom* and in 2016 I was co-author of a Historic England / Crown Estate / British Marine Aggregate Producers Association funded review of marine historic environment best practice guidance for the UK offshore aggregate industry.

I returned to South African in mid-2014 where I was re-appointed to my earlier post at SAHRA: Manager of the Maritime and Underwater Cultural Heritage Unit. In July 2016 I was appointed as Acting Manager of SAHRA's Archaeology, Palaeontology and Meteorites Unit.

I left SAHRA in September 2017 to join ACO Associates as Senior Archaeologist and Consultant. While at ACO I carried out a wide range of terrestrial and maritime archaeological assessments, many of which are listed in the following section. In 2018 I conducted an assessment of the potential impacts of marine mining on South Africa's palaeontological and archaeological heritage for the Council for Geoscience, on behalf of the Department of Mineral Resources.

On 1 September 2023 I left ACO to establish my own consultancy, TerraMare Archaeology (Pty) Ltd, which will provide specialist assessment and management services and advice for both terrestrial and maritime archaeological heritage.

I have been a member of the Association of Southern African Professional Archaeologists (No. 043) for nearly thirty years and am accredited by ASAPA's Cultural Resource Management section.

I have been a member of the ICOMOS International Committee for Underwater Cultural Heritage since 2000 and served as a member of its Bureau between 2009 and 2018.

Since 2010 I have been a member of the UK's Joint Nautical Archaeology Policy Committee.

I am a member of the Advisory Board of the George Washington University / Iziko Museums of South Africa / South African Heritage Resources Agency / Smithsonian Institution 'Southern African Slave Wrecks Project'.

I served on the Heritage Western Cape Archaeology, Palaeontology and Meteorites Committee between 2014 and 2023.

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