WEST COAST RESOURCES-NAMAQUALAND MINES – ENVIRONMENTAL IMPACT ASSESSMENT

HERITAGE IMPACT ASSESSMENT: WEST COAST RESOURCES NAMAQUALAND MINES

IMPACT ASSESSMENT FOR THE AMENDMENT OF AN ENVIRONMENTAL MANAGEMENT PROGRAMME AND ENVIRONMENTAL IMPACT ASSESSMENT IN SUPPORT OF A MINING RIGHT HELD BY WEST COAST RESOURCES ((PTY)) LTD OVER THE NAMAQUALAND MINES, NORTHERN CAPE PROVINCE

Prepared for

Myezo Environmental Management Services (Pty) Ltd

DRAFT 1 19 July 2016

ACO Associates cc
Archaeology and Heritage Specialists

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Summary

ACO Associates CC was appointed by Myezo (Pty) Ltd to provide a specialist contribution in terms of heritage to an Environmental Impact Assessment for renewed mining activities by West Coast Resources (PTY) Ltd (WCR). WCR is undertaking mining in terms of an existing EMP; however the addition of beach mining activities has triggered a renewed EIA process to consider the impact of the new activities. The land portions under consideration are the farms Zwartlintjies River 484, Kliphuis 496, Mitchell's Bay 495 and Samson's Bak 330.The project area commences north of the old De Beers town of Koingnaas (now an independent municipality) and extends southwards as far as Mitchell's Bay which lies just north of the Spoeg River Mouth. Previous studies have revealed that the project area contains a wide variety of heritage resources ranging from Palaeontology, Stone Age shell middens to maritime archaeology.

Findings

A feature of the project area is the excellent surface preservation of many archaeological sites; in particular those in un-mined areas under secure control. This preservation is as a result of these areas having been restricted to the public for many years. To minimise the destructive effects of human action in the future it is suggested that the following measures be applied:

- The palaeontology management plan (Pether 2008 Appendix B) remains valid, however to reiterate, mining has made a contribution to the understanding of the regional sequence in that work done by the mine itself and also by outside specialists has added to the academic understanding of the west coast geological sequence. Positive outcomes for knowledge and science can be gained by ensuring that a palaeontologist inspects pits and profiles before they are rehabilitated.

- Archaeological sites are an irreplaceable aspect of the environment and should be protected as vigilantly as any endangered animal or plant species. It should become part of the company environmental policy that people are actively discouraged from collecting artefactual material or conducting excavations without a SAHRA permit, or removing material from shipwrecks.

- Provided that a range of archaeological sites are preserved in areas which are not going to be mined, this will to some extent mitigate the damage that mining does to heritage sites elsewhere. In order to execute effective conservation and mitigation procedures the following measures are proposed.

- Mining should be treated like any other development activity. New mining areas should be subjected to a heritage impact assessment (HIA) well in advance of the start of any earthmoving. During the course of the HIA all archaeological and other heritage sites will have to be identified and their surface characteristics recorded and certain kinds of archaeological material collected. Sites which are important will have to be sampled/excavated as part of a mitigation programme.

- Off-road vehicles should be restricted to existing roads and tracks which will minimise damage to archaeological material. This is particularly so in areas within 1km of the shoreline which contain large concentrations of sites.

Potential for impacts to maritime heritage can occur in beach mining operation.

- If any shipwreck material or unexplained seabed anomalies are discovered during the seabed survey or mining activities, the findings should then be assessed by a maritime archaeologist at SAHRA to identify the need for further action / mitigation.

- It is recommended that should any shipwrecks be discovered, any relevant observations and position of the find be reported to SAHRA for inclusion on the National Shipwreck Database.

- SAHRA's permission in the form of a permit would be required to disturb a maritime archaeological site or material (this includes any sites within the inter-tidal zone below the high water mark), should it not be possible for the project to avoid such sites. It is important to bear in mind that such permission is likely to be premised on suitable archaeological mitigation of any such site having been conducted, to ensure preservation of the site by record.

Rehabilitation of mined areas, although positive for the environment, can pose a threat to otherwise undisturbed sites through earthmoving and related activity, particularly where the edges of deep excavations are collapsed and contoured. Archaeological sites that have survived on the edges of pits have been destroyed during rehabilitation. Similarly sites on prospective roads, mine dumps and infrastructure should be included in the HIA programmes. Work that has taken place to date under old De Beers management has resulted in survey and mitigation of many of the proposed mining blocks that WCS intends to mine, thus reducing impacts and the amount of archaeological work necessary before mining. A number of areas still need to be surveyed and mitigated. This can be done on an annual/bi or tri-annual basis depending on the mining block planning.

Conclusion

Provided that mitigation is applied where necessary, all mining work can proceed in accordance with the law. This report finds that the proposed activities are acceptable and that most impacts can be successfully mitigated.

Details of the specialist

This study has been led by Tim Hart BA Hons, MA (ASAPA, APHP) of ACO Associates CC, archaeologists and heritage consultants.

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Curriculum vitae

Name: Timothy James Graham Hart

Profession: Archaeologist

Date of Birth: 29/07/60

Parent Firm: ACO Associates

Position in Firm: Director

Years with Firm: 9

Years experience: 30 years

Nationality: South African

Education: Matriculated Rondebosch Boys High, awarded degrees BA (UCT) BA Hons (UCT) MA (UCT).

Professional Qualifications: Principal Investigator ASAPA, member of Association of Heritage Professionals (APHP)

Languages: Fully literate in English, good writing skills. Conversation in Afrikaans, mediocre writing skills, good reading skills. Some knowledge of Latin.

KEY QUALIFICATIONS

- Bachelor of Arts in Archaeology and Psychology
- BA Honours in archaeology
- MA in Archaeology
- Recipient of Frank Schweitzer Memorial Prize (UCT) for student excellence
- Professional member (no 50) Association of Southern African Professional Archaeologists (ASAPA)
- Principal Investigator, cultural resources management section (ASAPA)
- Professional member in specialist and generalist categories Association of Heritage Professionals (APHP)
- Committee Member Heritage Western Cape, Committee Member SAHRA
- Awarded Department of Arts and Culture and Sport award for best heritage impact study in 2014,

Relevant recent Project Experience with respect to large projects:

- Specialist consultant – Eskom's Kudu Integration project (identifying transmission line routes across Namaqualand)
- Specialist consultant – Eskom's Atlantis Open Cycle Gas Turbine project, upgrade and power lines
- Specialist consultant – Eskom's Mossel Bay Open Cycle Gas Turbine project, substations and power lines
- Specialist consultant – Eskom's proposed Omega sub-station
- Specialist consultant – Eskom's Nuclear 1 programme
- Specialist consultant – Eskom's PBMR programme
- Specialist consultant – Department of Water Affairs raising of Clanwilliam Dam project
- Specialist consultant to De Beers Namaqualand Mines (multiple projects since 1995)
- Specialist consultant – Saldanha Ore Handling Facility phase 2 upgrade
- Three years of involvement in Late Stone Age projects in the Central Great Karoo
- Wind Energy systems: Koekenaap, Hopefield, Darling, Vredendal, Bedford, Sutherland, Caledon, Pofadder, and central Karoo (86 completed to date).
- Specialist consultant – Eskom nuclear 1
- Consultant on various projects 1991-2008 Namaqualand diamond mines.
- Bantamsklip Nuclear 1 TX lines
- Koeberg Nuclear 1 TX lines
- Karoo uranium prospecting various sites
- HIA Houses of Parliament
- Proposed Ibhubesi gas project, West Coast of South Africa.

Experience

After graduating from UCT with my honours degree I joined the Southern Methodist University (SMU Dallas Texas) team undertaking Stone Age research in the Great Karoo. After working in the field for a year I registered for a Master's degree in pre-colonial archaeology at UCT with support from the SMU Zeekoei Valley Archaeological Project. On completion of this degree in 1987 I commenced working for the ACO when it was based at UCT. This was the first unit of its kind in RSA.

In 1991 I took over management of the unit with David Halkett. We nursed the unit through new legislation and were involved in setting up the professional association and assisting SAHRA with compiling regulations. The office developed a reputation for excellence in field skills with the result that ACO was contracted to provide field services for a number of research organisations, both local and international. Since 1987 in professional practise I have has been involved in a wide range of heritage related projects ranging from excavation of fossil and Stone Age sites to the conservation of historic buildings, places and industrial structures. To date the ACO Associates CC (of which I am co-director) has completed more than 2000 projects throughout the country ranging from minor assessments to participating as a specialist in a number of substantial EIA's as well as international research projects. Some of these projects are of more than 4 years duration

Together with my colleague Dave Halkett I have been involved in heritage policy development, development of the CRM profession, the establishment of 2 professional bodies and development of professional practice standards. Notable projects I have been involved with are the development of a heritage management plan and ongoing annual mitigation for the De Beers Namaqualand Mines Division, heritage management for Namakwa Sands and other west coast and Northern Cape mining firms. Locally, I was responsible for the discovery of the "Battery Chavonnes" at the V&A Waterfront (now a conserved as a museum – venue for Da Vinci exhibition), the discovery of a massive paupers burial ground in Green Point (now with museum and memorial), the fossil deposit which is now the subject of a public display at the West Coast Fossil Park National Heritage Site as well as participating in the development of the Robben Island Museum World Heritage Site. I have teaching experience within a university setting and have given many public lectures on archaeology and general heritage related matters. I am presently running a NLF funded project to research the historic burial grounds of Green Point.

Academic Publications

Hart, T.J.G. 1987. Porterville survey. In Parkington, J & Hall, M.J. eds. Papers in the Prehistory of the Western Cape, South Africa. Oxford: BAR International Series 332.

Sampson, C.G., Hart, T.J.G., Wallsmith, D.L. & Blagg, J.D. 1988. The Ceramic sequence in the upper Sea Cow Valley: Problems and implications. South African Archaeological Bulletin 149: 3-16.

Plug, I. Bollong, C.A., Hart, T.J.G. & Sampson, C.G. 1994. Context and direct dating of pre-European livestock in the Upper Seacow River Valley. Annals of the South African Museum, Cape Town.

Hart, T. & Halkett, D. 1994. Reports compiled by the Archaeology Contracts Office, University of Cape Town. Crossmend, HARG. University of Cape Town.

Hart, T. & Halkett, D. 1994. The end of a legend? Crossmend, HARG. University of Cape Town.

Hart, T 2000. The Chavonnes Battery. Aquapolis. Quarterly of the International Centre for Cities on Water. 3-4 2000.

Hine, P, Sealy, J, Halkett, D and Hart, T. 2010. Antiquity of stone walled fish traps on the Cape Coast of South Africa. The South African Archaeological Bulletin. Vol. 65, No. 191 (JUNE 2010), pp. 35-44

Klein, R.G., Avery, G., Cruz-Uribe, K., Halkett, D., Hart, T., Milo, R.G., Volman, T.P. 1999. Duinefontein 2: An Acheulean Site in the Western Cape Province of South Africa. Journal of Human Evolution 37, 153-190.

Klein, R.G., Cruz-Uribe, K., Halkett, D., Hart, T., Parkington, J.E. 1999. Palaeoenvironmental and human behavioural implications of the Boegoeberg 1 late Pleistocene hyena den, Northern Cape Province, South Africa. Quaternary Research 52, 393-403.

Smith, A., Halkett, D., Hart, T. & Mütti, B. 2001. Spatial patterning, cultural identity and site integrity on open sites: evidence from Bloeddrift 23, a pre-colonial herder camp in the Richtersveld, Northern Cape Province, South Africa. South African Archaeological Bulletin 56 (173&174): 23-33.

Smith, A., Halkett, D., Hart, T. & Mütti, B. 2001. Spatial patterning, cultural identity and site integrity on open sites: evidence from Bloeddrift 23, a pre-colonial herder camp in the Richtersveld, Northern Cape Province, South Africa. South African Archaeological Bulletin 56 (173&174): 23-33.

Halkett, D., Hart, T., Yates, R., Volman, T.P., Parkington, J.E., Klein, R.J., Cruz-Uribe, K. & Avery, G. 2003. First excavation of intact Middle Stone Age layers at Ysterfontein, Western Cape province, South Africa: implications for Middle Stone Age ecology. Journal of Archaeological Science

Cruz-Uribe, K., Klein, R.G., Avery, G., Avery, D.M., Halkett, D., Hart, T., Milo, R.G., Sampson, C.G. & Volman, T.P. 2003. Excavation of buried late Acheulean (mid-quaternary) land surfaces at Duinefontein 2, Western Cape province, South Africa. Journal of Archaeological Science 30.

Parkington, JE. Poggenpoel, C. Halkett, D. & Hart, T.2004 Initial observations from the Middle Stone Age coastal settlement in the Western Cape In Conard, N. Eds. Settlement dynamics of the Middle Palaeolithic and Middle Stone Age. Tubingen: Kerns Verlag.

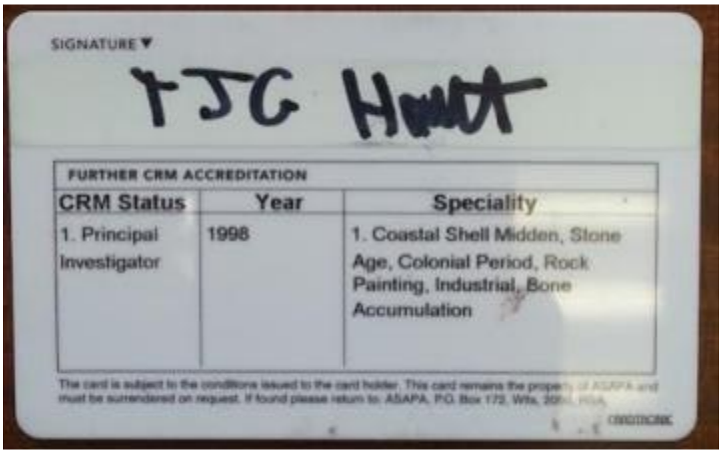
Orton, J. Hart, T. Halkett, D. 2005. Shell middens in Namaqualand: two later Stone Age sites at Rooiwalbaai, Northern Cape Province, South Africa. South African Archaeological Bulletin. Volume 60 No 181

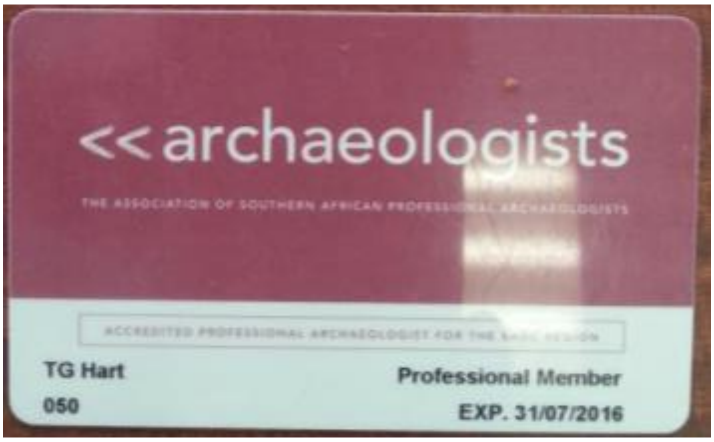
G Dewar, D Halkett, T Hart, J Orton, J Sealy, 2006. Implications of a mass kill site of springbok (Antidorcas marsupialis) in South Africa: hunting practices, gender relations, and sharing in the Later Stone Age .Journal of Archaeological Science 33 (9), 1266-127

Finnegan, E. Hart, T and Halkett, D. 2011. The informal burial ground at Prestwich Street, Cape Town: Cultural and chronological indicators for the informal Cape underclass. The South African Archaeological Bulletin Vol. 66, No. 194 (DECEMBER 2011), pp. 136-148

Malan, A. Webley, L. Halkett, D and Hart, T. 2013. People and places on the West Coast since AD 1600. In Jerardino, Braun, D and Malan, A. Eds. The archaeology of the west coast of South Africa. BAR International Series 2526. Oxford: archaeopress.

Malan, A. Halkett, D. Hart, T Webley, L and Schietecatte, E. In press. Grave Encounters. The archaeology of Green Points burial grounds.





Declaration of independence

Declaration of independence

PROJECT: WEST COAST RESOURCES EIA

I, **Tim Hart,** as the appointed independent specialist hereby declare that I acted as the independent specialist in this application; and that I

- 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, 2010 and any specific environmental management Act;

- have and will not have no vested interest in the proposed activity proceeding;

- have disclosed, to the applicant, EAP and competent authority, any material information that have 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, 2010 and any specific environmental management Act;

- am fully aware of and meet the responsibilities in terms of NEMA, the Environmental Impact Assessment Regulations, 2010 (specifically in terms of regulation 17 of GN No. R. 543) and any specific environmental management Act, and that failure to comply with these requirements may constitute and result in disqualification;

- have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;

- have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;

- have ensured that the names of all interested and affected parties that participated in terms of the specialist input/study were recorded in the register of interested and affected parties who participated in the public participation process;

- have provided the competent authority 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 71 of GN No. R. 543.

Note: The terms of reference must be attached.

Signature of the specialist:

TJG Hart

Name of company:
ACO Associates cc

Date: 18 July 2016

GLOSSARY

Archaeology: *Remains resulting from human activity which is 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.*

Anthropogenic: *Something made by humans.*

Calcrete: *A soft sandy calcium carbonate rock related to limestone which often forms in arid areas*.

Cultural landscape: *The combined works of people and natural processes as manifested in the form of a landscape*

Early Stone Age: *The archaeology of the Stone Age between 700 000 and 2500 000 years ago***.**

Fossil: *Mineralised bones of animals, shellfish, plants and marine animals. A trace fossil is the track or footprint of a fossil animal that is preserved in stone or consolidated sediment.*

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).*

Holocene: *The most recent geological time period which commenced 10 000 years ago.*

Late Stone Age: *The archaeology of the last 20 000 years associated with fully modern people.*

Middle Stone Age: *The archaeology of the Stone Age between 20-300 000 years ago associated with early modern humans.*

Midden: *A pile of debris, normally shellfish and bone that have accumulated as a result of human activity.*

National Estate: *The collective heritage assets of the Nation*

Palaeontology: *Any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or trace.*

Pan: *A shallow depression in the landscape that accumulates water from time to time.*

Palaeosole: *An ancient land surface.*

Pleistocene: *A geological time period (of 3 million – 20 000 years ago).*

Pliocene: *A geological time period (of 5 million – 3 million years ago).*

Miocene: *A geological time period (of 23 million - 5 million years ago).*

SAHRA: *South African Heritage Resources Agency – the compliance authority which protects national heritage.*

Structure (historic :) *Any building, works, device or other facility made by people and which is fixed to land, and includes any fixtures, fittings and equipment associated therewith. Protected structures are those which are over 60 years old.*

Acronyms

ESA	Early Stone Age
CRM	Cultural Resource Management
DEAT	Department of Environmental Affairs and Tourism
ESA	Early Stone Age
EMP	Environmental Management Plan.
GPS	Global Positioning System
HIA	Heritage Impact Assessment
HWC	Heritage Western Cape
LSA	Late Stone Age
MSA	Middle Stone Age
NHRA	National Heritage Resources Act
SAHRA	South African Heritage Resources Agency
UCT	University of Cape Town
WCR	West Coast Resources (Pty) Ltd

Table of Contents

1 Introduction

West Coast Resources (Pty) Ltd (WCR) has taken over prospecting and diamond mining areas in the Koingnaas region of the west coast, Northern Cape Province (Figure 1). West Coast Resources (Pty) Ltd is owned by a consortium of mining companies and the state including significant ownership by previously disadvantaged communities in the region. Transhex (Pty) Ltd, a company that has mined in the area for many years is also a shareholder and will guide the mining operations. The land portions under consideration are the farms Zwartlintjies River 484, Kliphuis 496, Mitchells Bay 495 and Samson’s Bak 330.

The project area commences north of the old De Beers town of Koingnaas (now an independent municipality) and extends southwards as far as Mitchells Bay which lies just north of the Spoeg River Mouth. The area has been mined in various ways for almost 70 years with the bulk of operations located in the high security area south of Koingnaas, however WCR will be not only continuing under the existing Environmental Management Plan (EMP) but will also engaging in beach mining activities that triggers a new Environmental Impact Assessment. This specialist report covers heritage issues and also makes reference to the fact that there has been heritage legislative change since the previous EMP was completed.

1.1 The proposed activity

West Coast Resources (Pty) Ltd (WCR) has taken over a number of prospecting and diamond mining areas in the Koingnaas region of the west coast, Northern Cape Province (Figure 1). West Coast Resources (Pty) Ltd is owned by a consortium of mining companies and the state including significant ownership by previously disadvantaged communities in the region. Transhex (Pty) Ltd, a company that has mined in the area for many years who is also a share holder will guide the mining operations. The land portions under consideration are the farms Zwartlintjies River 484, Kliphuis 496, Mitchells Bay 495 and Samson’s Bak 330.

The project area commences north of the old De Beers town of Koingnaas (now an independent municipality) and extends southwards as far as Mitchells Bay which lies just north of the Spoeg River Mouth. The area has been mined in various ways for almost 70 years with the bulk of operations located in the high security area south of Koingnaas, however WCR will be not only continuing under the existing Environmental Management Plan (EMP) but will also engaging in beach mining activities that triggers a new Environmental Impact Assessment. This specialist report covers heritage issues and also makes reference to the fact that there has been heritage legislative change since the old EMP was completed.

The mining will take place in a number of forms:

Land based mining, that is open cast excavation with bedrock cleaning and ore extraction will continue at land-based mining sites as per the existing EMP.

Shore and beach based mining has been practiced up to now on a limited scale, mostly by means of divers who pump diamondiferous gravels from rocky gullies below the high water mark. WCS intends to increase this operation to include larger scale mining which will involve the construction of retaining berms/walls to exclude the ocean. The areas will then be mined by means of mechanical excavation to extract ore which will be transported by truck to a nearby processing plant. This new form of activity is not included in the existing EMP and therefore triggers a renewed EIA.

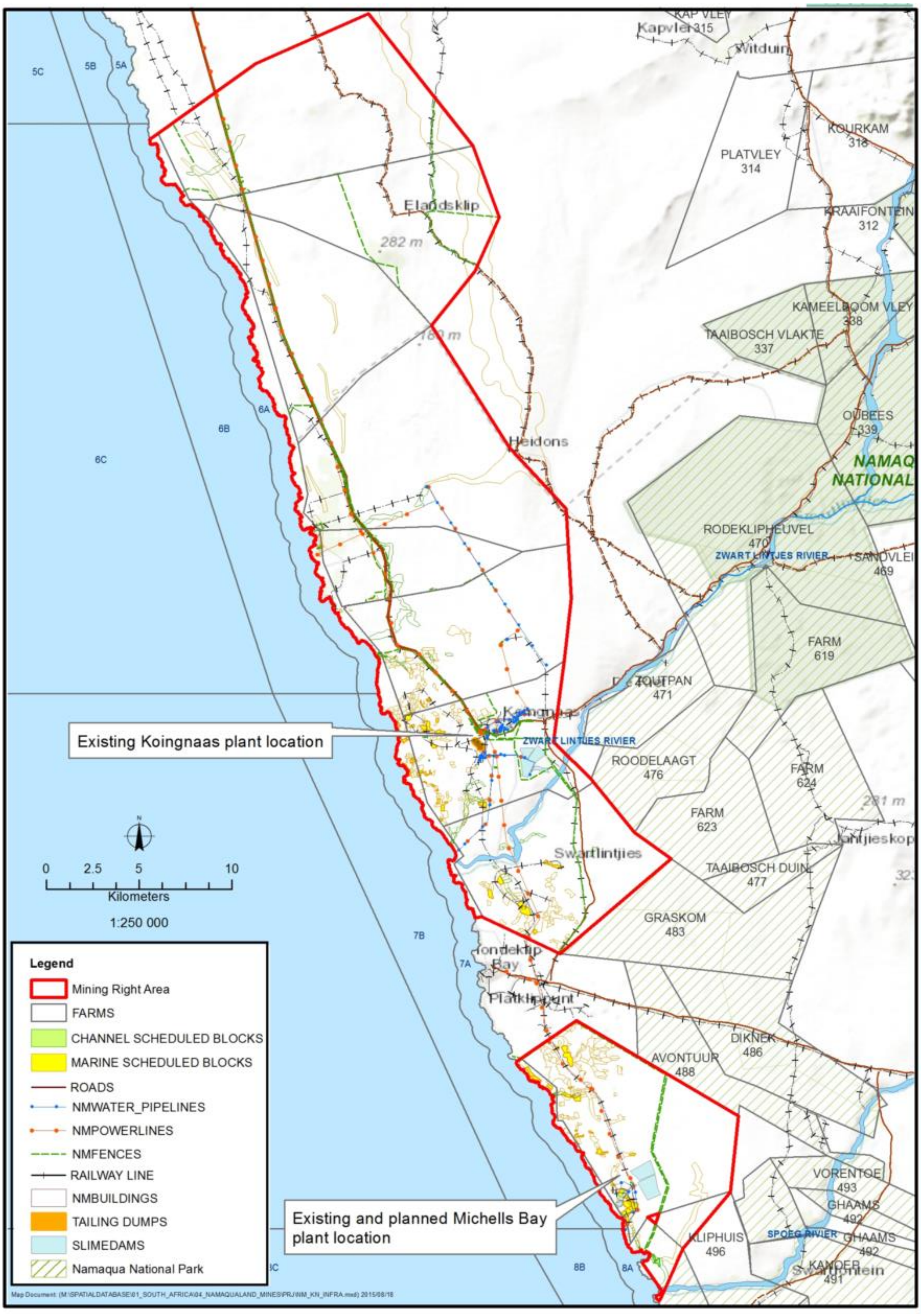


Figure 1 The WSP mining rights area

2 Legislation

Certain Archaeological sites in South Africa have been afforded legal protection since 1911 when the Bushmen Relics Protection Act became the first body of legislation that specifically protected artefacts and sites of 'South African Bushmen or other aboriginals' The first South African conservation authority - the Commission for the Preservation of Natural and Historical Monuments of the Union - was established in terms of the Natural and Historical Monuments Act of 1923. This body was more commonly known as the Historical Monuments Commission. In 1934, previous Acts were replaced by the Natural and Historical Monuments, Relics and Antiquities Act (see also Deacon and Pistorius 1996). This was superseded in 1969 with the creation of the National Monuments Council by an Act of Parliament. Various amendments have since been made to the Act, with the most recent amendment being in 1986. In 1999 new legislation was passed which is far more comprehensive than anything before, that is the National heritage Resources Act 25 of 1999 (as amended) which was implemented in 2003. A summary of critical elements of the legislation is included below.

The basis for all Heritage Impact Assessments (HIA) is the National Heritage Resources Act, No 25 of 1999 (NHRA), which in turn prescribes the manner in which heritage is assessed and managed. The legislation makes it mandatory that EIA process under taken under NEMA or under Minerals and Energy legislation applies the principals that are in place in sections 34 and 38 of the National Heritage Resources Act. The NHRA has defined certain kinds of heritage as being worthy of protection, by either specific or general protection mechanisms. In South Africa the law is directed towards the protection of human made heritage, although natural places and objects of scientific importance are covered. The National Heritage Resources Act also protects intangible heritage such as traditional activities, oral histories and places where significant events happened. Generally protected heritage, which must be considered in any heritage assessment, includes:

- Any place of cultural significance (described below);
- Buildings and structures (greater than 60 years of age);
- Archaeological sites (greater than 100 years of age);
- Palaeontological sites and specimens;
- Shipwrecks and aircraft wrecks; and
- Graves and grave yards.

Section 38 of the NHRA stipulates that HIAs are required for certain kinds of development such as changing the character of land greater than 5000 sqm in extent or exceeding 3 or more sub-divisions, linear developments in excess of 300 m or for any activity that will alter the character or landscape of a site greater than 5000 sqm. Subject to the provisions of subsections (7), (8) and (9), any person who intends to undertake a development categorised as:

a) the construction of a road, wall, powerline, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length;

b) The construction of a bridge or similar structure exceeding 50 m in length;

c) Any development or other activity which will change the character of a site--

i) Exceeding 5 000 sqm in extent; or

ii) Involving three or more existing erven or subdivisions thereof; or

iii) Involving three or more erven or divisions thereof which have been consolidated within the past five years; or

iv) The costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority;

d) The re-zoning of a site exceeding 10 000 sqm in extent; or

e) any other category of development provided for in regulations by SAHRA or a provincial heritage resources authority, must at the very earliest stages of initiating such a development, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development.

Section 3(3) of the National Heritage Resources Act (NHRA), No 25 of 1999 defines the cultural significance of a place or objects with regard to the following criteria:

(a) Its importance in the community or pattern of South Africa's history;
(b) Its possession of uncommon, rare or endangered aspects of South Africa's natural or cultural heritage;
(c) Its potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage;
(d) Its importance in demonstrating the principal characteristics of a particular class of South Africa's natural or cultural places or objects;
(e) Its importance in exhibiting particular aesthetic characteristics valued by a community or cultural group;
(f) Its importance in demonstrating a high degree of creative or technical achievement at a particular period;
(g) Its strong or special association with a particular community or cultural group for social cultural or spiritual reasons;
(h) Its strong or special association with the life or work of a person, group or organisation of importance in the history of South Africa; and
(i) Sites of significance relating to the history of slavery in South Africa.

The archaeological record and the Cenozoic palaeontology of the project area are the main heritage resources

Under **Section 2 - Definitions,** the term archaeological is defined as:

(a) material remains resulting from human activity which are in a state of disuse and are in or on land and are older than 100 years, including artefacts, human and hominid remains and artificial features and structures;
(b) rock art, being in any form of painting, engraving or any other graphic representation on a fixed rock surface or loose rock or stone, which was executed by human agency and is older than 100 years, including any area within 10m of such representation; and
(c) wrecks, being any vessel or aircraft, or any part thereof which is wrecked in South Africa, whether on land or in the maritime cultural zone referred to in section 5 of the Marine Zones Act, 1994 (Act 15 of 1994), and any cargo, debris or artefacts found or

associated therewith, which is older than 60 years or which the SAHRA considers to be worthy of conservation:
(d) Features, structures and artefacts associated with military history which are older than 75 years and the sites on which they are found.

Relating to what is protected:

Section 30 (1) *No person may alter or demolish any structure or part of a structure which is older than 60 years except under the authority of a permit issued by the provincial heritage authority.*

Section 31(4) *No person may, except under the authority of a permit issued by a responsible heritage authority-*

a) Destroy, damage, excavate, alter, deface or disturb any archaeological or palaeontological site or meteorite;
b) Destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or meteorite;
c) Trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological material or palaeontological material or object, or any meteorite; or
d) Bring onto use at an archaeological or palaeontological site any excavation equipment or any equipment which assists in the detection or recovery of metals or archaeological or palaeontological material or objects, or use such equipment for the recovery of meteorites.

Section 32(3) *No person shall, except under the authority of a permit issued by a provincial heritage authority-*

(a) destroy, damage, alter, exhume, remove from its original position or otherwise disturb the grave of a victim of conflict, or any burial ground or part thereof which contains such graves;
(b) destroy, damage, alter, exhume, remove from its original position or otherwise disturb any grave or burial ground which is situated outside of a formal cemetery administered by a local authority and which is older than 60 years; or
(c) Bring onto or use at a burial ground or grave referred to in clause (a) or (b) any excavation equipment, or any equipment which assists in the detection or recovery of metals.

2.1 Scenic Routes

While not specifically mentioned in the NHRA, No 25 of 1999, Scenic Routes are recognised as a category of heritage resources which requires grading as the Act protects area of aesthetic significance (see clause "e" above). Baumann & Winter (2005) comment that the visual intrusion of development on a scenic route should be considered a heritage issue. HWC has taken this opinion further by acknowledging that the aesthetics of a landscape/place/area are protected by the National Heritage Resources Act and like any other form of heritage, should be considered a grade-able entity. (The definition of cultural significance in terms of the NHRA includes the aesthetic value of a place or area).

2.2 Heritage Grading

A key tool in the assessment of heritage resources is the heritage grading system which uses standard criteria. In the context of an EIA process, heritage resources are graded following the system established by Winter & Baumann (2005) in the guidelines for involving heritage practitioners in EIA's (Table 1). The system is also used internally within Heritage Authorities around the country for making decisions about the future of heritage places, buildings and artefacts.[1] Presently Heritage Western Cape has a good guide to grading which is nationally applicable (http://www.westerncape.gov.za/public-entity/heritage-western-cape).
The grading system was designed with structures in mind but has been applied to archaeological sites, streetscapes, objects. The call has been made by the heritage authority to apply the system to landscapes. The decision making process that we have used in this report is based on a simple 3-phase process:

1) Decide what kind of landscape is involved (rural, natural wilderness, historical townscape or historical agricultural area) – establish its dominant characteristics taking cognisance of UNESCO guidelines and previous work.
2) Establish the value of the landscape in terms of its history, its aesthetic value and its heritage value to a given community.
3) Consider the intactness of the landscape – has it been recently intruded on by new development (we have taken 60 years as a marker as this is generally used as a historic cut-off), and using the grading system as a guide suggest a field grading.

The system is in its early days of development and still needs to be refined further.

Table 1**:** Grading of heritage resources (Source: Winter & Baumann 2005).

Grade	**Level of significance**	**Description**
1	National	Of high intrinsic, associational and contextual heritage value within a national context, i.e. formally declared or potential Grade 1 heritage resources.
2	Provincial	Of high intrinsic, associational and contextual heritage value within a provincial context, i.e. formally declared or potential Grade 2 heritage resources.
3A	Local	Of high intrinsic, associational and contextual heritage value within a local context, i.e. formally declared or potential Grade 3A heritage resources.
3B	Local	Of moderate to high intrinsic, associational and contextual value within a local context, i.e. potential Grade 3B heritage resources.
3C	Local	Of medium to low intrinsic, associational or contextual heritage value within a national, provincial and local context, i.e. potential Grade 3C heritage resources.

Heritage specialists use this grading system to express the relative significance of a heritage resource. This is known as a field grading or a recommended grading. Official

[1] http://www.westerncape.gov.za/other/2012/9/grading_guide_&_policy_version_5_app_30_may_2012.pdf

grading is done by a special committee of the relevant heritage authority; however heritage authorities rely extensively on field grading in terms of decision making.

Mining operations are not exempt from any heritage legislation; however it is lamentably common that mining operations continue to ignore heritage legislation. It is equally lamentable that Provincial and National heritage bodies whose duty it is to enforce legislation do not have the capacity to implement the law throughout their areas of jurisdiction. With due credit to De Beers Namakwaland Mines Division a good heritage management program was implemented with the result that West Coast Resources will benefit from large areas of land that have been subject archaeological assessment and in some areas, the necessary mitigation.

3 Methodology

This study is based on a considerable body of desktop information and directly relevant experience which ACO has accumulated over the last 26 years in the project area. New aerial photographs have been provided which has assisted the compilation of this report.

Much relevant information has been obtained from 30 reports and a number of scientific publications, the authors of which have been in the employ of this company. Raw data held by ourselves includes track-logs of areas that have been surveyed, co-ordinates of heritage sites and objects which has been used to compile information about areas that have been surveyed or otherwise, all of which has been stored in digital form.

The body of information was gathered by ACO while in the employ of De Beers Namakwaland Mines Division. Between 1991 and 2008 the team completed surveys of proposed mining blocks, recording all the heritage material and archaeological finds they could. Numerous archaeological sites were formally excavated and moved from the path of mining, hence this experience and the resulting body of information has allowed for a solid assessment of the impacts of the current mining proposals.

The assessment of impacts has taken place as per the guideline documentation provided by Myezo (Pty) Ltd.

Appendix B contains tables and maps indicating parts of the project area that have already been subject to HIA and mitigation, and what further areas need to be done, while Appendix C contains a copy of the palaeontological management plan (prepared for De Beers Namakwaland Mines Division) that is still relevant by John Pether 2008.

3.1 Season of work

This specialist assessment (undertaken in June – July of 2016) is not affected by season. Being an arid zone ground surface visibility is extremely good all year round.

4 BACKGROUND TO HERITAGE IN NAMAQUALAND

4.1 Palaeontology

An Assessment of the palaeontology of De Beers Namakwaland Mines Division was completed by Pether (2008). This study was completed under the NHRA and remains valid to this day. Relevant portions of his report are included below.

In terms of the National Heritage Resources Act No. 25 of 1999, Sections 35 & 38, palaeontological materials (fossils) are regarded as a heritage resource and appropriate actions are required to mitigate impacts from mining, construction and development on palaeontological heritage. If fossils are turned up in excavations, they must be rescued from destruction and loss.

The significance of fossils as natural heritage is primarily their scientific value. They contribute to the understanding of South Africa's geo-history, the progression through "deep time" of changing climates, oceanography and of the biota, both plant and animal, that lived on the land and in the sea. This history ultimately resulted in the landscapes and coasts and the resources that sustain us today. Generally-speaking they are scarce, non-renewable and irreplaceable when destroyed. Their value is also severely compromised when they are collected without proper recording of their geological context. Geological (sedimentological/palaeoecological) observations are indispensable for the interpretation of fossil finds.

The value of fossils extends far beyond the curiosity of palaeontological study in museums, for they provide the basis for biostratigraphy, the division of the sedimentary record into units of distinct ages that can be correlated both regionally and globally. The fossil content of strata is thus very important for understanding the genesis of exploitable mineral resources and for the geological models that furnish the basis for ongoing mineral exploration. Moreover, there are the intersecting broader concerns of **GeoHeritage**, scientifically with regard to the preservation of Type Sections of the deposits and **GeoTourism** as a sustainable endeavour for the future (Pether, 2008).

4.1.1 Koingnaas to Hondeklip Bay

Little information was forthcoming from the Hondeklip area of central coastal Namaqualand until Tankard (1966) described aspects of the succession revealed by prospecting. At that stage, the sequence was seen in terms of the preliminary biostratigraphy erected by Haughton (1932) (Zones E to A). Significantly, Tankard (1966) reported the presence of channel-infilling, kaolinitic, non-marine sediments overlying kaolinized gneiss (the "Channel Clays"). The occurrence of abundant phosphatic nodules was observed. Tankard encountered difficulties in the application of Haughton's (1932) biostratigraphic zones to the more extensive prospecting exposures he saw (*i.e.* the "megatrenches"). An important advance for the stratigraphy of Namaqualand coastal deposits was Carrington & Kensley's (1969) article describing new molluscan fossils from the central Namaqualand area in which a summary stratigraphic column was presented. Channel-infilling, unfossiliferous, fluviatile clays and clayey sands, considered Mio-Pliocene in age, were recognized as the oldest unit, which was succeeded by remnants of phosphatic beds with abundant shell moulds, considered Pliocene in age.
In contrast to the earlier suggestions of a Mio-Pliocene age for the higher elevation coastal-plain deposits (Wagner & Merensky, 1928; Haughton, 1932), Carrington & Kensley (1969) considered the bulk of the succession to be of Pleistocene age. They identified "transgression complexes" at 75-90, 45-50, 17-21, 7-8, ~5 and ~2 m ASL. and a 29-34 m Beach. Importantly, they found that the bivalve *Donax rogersi* Haughton, 1926,

actually subsumed two species; the thick-shelled, robust *D. rogersi* “proper” and a thin-shelled, generally smaller species (thought by Haughton to be juveniles), which they named *Donax haughtoni*. The latter species occurred only in the fine-grained, usually laminated, sands of the “45-50 m complex,” whilst *D. rogersi* occurred only in the coarse, usually cross-bedded, sediments of the younger “17-21 m complex”. This finding constituted a major advance in the biostratigraphic subdivision of the older coastal-plain marine deposits. Additionally, species obtained from the “45-50 m complex” suggested a fauna of warm-water affinity.

Further notes on the deposits of central Namaqualand were provided by Davies (1973) and by Tankard (1975a, 1975b). Tankard (1975a) differed from Carrington & Kensley (1969) in regarding the phosphatic beds in the Hondeklip area as older than the “channel clays”. However, Carrington & Kensley (1969) were correct and the “channel clays” are older than the phosphatic beds. Tankard provided some information on the phosphatic beds that infill hollows in the bedrock and which had come to be known as “E stage,” from Haughton‘s oldest biostratigraphic unit,”E Zone”. Tankard (1975a, 1975b) proposed correlations of lower, middle and upper “E stage” sub-units with the succession in the Varswater Quarry near Langebaanweg. Kent & Davies (1980) informally named the coastal-plain deposits between the Olifants River and Kleinzee the “Hondeklipbaai sandy gravels”.

Pether (1986) provided a summary of the main findings of his research on the succession at Hondeklipbaai, including suggested correlations farther afield. More intensive faunal sampling carried out during this study led to considerable additions to the marine molluscan fauna of Namaqualand coastal deposits (Kensley & Pether, 1986). The first extinct Tertiary barnacle recorded from South Africa was described from Hondeklip by Pether (1990). Brunton & Hiller (1990) have described the fossil brachiopods collected by the writer in the Hondeklip study area. Pether (1994b) provided detail on the exposures and palaeontology at Hondeklipbaai (Pether, 2008).

4.2 Archaeology

During the 1960’s several researchers reported sites from the diamond areas and pottery was collected (Rudner 1968). Since that time few researchers have worked in the area, probably as a result of a combination of factors such as increasing costs of fieldwork and difficulty of access. Since the completion of this survey small portions of the Namaqualand coast have been studied in more detail. Excavations have also been undertaken at a cave at the Spoeg River mouth where a sequence of occupation has been found (Webley 1992). In addition, six archaeological sites on De Beers owned land at Brand se Baai have been subjected to controlled archaeological excavation as part of a programme to mitigate the effects of diamond mining (Halkett and Hart 1993). More sites were excavated to the north of Brand se Baai as part of the mitigation of Anglo Americans’ Namakwa Sands project (Halkett and Hart 1994). Dates obtained from these excavations have provided the beginning of a chronological framework for the occupation of Namaqualand. Three areas, namely Brazil, Tweepad and Schulpfontein were partially surveyed during an IEM study for ESKOM (Parkington and Hart 1991).

Early in 1991, Professor John Parkington of the Department of Archaeology at the University of Cape Town (UCT) visited Kleinsee and was shown a number of archaeological sites along the coast in the mining areas. Following discussions with Mr.

Richard Molyneux, the chief geologist at the time, the Archaeology Contracts Office (ACO) was commissioned to make an inventory of the archaeology of De Beers owned coastal properties in Namaqualand. This took place over some three months in the latter half of 1991. It was hoped that ultimately important archaeological sites could be identified and saved from destruction by mining.

The archaeology of the Namaqualand coast has remained for many years, relatively unexplored apart from odd forays to study specific aspects (Rudner, 1968). In addition to making a partial inventory of sites, this early attempt was a pioneering exercise aimed at determining the range, age, quantity and context of archaeological material.

It became clear within the first few days of fieldwork that a complete inventory would be out of the question as the range and number of archaeological sites was greater than anything that had been expected. A sampling strategy was employed that concentrated on a coastal strip of approximately 1 km in width, in which most sites usually occur. Hence the information that was obtained from the 1991 survey was patchy and, being pre-GPS days, the accuracy of mapping was indifferent.

In 1997, De Beers Namakwaland Mines appointed ACO to develop a management plan for the protection and mitigation of archaeological sites that were to be affected by mining. The plan was implemented by De Beers for many years under the watchful eye of Mr Andrew Mackensie and Mr Paul Kruger. The management plan enjoyed considerable success in that no less than 30 reports, two PhD dissertations and numerous academic publications were produced. **All of this amounts to a considerable archive of knowledge which would have been completely lost if the management plan had not been implemented**. The 1997 management plan remained in place until De Beers reduced its coastal mining operation in recent years with the result that no further work has taken place on any new mining operations in the area. In 1999 the new National Heritage Resources Act was passed and eventually enabled in 2003. This effectively invalidated the 1997 heritage management plan that was drafted in terms of the old National Monuments Act; however the principals expressed in the plan remain valid. The National Heritage Resources Act 25 of 1999 is more comprehensive and very much more complex protecting a very wide range of resources including archaeology, palaeontology, the built environment as well as setting and cultural landscape.

4.3 Archaeology of the Koingnaas area

A simplified summary of the main characteristics of the various historical periods of the region is presented below. These summaries will help to place the findings of the archaeological investigation in context.

4.3.1 The Early Stone Age (ESA)

In 1911, an amateur archaeologist discovered some ancient stone artefacts on the banks of the Eerste River in Stellenbosch. Among these was an artefact type which he recognised as the hand axe and suggested that they were of extreme age. Modern research has shown that these artefacts were made by people who lived between 200 000 and 1 000 000 years ago. Sites containing these characteristic Early Stone Age (ESA) artefacts have been found throughout Africa, parts of Europe and the Far East

(Sampson, 1974) and locally, sites of this period have been found throughout South Africa. The makers of Early Stone Age artefacts are believed to be the hominid type known as *Homo erectus*. Although the population of these hominids was probably relatively small, the sheer depth of time over which they roamed the landscape has resulted in large numbers of sites found in widely differing ecological zones from the coast to the mountainous regions. The raw material favoured for the production of Early Stone Age tools was quartzite. It is no coincidence therefore that ESA sites are often found next to river beds where large quantities of water worn quartzite cobbles can be found. Within De Beers owned land extensive deposits of Early Stone Age material have been recorded in the Buffels-Marine complex and on the high surface quartzite ridges behind Kleinzee. This situation at Koingnaas is less well explored.

4.3.2 The Middle Stone Age (MSA)

Large cave sites discovered in the Kalk Bay Mountains on the Cape Peninsula in the 1920s contained deep deposits with large numbers of more refined stone artefacts in the lower parts of the sequences. These were recognisably different from ESA artefacts and had many similarities to artefacts found in the Palaeolithic sites of Europe. Similar kinds of artefacts have since been found on many open sites and on rare occasions, in the deposits of caves throughout South Africa. A larger selection of fine grained raw material was used for the manufacture of artefacts as new techniques of production, and secondary working into intricate tools, required more predictable flaking properties. Research has shown that these artefacts belong to a period known in South Africa as the Middle Stone Age and date to the period between 40 000 and 200 000 years ago. Stone artefact sites of this time period are not uncommon. In some very rare instances where circumstances permit, fossil animal bone and marine shells have been found in association with the artefacts giving some indication of the diet and lifestyle. On the west coast of South Africa only 3 open sites of this kind have been encountered. One of these is at Boegoeberg north of Port Nolloth (exposed and damaged by mining), at Brand se Baai (destroyed by mining) and at Yzerfontein which was partially damaged by a road cutting but since been successfully studied. Other intact cave deposits have been identified at Elands Bay. Intact MSA open sites are very rare and internationally prized. MSA people are thought to have been an early form of modern humans (*Homo sapiens*) who were capable of hunting large animals and capable of abstract thought. Current theory is that early *Homo sapiens* evolved in Africa and migrated to Europe and the Middle East circa 40 000 years ago (Klein, 1989). It is believed that these new migrants may have been responsible for the demise of the Neanderthal populations in Europe.

MSA sites are likely to be buried below the surface but invisible to archaeological survey. The MSA, which is of late Pleistocene age, is identifiable by the artefactual content. It has particular stone tool forms associated with the characteristic technology of that period. MSA material does exist in some active dune seas where artefacts are periodically exposed as the sand shifts. A few sites were located at prospecting trenches where the material is present in sections and on spoil heaps. It is known that some ESA and MSA material will have been inundated by rising sea level as sites dating to the glacial phases would have been located on ancient coastal plains.

Most MSA and ESA sites are often of limited archaeological value because little more than stone artefacts survive. Organic materials are seldom preserved on open sites of this age except in exceptional circumstances where fossilisation takes place. These kinds of sites are highly valued. A number of such localities have been found in the Western

Cape, for example Elandsfontein, Duinefontein and Saldahna. MSA sites with preserved organic material are prized internationally in terms of the information they contain about early modern human behaviour.

Although bone may be preserved on open sites where alkaline conditions prevail, caves and shelters are the best places for preservation. Where bone is found, extinct faunas are often present. Under these circumstances there is the possibility that included amongst them will be the remains of early human beings. While other parts of southern Africa have produced remains of Australopithecines under specific preservation circumstances, very few remains of humans have been found which date to the late Pleistocene. The few remains which have been found in southern Africa are of major importance as they represent the earliest known existence of early modern humans, whom some researchers believe, evolved in Africa about 200 000 years ago (Klein, 1989). We know that along the west coast we have artefactual material which attests to human activity from this time period but sites which produce hominid remains are extremely rare.

It is very difficult to date MSA sites in general because they require specialised direct dating techniques together with a range of supplementary Palaeoenvironmental information. As MSA sites are over 40 000 years old, they are beyond the range of normal radio carbon dating. Because the MSA period is so extensive, the optimum situation is to find material in stratified context where relative ages can be deduced by comparing the contents of stratified layers.

4.3.3 The Late Stone Age (LSA)

This period has been subjected to detailed study by archaeologists, and is an area of focus in this report as it is the most common form of heritage site within the project area. Late Stone Age people lived in southern Africa from 40 000 years ago up to the arrival of European colonists at the Cape, and co-existing with them for some time. Late Stone Age people were the ancestors of the San (Bushmen) and Khoi Khoi people who were present throughout the south-western and Northern Cape during the colonial period. Throughout most of the Holocene (last 10 000 years) southern Africa was inhabited by small groups of San hunter-foragers who were highly mobile. They hunted with bows and arrows, snared small animals and, where groups lived close to the shore, gathered shellfish and other marine resources, a habit which resulted in the use of the term “Strandlopers”. They used digging sticks, often weighted with bored stones, to find a variety of vegetable foods, particularly bulbs below the soil.

Not only did the San have a prodigious knowledge of the animals and plants around them, but they also had a complex belief system, aspects of which are represented in many of the rock painting and engraving sites of the Northern and Western Cape. It is now broadly accepted by archaeologists that shortly after 2000 years ago, a new economic system was introduced to southern Africa. Certain groups of people (the Khoi Khoi) who had adopted transhumant pastoralism (in this case with herds of fat-tailed sheep and later cattle) appeared in southern Africa (Smith, 1987, Sealy and Yates 1994). While the San groups seem to have co-existed with the pastoralists, it has been suggested that hunter-foragers were marginalised moving into areas where the grazing opportunities were less attractive to pastoralists (Parkington *et al.* 1986). The advent of pastoralism seems to have been accompanied by the technology of making clay pottery. The precise origin of early stock keeping and ceramic technology in southern Africa is still unclear but it is suggested that stock keeping was introduced from the north and gradually dispersed to the Cape.

The majority of archaeological sites in the study area date to the Late Stone Age, which is the heritage of the Khoi Khoi and San people. In the 1991 survey, which was by no means comprehensive, hundreds of these sites were recorded.

4.4 Late Stone Age shell middens and open sites

The majority of visible archaeological sites in the project area date largely to the Later Stone Age (LSA). For reasons that are not entirely clear, but possibly related to climatic factors, LSA sites dating to the Holocene seem to fall within the last 5000 years. Of these, a large number date after the last 2000 years, when it is known that there was a major change in the prevailing social situation in the Cape. This is believed to have coincided with the arrival of pastoralist groups (Khoi Khoi) from the north, who in addition to introducing ceramic technology, also introduced domesticated stock, initially sheep and sometime later cattle. While the route of this migration remains unresolved, it is believed that one possible route for the introduction to southern Africa was from Botswana along the Orange River and down the west coast (Elphick, 1977). Spoeg River cave has produced some of the oldest dates so far (2000 years ago) for domestic sheep in southern Africa (Webley, 1992, Sealy and Yates 1994)

Late Stone Age sites along the coast of the project area are represented by scatters of marine shell (Figure 2). Areas immediately adjacent to the coast, especially where there are rocky shorelines, are often covered by extensive shell middens resulting from hundreds of visits by groups of pre-colonial people. These sites which overlie and overlap each other are very difficult to resolve archaeologically. Fortunately this is a near shore phenomenon and further inland, sites have more defined boundaries. Unlike those sites along the immediate shoreline which contain few artefacts, occupation sites are generally believed to show a much wider range of artefactual material, with spatial arrangements indicating specific activity areas. Items that may be expected on such sites include stone artefacts, ostrich eggshell - particularly beads and water containers, grindstones, discrete shell piles, hearths, bone and whale bone structures. There seems to be no specific location which only attracts occupation sites however it has been observed that deflation bays along the coast or further inland were frequently selected for camping sites, and often contain suites of microlithic artefacts.

Within a kilometre of the shore, pre-colonial camp sites are found in a variety of environments and locations, some of which appear to have been favoured over others. Dune tops, dune lees, deflation bays and areas around sheltered bays appear to have strongly attracted pre-colonial people. We have noted clusters of middens and artefact scatters associated with coastal dune seas. These areas seem to have been popular 3000-5000 years ago. There are, however a significant number of sites that are not located at obvious natural foci and can be found on featureless coastal flatlands. This variability makes accurate prediction of location very difficult. What is clear is that people in this marginal landscape were attracted to the coast where food resources were the most reliable.

Later Stone Age sites along the coast are largely identified by scatters of marine shell. In some cases these dumps (called middens by archaeologists) are associated with domestic artefactual debris and are believed to represent occupation sites of long duration. Other sites, lacking a formal stone artefact component may represent visits of short duration.

Shell Middens typically occur within 1 km of the coast and tend to be prolific near estuaries and in dune fields, and adjacent to rocky shores. The immediate coastal dunes, especially close to rocky shorelines were greatly favoured by prehistoric people as marine food was close by. Areas close to sheltered bays contain so many middens that at times it is difficult to distinguish one from the next. Inland of the coast the frequency of shell middens drop away, however the pattern is not always predictable as an area with good game and a source of fresh water can result in middens existing kilometres inland.

4.4.1 The content of Late Stone Age middens

Three species of shellfish were heavily exploited by prehistoric people namely, the limpets *granatina, argenvillei* and *granularis*. Other species noted are the black mussel *Choromytilus meridionalis*, whelks *Burnupena sp*. and the limpet *barbara*. Information from the recorded sites indicates a tendency for higher quantities of *Choromytilus meridionalis* and *argenvillei* to be found on sites suspected to predate the ceramic period. The presence of the razor clam, *Solen capensis,* on MSA sites, particularly around the present Swartlintjies River, suggest that estuarine conditions existed at some stage in the past and would be consistent with a higher sea level. Other species which occur in low numbers are *Patella compressa and Argobuccinum pustulosum pustulosum*. Some species have been collected for decorative purposes e.g. *Conus mosambicus,* a species of cowrie appears to have been perforated and used as decorative beads.

Figure 2 **A late Stone Age shell midden situated close to Zwartlintjies Rivier.**

The contribution of rock lobsters to the diet can be assessed on the basis of the number of mandibles found on the sites as these hard. Although lobster remains have been seen on most sites, observations so far indicate that sites suspected to be older than 1800 years show markedly higher mandible counts.

Archaeological sites in the Koingnaas area tend to be quite rich in both bone artefacts as well as local fauna. Numerous bone points have been recorded on middens and in some instances, even signs of ritual activity such as the burying of tortoise carapaces and carapace bowls under archaeological deposits, particularly at Rooiwal Bay (Orton, J. Hart, T. and Halkett, D. 2005). Whale bones (particularly ribs) are found on a number of sites and were used as support struts in small huts and shelters. Whale vertebrae are also found on occasions and the use of these as seats has been ethnographically documented. A painting of a group of "Strandlopers" made during Robert Jacob Gordons' expedition of 1779, shows not only whale bone in the form of vertebral discs and ribs adjacent to a fire place, but also shows discarded shellfish remains, and attests to the use of small shelters and ostrich eggshell water containers (in Raper & Boucher 1988: 271). Two entries in Gordons' journal specifically describe the use of whale ribs: *We found seven huts standing together which the wild Bushmen had made of whale bones all protected to the NW. At these huts were large amounts of shells....*(ibid:258) and later: *There was a large hut made differently from those of the Hottentots with two high doors - or rather openings - open to the east, of wood from cast up trees, and Noordcaper or* *whale bones covered with grass and vegetation, and very hot.* (ibid: 269). The whale bones which he saw are most likely those of the Southern Right whale, *Balaena australis*.

For the early inhabitants of the area these were ostrich egg shells were versatile objects with a number of uses. They could be used as food and if the shells were carefully perforated could be used as water containers that could be filled and carried or stored in caches below ground for future use. Decorated ostrich eggshell fragments have been found on a number of sites indicating that decorated containers were once abundant. We have noted that certain parts of the coast thus far surveyed, contain more sites with decorated ostrich eggshell than others. Active dune fields close to the shoreline frequently contain sites with this material present. The regional patterning of such occurrences as well as the geographical distribution of decorative patterns may hint at the arrangement of population and usage of the land by different groups of people. Ostrich eggshell has also been used in the manufacture of pendants and beads. Diameters of beads vary from site to site. Exterior diameters of beads thus far measured range from 4 to 16 mm. Current research at UCT suggests that there may be chronological as well as cultural aspects related to size differences.

The range of tools includes flakes, cores, hammer stones, upper and lower grindstones, small convex scrapers, backed scrapers, segments, drills and a variety of miscellaneously retouched pieces. The formal tool element includes scrapers, drills and segments. Drills and segments normally occur on sites that are older than those without, that are more than 3000 years ago. Scrapers seem to have had a longer history of use and occur on both early and later sites. Formal tools are more common on sites not on the immediate shoreline and are frequently found in deflation bays (see also Manhire, 1987). Near shore sites more commonly contain informal stone assemblages of flakes made from quartzite and quartz. The range of stone used is limited to a number of types. Fine grained siliceous materials such as chalcedony and chert were used for scrapers, drills and segments. Quartz is found in large quantities on most sites but does not seem to have been regularly used for formal tools. Silcrete flakes and cores are present. Sources of silcrete and chalcedony have been identified in the vicinity of Kleinzee. A small outcrop of fine grained quartzite at Goraap was quarried for use in stone tool manufacture.

Many potsherds have been noted on this part of the coast. Sizes and quantities of the sherds varied considerably from site to site. In some instances it was clear that the remains represented reconstructable pots while in others only fragments of pots were present. While most sherds are plain, some do show traces of decoration. We have observed three kinds of decoration namely i) Impressed - usually linear arrangements of small depressions, ii) Lined - rows of horizontal lines around the neck, and iii) "Thumbnail" impression - series of crescent shaped depressions in various positions on the pot. Most vessels had perforated lugs and the presence of base nipples has been noted suggesting that some of the pots had pointed bases. The presence of fragments bearing traces of more conventional basal studs (feet) shows that some pots had round bases. While the established chronology for this material suggests that sites containing it post-date 2000 years, in some cases it is found on sites with an earlier signature. This has probably resulted from the multiple uses of those sites at different times. Pottery may provide regional and chronological information, particularly through the analysis vessel shapes and decorative motifs (Smith *et al.* 1991). Collections of pottery from different parts of the South African coast have showed that there is variation in both vessel shape and decoration (Rudner, 1968).

4.4.2 Age of sites

These observations show strong evidence of chronological variation. Sites with decorated ostrich eggshell and formal tools are virtually certain to be older than sites containing both decorated and undecorated pottery. Our observations also show that certain classes of artefacts are more common in some locations than others and suggest that there have been shifts in habitation patterns through time. It is possible at this stage to suggest a hypothetical chronology of occupation on the Namaqualand coast. Numerous MSA artefacts attest to the use of the coast during the late Pleistocene. Since the MSA sites that we have observed often contain shellfish, it would seem likely that some occupation occurred during interglacial periods when the shoreline closely resembled that of today. Some early material relating to the glacial stages was probably lost following inundation of the ancient coastal plain.

Between the end of the MSA (approximately 40 000 years BP) and about 5000 years ago, few sites dating to this period have been found anywhere along the west coast. Between about 5000 years ago and 2000 years ago (the ceramic period), the region was occupied by hunter/gatherers who were exploiting large amounts of marine foods which included quantities of mussels and lobsters, rather higher than what we have seen on ceramic period sites. This may reflect environmental changes associated with Holocene sea level fluctuations, depletion of marine resources in later times, or even a change in cultural values associated with the ceramic period. It is known that the advent of a stock keeping economy in southern Africa was associated with changes in material culture. It is hypothesised that in Namaqualand this is reflected by the disappearance of types of formal artefacts from open sites and shifts in marine food collecting habits.

Before the 1991 study very little was known about the length of time that Late Stone Age people occupied Namaqualand. It is now known that the chronology of occupation is long and complex. Fragments of pottery are common on sites indicating that much of the pre-colonial occupation post-dates the arrival of the Khoi Khoi. We have also found a number of instances where fragments of pottery have been found on sites with older types of stone artefacts indicating that some sites were re-used over a long period of time.

In the same way as ceramics are indications of sites dating to after 2000 years ago, so certain types of stone artefacts are an indication of even earlier occupation. In South Africa, within the Holocene, the prevalence of refined microlithic artefacts such as segments, backed scrapers and backed bladelets indicate occupation approximately 3000-5000 years ago. In Namaqualand, a number of sites contain these types of formal artefacts indicating occupation since the mid-Holocene. In addition, formal artefacts are often accompanied by decorated ostrich eggshell and this material is also believed to have a mid-late Holocene signature. Layers in sites at Brand se Baai and Lamberts Bay containing formal artefacts, have been radio-carbon dated to between 4000-5000 years ago (Hart & Halkett 1994; Orton, 2012).

4.4 The Colonial Period

When the Dutch colonists arrived to set up a replenishment station at the Cape in 1652, they encountered several Khoi Khoi groups. Some of these lived on the Cape Peninsula while the larger groups grazed herds of sheep and cattle in the Tygerberg Hills and Cape Flats. First contact between Europeans and indigenous southern African pastoralist groups had occurred much earlier when Portuguese mariners sailing down the coast in the 15th and 16th centuries had bartered supplies of meat from the Khoi that they encountered at places such as Saldahna Bay (Smith, 1985). With the increase of shipping rounding the Cape, it was inevitable that some would be wrecked. Encampments were set up by the survivors of such wrecks, and they often recount meeting and trading with the indigenous groups (Smith, 1985; Raven-Hart, 1967) so that by the time that Van Riebeeck arrived, a history of contact had already been established. Although it is not entirely clear from the writings of the early settlers, it appears that some San groups still existed in the Cape. They still seemed to be pursuing a largely hunting and foraging lifestyle and were often encountered in the more mountainous regions where there was less possibility of conflict with either the Khoi or Dutch settlers (Parkington *et al.* 1986).

At first the relationship between the Dutch and the Khoi Khoi was one of co-operation, with a great deal of bartering taking place primarily to get regular supplies of fresh meat. However, as the colony grew and free burghers were granted lands further away from Cape Town, grazing lands previously available to the Khoi Khoi were encroached upon. The conflict for land began a process of attrition which when accompanied by several deadly smallpox epidemics broke down the indigenous population and its political structures. Those who survived, were pressed into service as farm labour or settled around several large mission stations that had been established in the Cape. Namaqualand was one of the least desirable parts of South Africa for the colonists and meant that San and Khoi Khoi people were able to continue many aspects of their traditional ways of life in this area until they were displaced during the early 20th century. The accounts of several early travellers who passed through Namaqualand, most notably that of Robert Jacob Gordon in 1779, clearly attest to the presence of indigenous hunter-forager and pastoralist groups in the area (Raper and Boucher, 1988). The Nama, originally one of the Khoi Khoi groups, still practice transhumant pastoralism in reservations in Namaqualand today, while many other people of Khoisan discordancy worked on the mines and on farms. Loss of traditional land now followed by the closure of many mining operations has had a serious impact on these communities.

Historical research in Namaqualand is minimal, since there is rather less recent archaeology here than is the case further south. Historical sites, primarily in the form of ruins from the 19th and 20th centuries, are sparsely spread over the landscape, while a few contact period sites have been documented (Orton, 2009; Webley, 1984, 1986). These latter are sites inhabited by indigenous hunter-gatherers or herders that include evidence of contact with European colonists. Historical material almost certainly all relates to early mission stations and farmers of the region; the first mission station was established at Leliefontein in 1816 (Shaw, 1840), although Johann Schmelen and others were preaching in the area from about 1812 (Trüper, 2006). In this area, formal land grants were all relatively late in the context of the history of the Northern Cape, most dating to the late 19th or 20th centuries. Prior to acquisition by De Beers, the land was used for farming livestock. Original farm boundaries are still retained although De Beers owns most of the land.

Mining has perhaps been the greatest force that brought colonial settlement to the west coast. The towns of Hondeklipbaai and Port Nolloth owe their presence to the establishment of copper mining in the 19th century, while later on in the early –mid 20th century the discovery of diamonds saw the development of the towns of Alexander Bay, Kleinzee and Koingnaas (Carstens *et al*.1987, Davenport, 2010 Fleminger, 2008 and Williamson, 2000). Mission Stations also played a very important role in consolidating the remaining Khoikhoi communities who found themselves bereft of traditional land.

In 1925, the first Namaqualand diamond was discovered. It came from a site 10.5 km south of Port Nolloth and was found by Jack Carstens on 15th August using very rudimentary techniques (J. Carstens, 1962; P. Carstens, 2001). For the remainder of the 20th century the mining industry has been the dominant force of development on the west coast.

4.5 Maritime archaeology

There are shipwrecks in the surf zones on the west coast. These are considered part of the heritage of the area and giving the kinds of beach mining operations envisaged by West Coast Resources, are potentially under threat.

Shipwrecks greater than 60 years of age and within the territorial waters of South Africa are protected under the National Heritage Resources Act and considered to be part of the National Estate. There are an estimated 3000 known shipwrecks off the coast of South Africa, the earliest of which date to those of Portuguese mariners who rounded the Cape after 1500 AD. The amount of unknown or undocumented shipwrecks is unclear. Numerous vessels have been documented as leaving port bound past the Cape but have failed to arrive at their destinations, their whereabouts is unknown.

Inevitably records of the location of documented wrecks are poor as in a disaster situation ships' masters and navigators had other priorities than documenting the ships position at time of sinking. Positions tend to be estimates obtained from survivors and can be scores of kilometres off, even in sight of land. Ships that were wrecked off-shore can be incorrectly positioned in the order of hundreds of kilometres. Ships that were abandoned at sea can drift for many kilometres before they sink, and even then may drift below the ocean surface before the timbers get water-logged. Given these uncertainties assessing the impacts of a given development project is fraught with difficulties. Pro-active searches for wrecks over vast tracts of oceans is a technically demanding and laborious task, hence one is compelled to use what historical evidence there is available.

The database which is available (namely the national shipwreck database) reflects the estimated positions of wrecks where the provenance is known or can be roughly estimated. There are numerous shipwrecks off the west coast that potentially range in age from the days of the Portuguese navigators and Dutch East India Company to the late 20th century; the hotspots for these wrecks are rocky shorelines and inlets and peninsulas, off-shore reefs. Further out at sea the coastal shipping route was subject to wartime casualties and ships that were abandoned at sea due to foundering, collision or fire on board. The majority of wrecks however are caused when ships hit a reef, an obstacle or are driven on shore. While a number of late 20th century casualties are reflected on the databases and maps, it is only wrecks that are greater than 60 years of age that are formally protected. The recent discovery of the oldest shipwreck south of the equator is that of the Portuguese galleon, the *Born Jesus (ran aground 1533)* found in a beach mining operation north of Oranjemund attests to the fact that this possibility exists in any place where beach mining takes place.

5 Impacts of Mining on heritage

The impacts of mining of heritage are discussed in this section of the report and illustrated with a few case studies that are relevant. Open cast mining, by nature is invasive and disruptive to the natural layering of soil and geology. This affects anything buried in the soil such as archaeology and geology and palaeontology. Impacts can occur during prospecting, operation of mine and during rehabilitation.

The proposed sea shore mining operation will affect the seabed to up to several hundred meters offshore but also affect areas adjacent to the beach/shore through peripheral earthmoving and disturbance by equipment installation, creation of new roads and areas for processing plants.

The near shore areas have not been surveyed in details up to now although certain areas near Mitchells Bay have been studied in detail (see appendix B) and are already mitigated and prepared for mining.

5.1 Importance of physical heritage

While written historical texts provide invaluable information, history is preserved in many other forms as well. Buildings, art, antiques and many other artefacts are also aspects of history which in themselves tell a tale. It is common knowledge that written texts document only a small fraction of the trajectory of human history and the balance must be inferred from the remains of activity which have been left behind. This is particularly true in Africa where the human species evolved some 4 million years ago, but written records have only existed in some areas for last few hundred years. The bulk of this history must therefore be gained from examining the remains of human activity in all its forms which is preserved on archaeological sites.

Historical buildings, archaeological sites and other artefacts are non-renewable and once destroyed can never be replaced. This realisation has resulted in the formulation of statutory controls for the preservation of such resources in most countries in the world today. The International Council on Monuments and sites (ICOMOS), of which South Africa is now a member along with 84 other countries, seeks to apply the highest principles of conservation to the Monuments and Sites of the world (Deacon ed. 1996).

5.2 Sources of Impact

We generally identify two major sources of impact on heritage material. These are defined as primary sources which are often large scale organised activities which modify the landscape and secondary impacts which are of an *ad hoc* and usually more limited nature. While the action of mining itself has the most serious impact, there are other activities that can be detrimental and these are indicated below.

5.2.1 Primary sources of impact on heritage material

The activities identified below are generally responsible for the most damage to heritage resources.

1) Development of land as a result of a structure plan.
2) Development of land as a result of a rezoning application.
3) Development of land as a result of a subdivision.
4) Establishment of housing developments not subject to conditions of 1, 2, 3 above.

5) Establishment of townships.
6) Establishment of resorts.
7) Any development on undeveloped land.
8) Mining and quarrying activities.
10) Construction of airports.
11) Construction of dams.
12) Construction of ports harbours and marinas and seabed work.
13) Laying of pipelines.
14) Construction of major sporting facilities.
15) Flood control schemes, canals, aqueducts, river diversions;
16) Any major landscaping, excavation or land remodelling projects;
17) Construction of roads;
18) Construction of railway lines;
19) Illegal demolition of structures over 50 years old; and
20) Agricultural activity.

5.2.2 Secondary sources of impact on heritage material

These impacts can be as serious as those caused by large developments but are usually of more limited nature and occur on an *ad hoc* basis. They are generally associated with increase in human activity resulting from proximity of residential areas and recreational facilities. Primary impacts which lead to the increase in human use of an area will usually be accompanied by secondary impacts. In a mining situation these impacts can occur on short term prospecting sites which can cause disturbance of surface archaeology, as well as driving off-road and creation of dirt tracks. Impact assessments must also consider these additional factors resulting from development activity. *The ad hoc* nature of the impact makes it difficult to control beyond educating the public as to the sensitivity of archaeological resources. We have identified some of the secondary impacts on archaeological sites below, many of which have the potential to occur in the project area.

1) Illegal collection of artefactual material;
2) Indiscriminate use of off-road vehicles;
3) *Ad-hoc* creation of dirt tracks or tracks for off-road vehicles;
4) Establishment of informal parking areas;
5) Establishment of informal camp sites and picnic areas;
6) Dumping;
7) Unplanned footpaths; and
8) Erosion resulting from any of the above or any other source.

5.2.3 Impacts of mining on palaeontology

Palaeontology sensitivity is a risk at the land-based mining areas unless the management plan supplied by Pether (2008) is implemented. In the past, mining operations have opened a number of deep excavations which have contributed significantly to understanding the palaeontology of Namaqualand and developing the regional sequence. Much of this work was done by De Beers geologists themselves, however they also allowed opportunities for research to take place through allowing access to pit profiles before remediation took place. Hence, there is considerable benefit to be had by using mining operations as an opportunity to examine deep sequences that would not normally be available to researchers. The gaining of this knowledge is a positive impact provided that pit profiles are examined before backfilling or remediation takes place.

The mining of beach sequences has the potential to provide new knowledge with respect to marine regressions and transgressions in the project area. The presence of fossil shell beds exposed in beach mining must described/sampled and provenance by a suitably qualified person.

5.2.4 Mining impacts on shallow archaeological sites

The spatial distribution of the components of archaeological sites are very important as it is the relationships between objects in time and space that that archaeologists use to deduct the events of the past. Artefacts for which there is no contextual knowledge have little more than curiosity value. Hence the breaking of the physical relationships between the components of archaeological sites destroys 90 percent of its scientific and heritage value. Such destruction will occur if a site is raided by illegal collectors or even driven over with a 4x4. Mining operations are the extreme of this spectrum of disturbance due to the scale of earthmoving and the size of the equipment used. Typically the destruction tends to be complete, permanent and non-reversible. While exact figures are not available, diamond mining has destroyed at least half of the west coast heritage resources, while outside of mining areas uncontrolled 4x4 use, property development and farming has caused extensive damage. The impacts are of very high significance, irreversible and permanent.

5.2.5 Impacts on deeply buried archaeological sites

Considering that humans have inhabited Namaqualand for more than a million years, and through multiple sea level regressions and transgressions, erosion and depositional phases in the earth’s history, archaeological sites can be deeply buried. Diamond mining operations clear all sediment down to bed rock which means that any archaeological site buried by sediment has the potential to be negatively impacted by mining. No archaeologists have ever had the opportunity to audit the extent of buried sites in Namaqualand, so it is very difficult to understand the extent to which impacts have taken place in the past. There are at least two recorded incidents of ancient archaeological sites destroyed by mining.

Case study – Brand se Baai. The first of these was recorded by ACO at Brand se Baai. Ancient archaeological materials with fossilized organic remains were found lying on the edge of an old prospecting trench immediately on the coastal dunes. Indications were that a Middle Stone Age site with very rare organic remains had been cut through by excavators. Trial excavations to a depth of about 3 m deep along the edge of the trench showed that none of the material had survived *in-situ*.

Case study – Boegoeberg. Mining by Alexcor along the coastline close to the Boegoeberge targeted old wave cut shorelines and inlets. Two shallow caves were exposed in a sea-cliff some 7 m below today’s surface. Diamondiferous gravels were mined out of a cave (Boegoeberg ll) and in the process destroyed a 120000 year old archaeological site to the extent that only 10 percent of the site survived. The remaining 10 percent was sampled and studied and resulted in several scientific papers being written. It was one of a few archaeological sites of its kind in the world dating to early modern humans who lived on the coast of Namaqualand during the interglacial when sea levels were little higher than they are today. Fortunately at the adjacent cave (Boegoeberg I) mining was halted by the mine geologist before complete damage was done. The site was not anthropomorphic but an ancient hyena lair that provided a wealth of information about ancient environments.

The above cases show that archaeological sites can occur deep underground, especially in caves in ancient sea washed gullies. Finding one intact would make a huge contribution to science. This is of particular importance where mining of gullies and ancient sea cliffs are envisaged. The total loss of such archaeological sites due to impacts of mining is scientifically disastrous, so measures must be put in place to stop this from happening.

5.2.6 Impacts of mining on historical and proto-historical sites

Historical sites that are over 100 years of age are very rare in the study area. Only one historical site is known from the study area at Samsonsbak which included numerous glass bottles of the 19th century, fragments of metal and foundations of a simple dwelling. Also evident were several simple graves. Like other forms of surface archaeological material, they will be destroyed by earthmoving.

5.2.7 Impacts of mining on shipwrecks

There are a number of known wrecks on the Namaqualand coast and those that are greater than 60 years of age are protected. Off-shore and coastal operations can impact wrecks. Boshoff (pers. com.) has conducted a number of beach surveys on the south coast using proton-magnetometry and has encountered a number of early wrecks completely covered by sand with no surface evidence whatsoever. The discovery of the oldest known wreck in the southern hemisphere took place when a geologist found copper ingots in a beach mining operation. In the sediments behind the see dam were the remains and cargo of a Portuguese East Indiaman that had foundered north of Oranjemund. It was laden with ivory, copper, bronze cannons and gold bullion. The Namdeb resident archaeologist, Dieter Noli, was put under some pressure to shift the material as quickly as possible which was a near disaster, as Namibia (like RSA) did not have a dedicated conservation laboratory which resulted in very valuable artefacts being exposed to oxygen and resulting rapid deterioration. It has taken an international effort to salvage what could be done, however irreparable damage has been done to some material (Noli pers. com.). The bullion (worth a considerable fortune) is housed in the Bank of Namibia as the country's heritage legislation deems all material to be the property of the state (as in RSA). Ideally, the wreck should have been left undisturbed behind the sea wall and mining deferred until international effort could be mustered to have the necessary conservation facilities put in place before any aspect of the ship was removed.

There is a real but generally low possibility that shipwreck material may be impacted by mining in the near shore areas. Should a wreck of significance be destroyed, this would be a severe impact without mitigation being in place, but a positive contribution to knowledge and history with mitigation.

5.2.8 Impacts of mining on human remains

Human remains are strongly protected by several bodies of legislation including the National Heritage Resources Act. To date, a number of human skeletons have been found in west coast mining areas, a number of which have been either excavated or collected by ACO. Graves are hard to recognise more often than not being unmarked, or marked with a pile of stone. Even historic graves marked with earth mounds and wooden crosses disappear over time. In the face of mining, a grave or human skeleton is unlikely to be noticed and will end up in the processing plant or mine dump. The impacts of mining are therefore high, and the presence of human remains very difficult to mitigate unless they are identified in pre-disturbance surveys and exhumed.

5.2.9 Impacts of mining of landscape and setting

Landscapes and places of scenic value to a given community are protected under the NHRA. Mining on the West Coast has been taking place for 70 years or more, and as such has become a heritage layer and a characteristic of this part of the world. From this perspective it is hard to argue that continued mining has a major negative impact under circumstances that are so well established, and which under the NHRA are in some instances functionally generally protected. There are scenic areas and enclaves that will be impacted and the character of such places will change as infrastructure is established. Mine rehabilitation can be very successful to the extent that intimately some scenic impacts can be fully reversed.

Table 2 Assessment of impacts

<table>
<tr><th>Activities</th><th>Impacts</th><th>Aspects affected</th><th>ase</th><th colspan="3">Significance rating</th><th>Typical mitigation measures</th></tr>
<tr><td rowspan="12">Impact of beach mining on palaeontology</td><td rowspan="12">The process of creating a berm, followed by pumping out of the sea followed by excavation to bedrock has the potential to expose prehistoric marine regression events, shell beds and extinct invertebrate species. There is also a low possibility of fossil bone and shark teeth.</td><td rowspan="12"></td><td rowspan="12"></td><td></td><td>Without mitigation</td><td>With mitigation</td><td rowspan="12">Mine geologist to be mindful of palaeontological potential. Mine to foster a relationship with a palaeontologist and facilitate opportunities to make research observations and collect samples (see management plan by Pether 2008).</td></tr>
<tr><td>Severity</td><td>Low</td><td>Low</td></tr>
<tr><td>Duration</td><td>High</td><td>Low</td></tr>
<tr><td>Extent</td><td>Local</td><td>Local</td></tr>
<tr><td>Consequence</td><td>Medium</td><td>Low</td></tr>
<tr><td>Probability</td><td>Medium</td><td>Low</td></tr>
<tr><td>Significance</td><td>Low</td><td>Low</td></tr>
<tr><td>Status</td><td>Negative</td><td>Positive</td></tr>
<tr><td>Confidence</td><td>High</td><td>High</td></tr>
<tr><td>Reversibility</td><td>Low</td><td>High</td></tr>
<tr><td>Loss of resource</td><td>High</td><td>Low</td></tr>
</table>

<table>
<tr><td></td><td></td><td></td><td></td><td><table><tr><td>Degree to which the impact can be mitigated</td><td></td><td>High</td></tr></table></td><td></td></tr>
<tr><td>Impact of beach mining on maritime heritage</td><td>The process of creating a berm, followed by pumping out of the sea followed by excavation to bedrock has the potential to expose maritime archaeological debris including shipwrecks.

Shipwrecks have varying importance which has a bearing on the severity of the impact; however destruction of a previously undescribed wreck with significant cargo and great age is a possibility. Destruction of such a wreck through uncontrolled excavation, looting of cargo and non-implementation of artefact conservation measures would be a significant loss of historical information as well as a breaking of the law of the land if destruction takes place without a permit.</td><td></td><td></td><td><table>
<tr><td></td><td>Without mitigation</td><td>With mitigation</td></tr>
<tr><td>Severity</td><td>High</td><td>Low</td></tr>
<tr><td>Duration</td><td>High</td><td>Low</td></tr>
<tr><td>Extent</td><td>Regional</td><td>Local</td></tr>
<tr><td>Consequence</td><td>Medium</td><td>Low</td></tr>
<tr><td>Probability</td><td>Medium</td><td>Low</td></tr>
<tr><td>Significance</td><td>High</td><td>High-Low</td></tr>
<tr><td>Status</td><td>Negative</td><td>Positive</td></tr>
<tr><td>Confidence</td><td>High</td><td>High</td></tr>
<tr><td>Reversibility</td><td>Low</td><td>Medium</td></tr>
<tr><td>Loss of resource</td><td>High</td><td>Low</td></tr>
<tr><td>Degree to which the impact can be mitigated</td><td>Low</td><td>High</td></tr>
</table></td><td>Pro-active measures involve conducting remote sensing scans for evidence of shipwrecks with are best avoided, or if need be removed under a SAHRA issued permit.

Staff on site to be mindful of artefacts that may appear in excavated material from seabed. Such material can include lumps of iron, ballast stones or ingots, pieces of rope, wood, leather as well as ceramics and porcelain. Iron and bronze cannons are also possible. In the event of a find, an archaeologist must be consulted.

Shipwrecks that need to be destroyed or moved that are more than 60 years old require a permit for this to be issued by SAHRA.</td></tr>
</table>

<table>
<tr><td>Impact of beach mining on maritime heritage</td><td>Any earthmoving activities, establishment of roads and areas for setting up processing plants in areas immediately behind beaches and bays hold the possibility of impacting some of the many shell middens and other archaeological sites that exist close to the shoreline, in particular estuaries, rocky headlands and sheltered bays tend to be very archaeologically rich.</td><td></td><td></td><td><table>
<tr><td></td><td>Without mitigation</td><td>With mitigation</td></tr>
<tr><td>Severity</td><td>High</td><td>Low</td></tr>
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<tr><td>Probability</td><td>High</td><td>Low</td></tr>
<tr><td>Significance</td><td>High</td><td>Low</td></tr>
</table></td><td>Pro-active measures involve contracting an archaeologist to survey and mitigate the coastal zone adjacent to beach mining operations, as well as any proposed roads and infrastructure.

This work can happen on a periodic basis to coincide with mining schedule.</td></tr>
</table>

Status	Negative	Positive
Confidence	High	High
Reversibility	Low	Medium
Loss of resource	High	Low
Degree to which the impact can be mitigated	Low	High

6 Heritage Management and mitigation

The numerous surveys that have been done to date have established that there is a wealth of archaeological material within the West Coast Resources controlled areas. This is a heritage that can be considered significant at both local and international levels. Some of this has been seriously impacted by mining activities. On the other hand, due to the high security nature of the mining operation, large tracts of land have been conserved and the preservation of archaeological material in these areas is excellent. Township and resort development, industry, as well as establishment of nature reserves will follow when the mining ceases. This means that management of heritage resources will have to operate within a wider range of circumstances. The long term aim of any management goals should be to:

i) conserve the archaeology of those areas that have been protected or excluded from the public;

ii) ensure that good heritage impact assessments are made in any areas that may be developed or mined in the future; and

iii) mitigate the archaeology of those areas to be impacted by mining during the remaining life of the mine (Figure 3).

Figure 3 Mitigation of archaeological sites at Rooiwalbaai

7 Current Heritage Management Mechanisms

While mechanisms for impact assessment are prescribed by the Environmental legislation (IEM procedures), the National Heritage Resources Act 25 of 1999 indicates what kinds of heritage are protected and how they should be assessed in the context of an impact assessment. The system that is presently in operation and described below, is one that has evolved over time.

7.1 Reactive management

Many heritage assessments or rescue excavations take place reactively because the archaeological potential of development is seldom taken into account at the initial planning stage. In many cases, management can be characterised as knee-jerk responses, with mitigation procedures carried out as a result of the intervention of an authority or lobbying by interest groups and members of the public, or if a find of significance is exposed during the course of construction.

Whilst the reactive approach will always be a component of heritage resource management, it should not be seen as an acceptable mechanism for dealing with heritage issues. In some instances there will be no indication that important finds will be uncovered and the reactive approach therefore becomes unavoidable. This way of carrying out mitigation has many disadvantages for both the archaeologist and developer/mine alike. One of the major disadvantages is in terms of delays to the development/mining which can be extremely costly. In addition money will not have been budgeted for the purpose of mitigation and may mean that the archaeologist is forced to complete the task unsatisfactorily. Secondly, should any conservation worthy features be found, it may not be possible to preserve these for posterity. Despite its disadvantages reactive management will be necessary at West Coast Resources. As described in the in the impact section of this report, there are deeply buried heritage sites that will only become visible during mining. These must be reported to SAHRA and/or an archaeologist for evaluation and mitigation of need be.

7.2 Pro-active Management

Pro-active management is through the identification of heritage sites as described in sections 34-38 of the National Heritage Resources Act and more or less marries with the IEA process. The process is by no means perfect but a good deal of successful mitigation has been accomplished using these procedures over the last 10 years. The process consists of two phases of work, which we believe greatly lessens the need for the reactive approach to be adopted. These procedures are described below.

Heritage impact assessment

The heritage resource professional (archaeologist, architect, historian, and palaeontologist) needs to be approached as early as possible in the planning phase of a development/mining project. The project is initially assessed as to whether it is likely to impact heritage resources and the details are uploaded onto the SAHRIS web-based application system. Normally a more detailed study is required which can form the specialist component of an EIA process or take the form of a stand-alone HIA which will usually involve fieldwork and/or interrogation of archival material and other documentary sources, depending on the age and nature of the remains. Typically with previous mining operations in the area, as well as further south in the Western Cape at the Tronox operations the over-arching study formed part of an EMP after which stand-alone HIA's were conducted on an annual or bi-annual basis in response to planned mining blocks.

The stand-alone HIA's will identify any heritage that needs to be mitigated. This is reported on, then the necessary permits applied for and obtained. With archaeological sites and palaeontological exposures mitigation involves systematic sampling and in some cases the complete removal of archaeological material. This is normally taken out of the mine and transported to a laboratory for curation, after which it is re-patriated to a regional museum where it is kept indefinitely (the law requires all archaeological material to be housed in a registered museum). Previous experience has shown it is advantageous to "batch" mitigation operations to cut down on paperwork and logistics. Typically, in previous De Beers operations a month of mitigation operations were carried out on proposed mining blocks every two years or so in keeping with the mines planned phasing of operations and scale of works. SAHRA, who managed Northern Cape heritage by agency, require the issuing of permits for material to be moved, sampled or documented. Provided that the mitigation is carried out satisfactorily, the mine will be given permission to proceed.

The company will have to allocate an annual (or as fit) budget to heritage resources management. This size of this would depend on the amount of new mining areas opened up during any one financial year. The budget would have to be enough to bring in a heritage management team to do Heritage Impact Assessments as well as cover the costs of any mitigation if this is required.

Table 3 Mitigation measures

ACTIVITIES	**PHASE**	**SIZE AND SCALE of disturbance**	**MITIGATION MEASURES**	**COMPLIANCE WITH STANDARDS**	**TIME PERIOD FOR IMPLEMENTATION**
Prospecting Beach mining operations. Establishment of roads and infra-structure (	Most impacts will take place during the operational and construction phases of mining. Archaeological sites can be affected by earthmoving during which destroys the context and content. Earthmoving during rehabilitation can obscure un-recorded paleontological evidence.	**N/a**	An archaeologist must be appointed to survey and assess archaeological material in mining areas before mining commences. If necessary the archaeologist will need to apply for permits to excavate archaeological material prior to mining. For beach mining, location of shipwrecks is Best established before mining and wrecks mitigated or avoided. During mining any human made finds must be reported to an archaeologist. Pits should be checked by a palaeontologist before rehabilitation.	Sections 34 and 38 of the National Heritage Resources Act 25 of 1999 mandate the EIA process to take cognisance of heritage. All heritage as defined in the NHRA is also generally protected by the NHRA. Following due process allows for legal protection mitigation and destruction of heritage,	Archaeological assessment of mining areas should take place well in advance of mining. A year – 6 moths is ideal as this allows for time to mitigate if need be. Maritime heritage studies should be done well in advance of mining, ideally during mine planning. Palaeontological assessments must take place before mine pits are rehabilitated.

8 Mitigation

8.1 Pro-active assessment

While some sites are extremely important and merit careful study and need to be mitigated or even conserved where mining is envisaged, work done to date demonstrates that the majority of surface archaeological sites have limited information potential on an individual basis but on a broader scale, each site and its location is part of a pre-colonial system of human habitation on the landscape and is therefore worthy of some measure of recording.

Provided that a range of archaeological sites are preserved in areas which are not going to be mined, this will to some extent mitigate the damage that mining does to heritage sites elsewhere. However, there are will always be the possibility that unique archaeological sites exist in proposed mining areas and these should nevertheless be identified. In order to execute effective conservation and mitigation procedures, mining should be treated like any other development activity. New mining areas should be subjected to a heritage impact assessment well in advance of the start of any earthmoving. During the course of the HIA all archaeological and other heritage sites will have to be identified and their surface characteristics recorded and certain kinds of archaeological material collected. Sites which are important will have to be sampled/excavated as part of a mitigation programme.

8.2 Heritage sites and fossils found during mining operations – the reactive approach

There are some types of heritage sites that are not going to be detected during the course of a heritage impact assessment, although the possibility of their presence may be anticipated. Of particular concern are deeply buried ancient archaeological sites dating to the Middle or Early Stone Age. Experience has shown that these can be located in areas associated with previous Pleistocene marine transgressions. Especially sensitive are buried caves and gullies that would have acted as *foci* for ancient camp sites. Well preserved ESA and MSA sites are extremely rare in international terms which mean that the loss of such material is very serious. If such finds are located, earthmoving will need to be diverted and an archaeologist be immediately appointed to sample the material. Short of the mining operation employing a full-time archaeologist to monitor earthmoving in all active mining areas, it is suggested that suitable personnel (such as an environmental officer or geologists) be designated the task of checking deep excavations for any archaeological deposits. It may be necessary for such a person to undertake some practical archaeological training so that he/she has enough knowledge to recognise such deposits and the materials associated with them. In addition, consideration should be given to the distribution of a handbook which would describe typical sites and their content. These could be made available to the mine geologists, environmental officers, foremen, machine operators and other field personnel who may come across sites in the course of their duties.

8.3 Impacts of rehabilitation

Rehabilitation of mined areas, although positive for the environment, can pose a threat to otherwise undisturbed sites through earthmoving and related activity, particularly where the edges of deep excavations are collapsed and contoured. Archaeological sites that have survived on the edges of pits have been destroyed during rehabilitation. Similarly sites on prospective roads, mine dumps and infrastructure should be included in the HIA programmes.

8.3.1 Palaeontology
Almost every deep excavation contains some form of palaeontology that is exposed in the stratigraphy. Positive outcomes for knowledge and science can be gained by ensuring that a palaeontologist inspects pits and profiles before they are rehabilitated.

8.4 Conservation of sites on undeveloped Land

One of the most striking features of the project area is the excellent surface preservation of many archaeological sites; in particular those in un-mined areas under secure control. This preservation is as a result of these areas having been restricted to the public for many years. In other parts of South Africa sites which are as well preserved are scarce because they have been negatively affected by the actions of people. Even on parts of the coast where property development has not taken place, many sites have been damaged by illegal collection of artefactual material such as pottery and stone artefacts. Furthermore, recreational use of off-road vehicles has caused irreparable damage to sensitive dune areas and the sites that they contain. To minimise the destructive effects of human action in the future it is suggested that the following measures be applied:

- Archaeological sites are an irreplaceable aspect of the environment and should be protected as vigilantly as any endangered animal or plant species. It should become part of the company environmental policy that people are actively discouraged from collecting artefactual material or conducting excavations without a SAHRA permit, or removing material from shipwrecks.

- Off-road vehicles should be restricted to existing roads and tracks which will minimise damage to archaeological material. This is particularly so in areas within 1 km of the shoreline which contain large concentrations of sites.

8.5 Maritime heritage

The identification of shipwrecks and other seabed risks will be necessary for the shore mining operations. There are a number of technologies available that can be used for the detection of shipwrecks; however it suggested that a proton-magnetometer survey of sea mining areas would be of benefit. This can potentially be done from the air as a single survey.

The SAHRA maritime unit has indicated that they would like to have a working relationship with any operation that is involved with seabed work. Their requirements are indicated below. Overall, the best form of mitigation is avoidance and micro- adjustment of mining areas. Salvage of historic shipwrecks as a mitigation measure is slow, complex and expensive, therefore if the wreck is highly significant, the costs of its removal would need to be considered. Minor wrecks can be recorded and described the removed under permit.

SAHRA has recommended that, to manage any potential impacts on maritime heritage sites, a geophysical (side scan sonar, multi-beam bathymetry and/or magnetometer) be used to survey the seafloor. There is advantage in knowing where shipwrecks are located ahead of mining to avoid impacts during excavation which could result in down time, instead of waiting for a find on site then implementing reactive measure which may result in costly delays (which is what the law demands).

- If any shipwreck material or unexplained seabed anomalies are discovered during the seabed survey or mining activities, the findings should then be assessed by a maritime archaeologist at SAHRA to identify the need for further action / mitigation.

- It is recommended that, should any shipwrecks be discovered, any relevant observations and position of the find be reported to SAHRA for inclusion on the National Shipwreck Database.

- SAHRA's permission in the form of a permit would be required to disturb a maritime archaeological site or material (this includes any sites within the inter-tidal zone below the high water mark), should it not be possible for the project to avoid such sites. It is important to bear in mind that such permission is likely to be premised on suitable archaeological mitigation of any such site having been conducted, to ensure preservation of the site by record.

8.6 Surveys and mitigation completed to date within the projects area.

Appendix B contains a schedule of mining blocks and assesses the work done up to 2008 when De Beers began to wind down its west coast operations. A considerable amount has been accomplished which will lessen the need for renewed heritage impacts assessments and mitigation, however there are some 45 mining blocks that have not been surveyed and 36 (including some large areas) which have been surveyed and mitigated, all of which are presented and mapped in appendix B (Figures 4-8). Most of the beach mining areas have not been considered as in the past these were not De Beers priority areas, furthermore the ACO survey team was excluded from undertaking beach checks in the high security areas.

9 Acceptability of the proposed activity

Provided that mitigation is applied where necessary, all mining work can proceed in accordance with the law. This report finds that the proposed activities are acceptable and that most heritage impacts can be successfully mitigated.

10 References

Deacon, J. (1992) Archaeology for developers, planners and local authorities. National Monuments Council: Cape Town.

Deacon, J. ed. (1996) Monuments and Sites in South Africa. ICOMOS Central Cultural Fund Publication No. 206. National Committee of ICOMOS: Sri Lanka.

Deacon, J. & Pistorius, P. 1996. in: Deacon, J. ed. (1996) Monuments and Sites in South Africa. ICOMOS Central Cultural Fund Publication No. 206 pp 1 - 8. National Committee of ICOMOS: Sri Lanka.

Dewar, G Halket, D. Hart, T and Orton J and Sealy J. 2006 Implications of a mass Springbok kill site (Antidorcas marsupialis), South Africa. Journal of Archaeological Science.

Elphick, R.H. 1977. Kraal and castle. Khoikhoi and the founding of white South Africa. New Haven: Yale University Press.

Raper, P.E. & Boucher, M. eds. 1988. Robert Jacob Gordon-Cape Travels, 1777 to 1786. Vol2. Brenthurst Press: Houghton.

Halkett, D. & Hart, T. 1993. Excavations at six archaeological sites in the near shore diamond mining area, Brand se Baai, Namaqualand. Unpublished CRM report prepared for De Beers Namaqualand Mines Division.

Halkett, D. & Hart, T. 1994. Report on phase 2 archaeological excavations at the Namakwa Sands project, Vredendal district, Namaqualand. Unpublished CRM report prepared for Namakwa Sands Ltd.

Huffman, T.N and Sievers, C. 1996. Cultural resource management on South African Mines. Unpublished report prepared for the Department of Environment Affairs and Tourism

Jerardino, A.M., Yates, R., Morris, A.G. and Sealy, J. 1992. A dated human burial from the Namaqualand coast: observation on culture, biology and diet. *South African Archaeological Bulletin* 47: 75-82.

Kaplan, J. 1993. The state of archaeological information in the coastal zone from the Orange River to Punta Do Oura. Unpublished report prepared for the Department of Environment Affairs and Tourism

Klein, R.G. 1989. The human career. University of Chicago Press: Chicago & London.

Orton, J. Hart, T. Halkett, D. 2005. Shell middens in Namaqualand: two later Stone Age sites at Rooiwalbaai, Northern Cape Province, South Africa. South African Archaeological Bulletin. Volume 60 No 181

Klein RG, Cruz-Uribe K, Halkett D, Hart T, Parkington JE. Palaeoenvironmental and human behavioural implications of the Boegoeberg 1 late Pleistocene hyena den, Northern Cape Province, South Africa. Quat Res. 1999; 52(3):393–403.

Manhire, A.H. 1987. Sandveld deflation hollows: a study of open site assemblages in the south-western Cape. In: Parkington, J.E. & Hall, M. (eds) Papers in the Prehistory of the of the western Cape, South Africa: British Archaeological Reports International Series 332: 326-349.

Morris, A.G. 1995. The Einiqua: an analysis of the Kakamas skeletons. *In* Einiqualand: Studies of the Orange River frontier. UCT Press Rondebosch.

Klein RG, Cruz-Uribe K, Halkett D, Hart T, Parkington JE. Palaeoenvironmental and human behavioural implications of the Boegoeberg 1 late Pleistocene hyena den, Northern Cape Province, South Africa. Quat Res. 1999; 52(3):393–403.

Manhire, A.H. 1987. Sandveld deflation hollows: a study of open site assemblages in the south-western Cape. In: Parkington, J.E. & Hall, M. (Eds) Papers in the Prehistory of the of the western Cape, South Africa: British Archaeological Reports International Series 332: 326-349.

Morris, A.G. 1995. The Einiqua: an analysis of the Kakamas skeletons. *In* Einiqualand: Studies of the Orange River frontier. UCT Press Rondebosch

Parkington and Hart 1991. An assessment of the archaeological sensitivity of Tweepad, Brazil and Skulpfontein, Kleinzee. Report prepared for The Environmental Evaluation Unit, UCT.

Parkington, J.E., Jerardino, C., Yates, R., Halkett, D., Hart, T. & Kaplan, J. in prep. Mid -Holocene deposits at Doorspring 16.

Parkington, J.E., Yates, R., Manhire, A. & Halkett, D. 1986. The social impact of pastoralism in the south Western Cape. *Journal of Anthropological Archaeology* 5: 313-329

Pistorius, P. 1996. In: Deacon, J. ed. (1996) Monuments and Sites in South Africa. ICOMOS Central Cultural Fund Publication No. 206:1-8. National Committee of ICOMOS: Sri Lanka**.**

Raven-Hart, R. 1967. Before Van Riebeeck. Cape Town: Struik.

Rudner, J. 1968. Strandloper pottery from South and South West Africa. Annals of the South African Museum 49: 441-663

Sampson, C.G. 1974. Stone age archaeology of southern Africa. New York Academic Press

Sealy, J. & Yates, R. 1994. The chronology of the introduction of pastoralism to the Cape, South Africa. Antiquity 68: 58-67

Smith, A.B. 1985. Excavations at Plettenberg Bay, South Africa of the campsite of the survivors of the wreck of the *Sao Gancalo* 1630. *International Journal of Nautical Archaeology and Underwater Exploration* 15.1: 53-63

Smith, A.B. 1987. Seasonal exploitation of resources on the Vredenberg Peninsula after 2000BP. in Parkington, J.E. and Hall, M.J. (Eds) Oxford: BAR International series 332 (ii).

Smith, A.B., Sadr, K., Gribble, J., & Yates, R. 1991. Excavations in the south-western Cape, South Africa, and the archaeological identity of prehistoric hunter-gatherers in the last 2000 years. South African Archaeological Bulletin 46: 71-91

Webley, L. 1992. Early evidence for sheep from Spoeg River Cave, Namaqualand. *Southern African Field Archaeology* 1: 3-13

Yates, R. in prep. Ostrich eggshell beads and the appearance of pastoralism: a study of size changes in the southern and south-western Cape, and Namibia. M.A. thesis: University of Cape Town.

Parkington and Hart 1991. An assessment of the archaeological sensitivity of Tweepad, Brazil and Skulpfontein, Kleinzee. Report prepared for The Environmental Evaluation Unit, UCT.

Parkington, J.E., Jerardino, C., Yates, R., Halkett, D., Hart, T. & Kaplan, J. in prep. Mid -Holocene deposits at Doorspring 16.

Parkington, J.E., Yates, R., Manhire, A. & Halkett, D. 1986. The social impact of pastoralism in the south Western Cape. *Journal of Anthropological Archaeology* 5: 313-329

Pistorius, P. 1996. in: Deacon, J. ed. (1996) Monuments and Sites in South Africa. ICOMOS Central Cultural Fund Publication No. 206:1-8. National Committee of ICOMOS: Sri Lanka**.**

Raven-Hart, R. 1967. Before Van Riebeeck. Cape Town: Struik.

Rudner, J. 1968. Strandloper pottery from South and South West Africa. Annals of the South African Museum 49: 441-663

Sampson, C.G. 1974. Stone age archaeology of southern Africa. New York Academic Press

Sealy, J. & Yates, R. 1994. The chronology of the introduction of pastoralism to the Cape, South Africa. Antiquity 68: 58-67

Smith, A.B. 1985. Excavations at Plettenberg Bay, South Africa of the campsite of the survivors of the wreck of the *Sao Gancalo* 1630. *International Journal of Nautical Archaeology and Underwater Exploration* 15.1: 53-63

Smith, A.B. 1987. Seasonal exploitation of resources on the Vredenberg Peninsula after 2000BP. in Parkington, J.E. and Hall, M.J. (Eds) Oxford: BAR International series 332 (ii).

Smith, A.B., Sadr, K., Gribble, J., & Yates, R. 1991. Excavations in the south-western Cape, South Africa, and the archaeological identity of prehistoric hunter-gatherers in the last 2000 years. South African Archaeological Bulletin 46: 71-91

Webley, L. 1992. Early evidence for sheep from Spoeg River Cave, Namaqualand. *Southern African Field Archaeology* 1: 3-13

Yates, R. in prep. Ostrich eggshell beads and the appearance of pastoralism: a study of size changes in the southern and south-western Cape, and Namibia. M.A. thesis: University of Cape Town.

11 Appendix A: List of Appendices

Appendix A: List of Appendices

Appendix B: Heritage Impact Surveys and mitigation completed to date

Appendix C: De Beers Palaeontological management plan (by John Pether 2008)

Appendix D: List of Figures

Appendix E: List of Tables

12 APPENDIX B: Mining blocks that have been subject to survey and mitigation

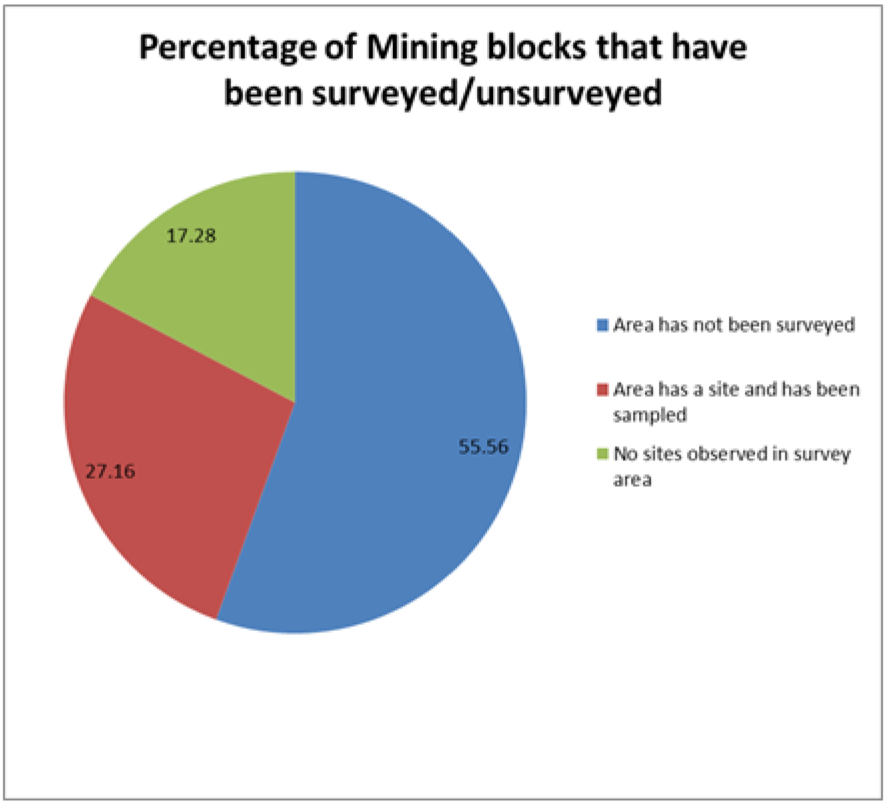
Mining blocks that have been subject to survey (HIA) and mitigation vs those for which no action has been taken.

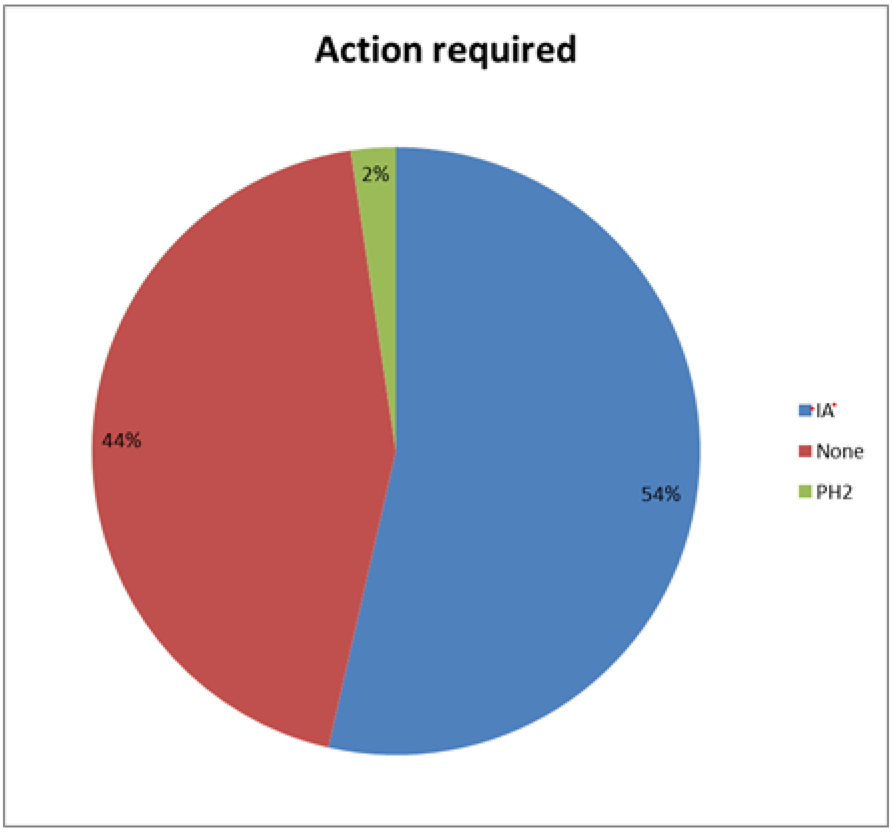
Mining Block	Associated Sites	Subj. to HIA	Mitigation	Action Required	Comment
SN16	-	YES	NO	NONE	NO SITES OBSERVED IN HIA
SN17	-	YES	NO	NONE	NO SITES OBSERVED IN HIA
SN_SN_17	-	YES	NO	NONE	NO SITES OBSERVED IN HIA
KN_KLNA_02	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
KN_3R	KN2005/09	YES	PH1	NONE	SURFACE COLLECTION
KN_KLNA_06	-	YES	NO	NONE	NO SITES OBSERVED IN HIA
KN41A	-	YES	NO	NONE	NO SITES OBSERVED IN HIA
KN41B	-	YES	NO	NONE	NO SITES OBSERVED IN HIA
KN114OR	KN2004/021	YES	PH1	NONE	LSA SAMPLED
KN114OR	KN2005/096	YES	PH1/2	NONE	LSA SAMPLED SURFACE COLLECTION
KN114OR	KN2004/022	NO	NO	NONE	SITE DEEMED INSIGNIFICANT
KN15A	KN2005/099	YES	PH1	NONE	LSA SAMPLED SURFACE COLLECTION
KN15A	KN2005/101	YES	PH1	NONE	LSA SAMPLED SURFACE COLLECTION
KN15A	KN2005/100	YES	PH1	NONE	LSA SAMPLED SURFACE COLLECTION
KN9882_29	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
KN9882_24	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
KN9882_21	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
KN9882_20	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
KN51	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
KN7-1	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
KN114OR	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
KN7-2	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
KN_R7	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
KN_R8	KN2004/023	YES	PH1	NONE	LSA COASTAL SHELL SCATTER WITH ARTEFACTS
KN14	-	YES	NO	NONE	NO SITES OBSERVED IN HIA
KN15A	-	YES	NO	NONE	NO SITES OBSERVED IN HIA
KN17-1	KN2004/032	YES	PH1	NONE	LSA SHELL MIDDEN COASTAL
KN17-2	KN2004/033	YES	PH1	NONE	LSA SHELL MIDDEN COASTAL
KN17-3	KN2005/110	YES	NO	NONE	NO MITIGHIATION REQUIRED
KN17-2	-	YES	NO	NONE	NO SITES OBSERVED IN HIA
KN18-1	-	YES	NO	NONE	NO SITES OBSERVED IN HIA
KN16-1	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
KN19-1	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
KN20-1	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
KN27_C	KN2004/001	YES	PH1	NONE	NOT SAMPLED
KN27_C	KN2004/002	YES	PH1	NONE	NOT SAMPLED

KN27_C	KN2004/005	YES	PH1	NONE	NOT SAMPLED
KN27_C	KN2004/007	YES	PH1	NONE	NOT SAMPLED
KN27_C	KN2004/008	YES	PH1	NONE	NOT SAMPLED
KN27_C	KN2004/009	YES	PH1	NONE	NOT SAMPLED
KN27_C	KN2005/052	YES	NO	NONE	SHORELINE LSA NO MIT REQ
KN27_C	KN2005/074	YES	NO	NONE	SHORELINE LSA NO MIT REQ
KN27	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
KN26	KN2005/108	YES	PH1	NONE	LSA
KN26	KN2005/109	YES	PH1	NONE	LSA
KN25_B	KN2004/029	YES	PH1	PH2 mitigation	
KN25_B	KN2004/028	YES	PH1	PH2 mitigation	
KN25_B	KN2004/027	YES	NO	NONE	
KN25_B	KN2004/026	YES	PH1	NONE	RANDOM SAMPLE
KN_6869_17-1	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
KN_6869_17	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
SLS_15	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
SLS_19A	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
SL__20_05	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
SL_4-1	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
SL__20_09	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
SL__20_10_A	-	YES	NO	NONE	NO SITES OBSERVED IN HIA
SLS_14	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LK_N15	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LK_N10-3A	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LK_N10-2	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LK_R1A	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LK_R1C	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LK_L1D	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LKC1-8	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LKC1-3	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LKC1-2B	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LKC1-2E	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LKC-15	-	YES	NO	NONE	NO SITES OBSERVED IN HIA
LKC5-3	-	YES	NO	NONE	NO SITES OBSERVED IN HIA
LKC-16	-	YES	NO	NONE	NO SITES OBSERVED IN HIA
LKC6-1	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LKC6-3	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LKC10-1	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LK_LK_02	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LK_LK_05	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LK_LK_09	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LK_LK_10	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LK_LK_13	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED

LK_LK_12	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LK_LK_11	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LK_LK_14	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LK_LK_08	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED
LK_LK_18	-	NO	NO	HIA	AREA HAS NOT BEEN SURVEYED

HIA: Impact Assessment, LSA: Late Stone Age, PH1: Phase 1, PH2: Phase 2, MIT: Mitigation.


Percentage of Mining blocks that have been surveyed/unsurveyed
17.28
27.16
55.56
Area has not been surveyed
Area has a site and has been sampled
No sites observed in survey area


Action required
2%
44%
54%
IA
None
PH2

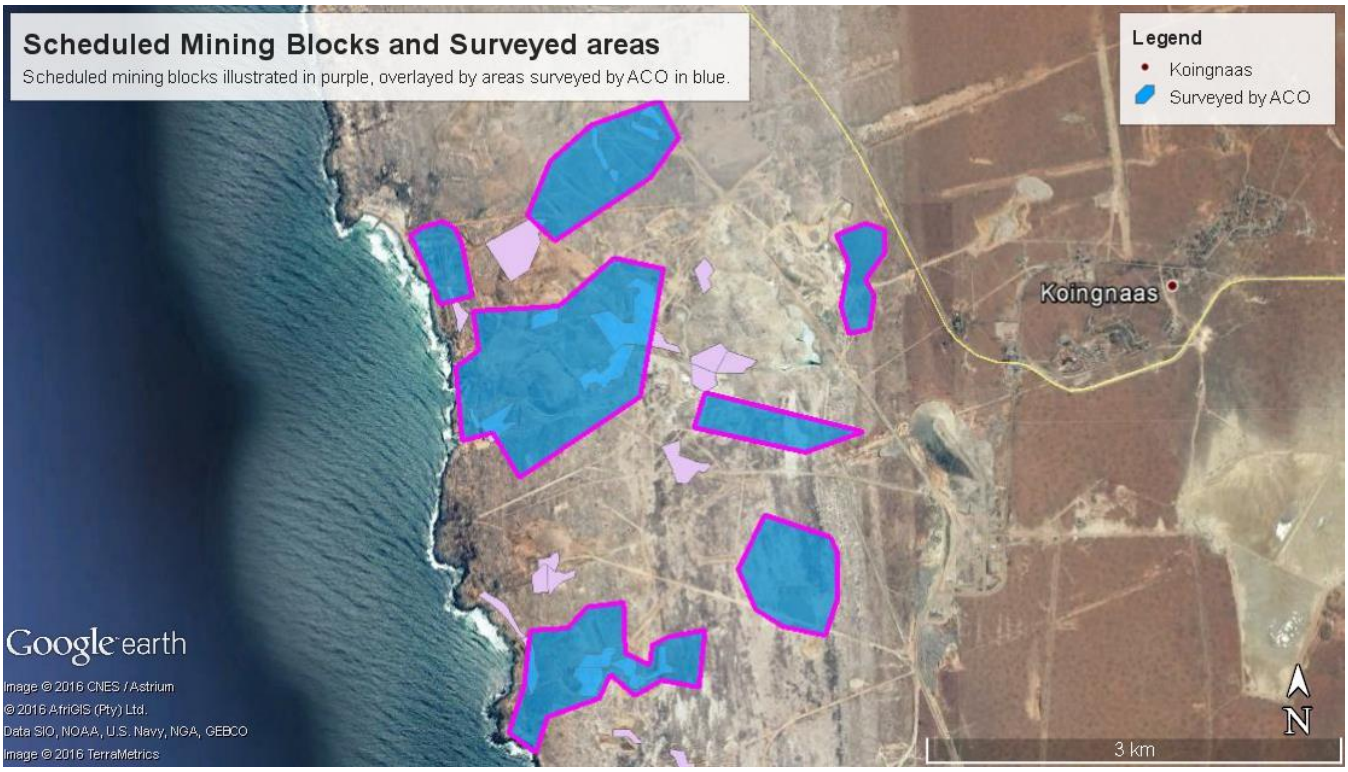


Figure 4 Koingnaas areas - old De Beers blocks already assessed vs new mining areas

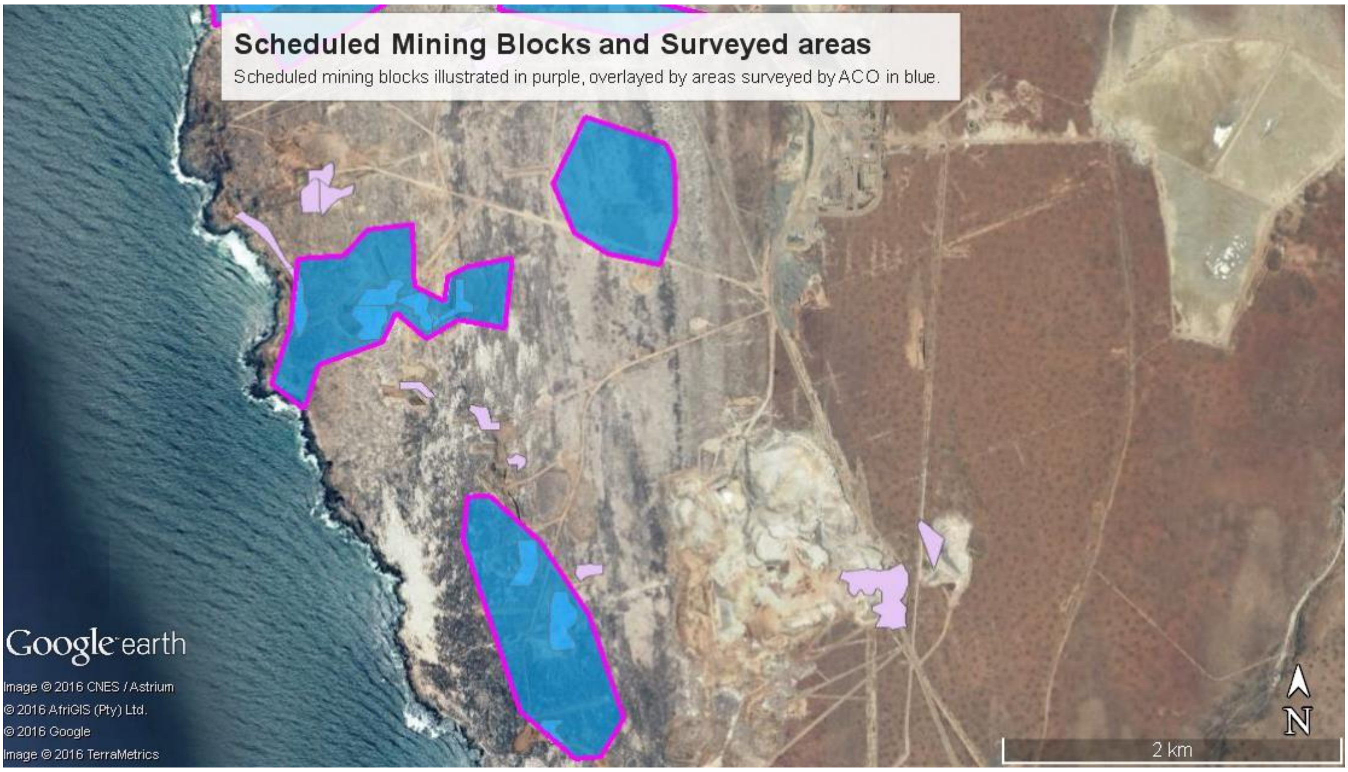


Figure 5 Southern Koingnaas areas - old De Beers blocks already assessed vs new mining areas

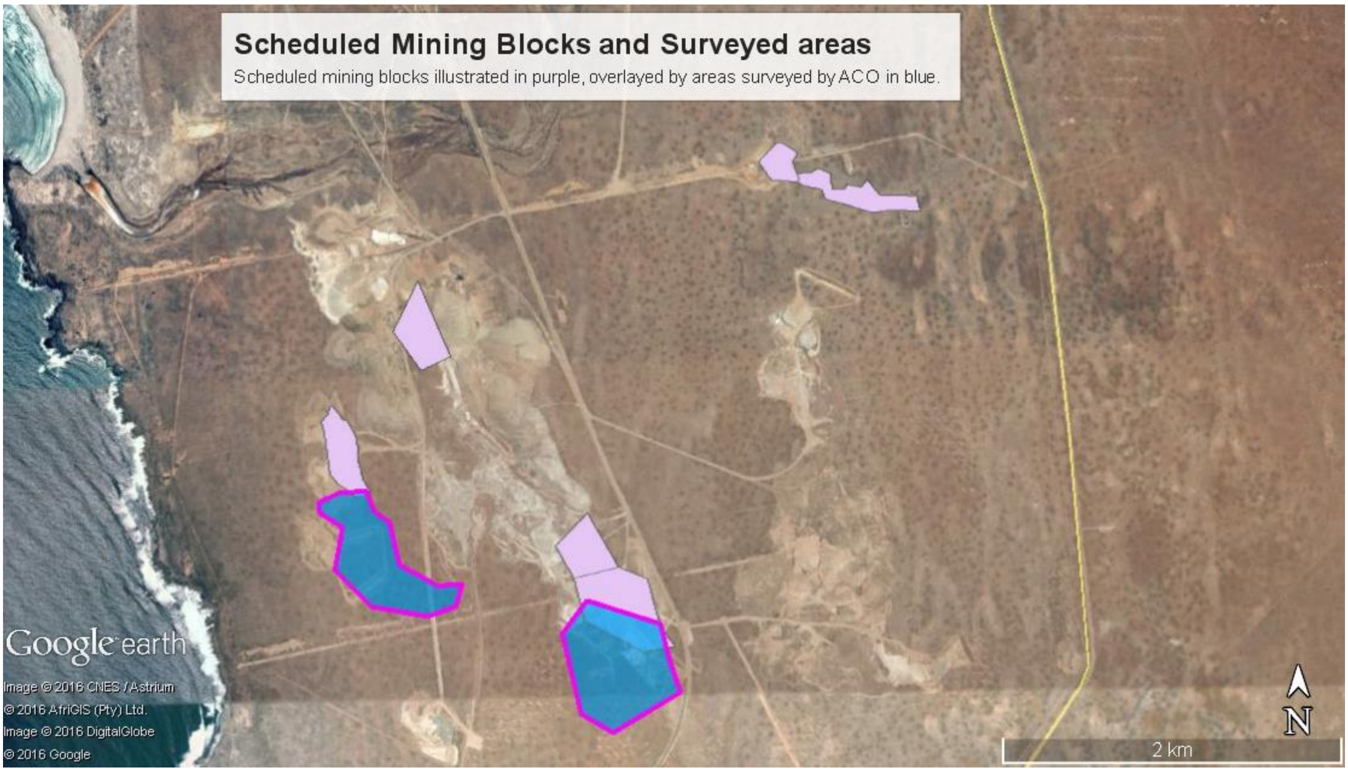


Figure 6 **Swartlintjies – Doctor se Baai areas - old De Beers blocks already assessed vs new mining areas**

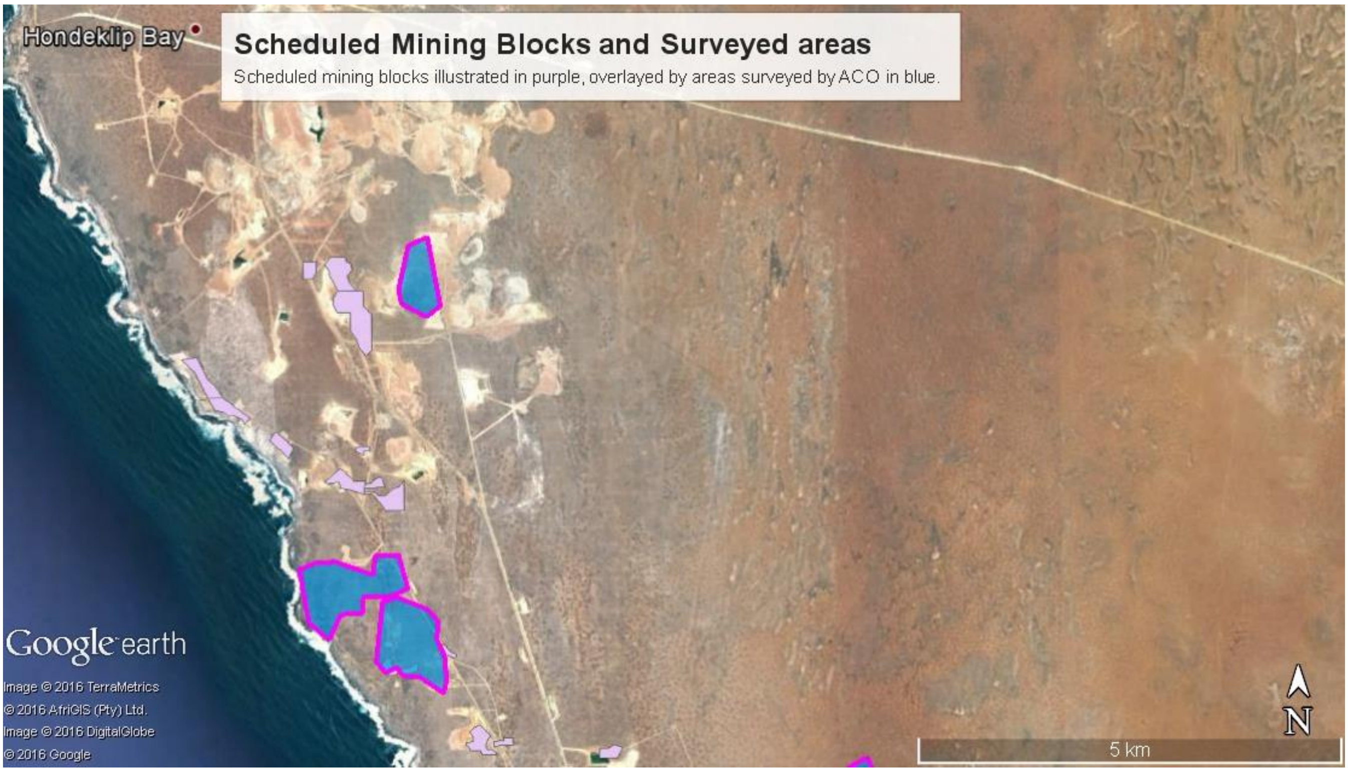


Figure 7 **Hondeklipbaai south - old De Beers blocks already assessed vs new mining areas**

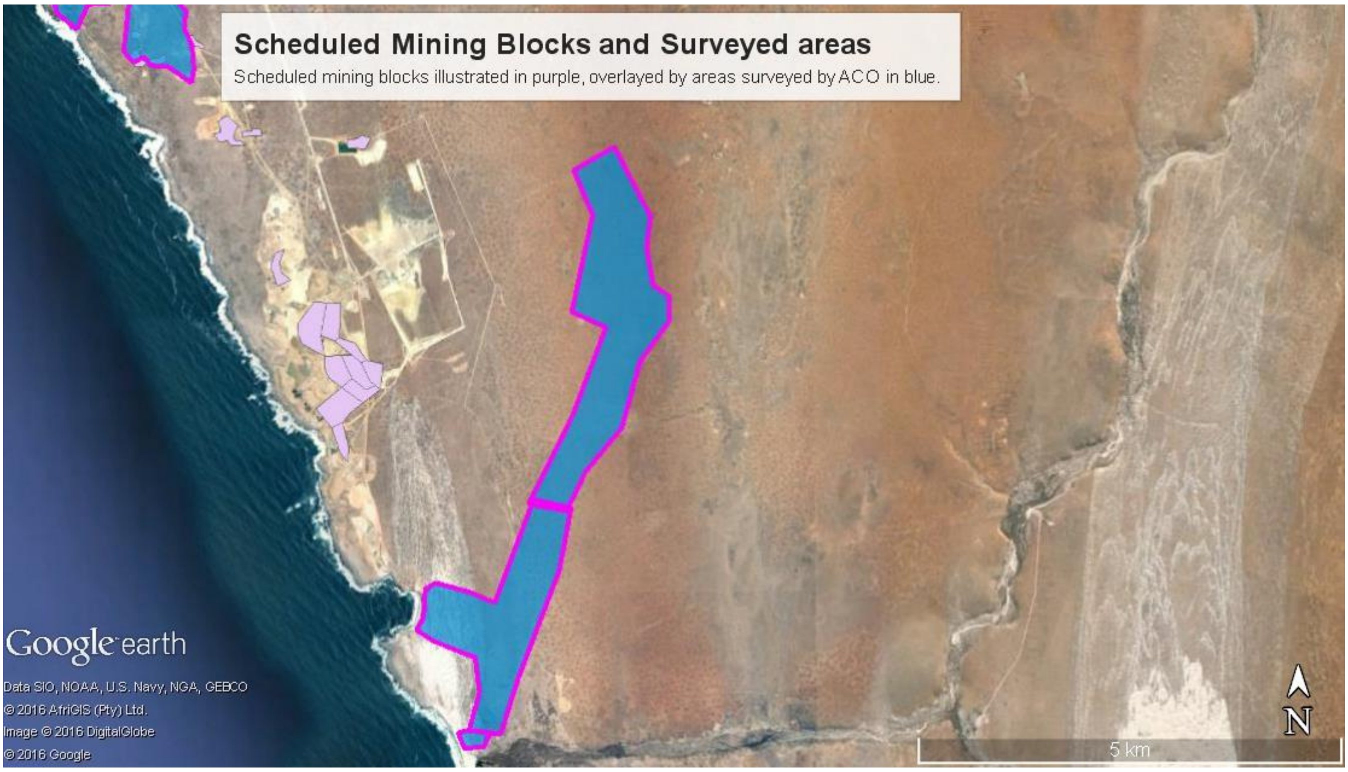


Figure 8 Mitchells Bay - old De Beers blocks already assessed vs new mining areas

13 APPENDIX C: Palaeontological report

Palaeontological Management.

- **Heritage Conservation Management**

- **PALAEONTOLOGICAL MITIGATION AND GEOHERITAGE**

- **DE BEERS NAMAQUALAND MINES**

- **INITIAL DRAFT REPORT**

- **MAY 2008**

Version 2

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ACCOMPANYING SEPARATE DOCUMENTS

Maps 1-4

Images 1 - 8: 8 Document files with selected digital images nos. 1-49.

ICS Stratigraphic Chart

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- ## ACKNOWLEDGEMENTS

De Beers Namaqualand Mines
Paul Kruger
Graham Avery
David Halkett

- ## SUMMARY

This report provides an assessment of the status of palaeontological scientific research along the Namaqualand coast, with particular reference to the De Beers Namaqualand Mines (DBNM) exposures. It is undertaken at the request of DBNM Environmental/Conservation Management, under the auspices of the Iziko S. A. Museum (Dr G. Avery) and is allied to the existing archaeological heritage mitigation programme carried out by the Archaeology Contracts Office of UCT (Dr D. Halkett).

The purpose is to provide the initial inputs to the palaeontological aspects of the Heritage Management part of the overall Environmental Management Plan (EMP) for the terminal phases of the mine. In essence, this is about the "last chance" opportunities to collect fossils from the remaining mine exposures, before they are finally backfilled. Conversely, that a number of selected mine pits be rehabilitated as "open" geoheritage sites for the intersecting purposes of science and geotourism. Thirdly, that a palaeontological mitigation programme is established for future mining activities.

The report includes a Desktop Study (Sections 2-6) summarising:

- The current understanding of the stratigraphy of Namaqualand coastal deposits.
- The ages of the formations, on the basis of the fossil evidence from Namaqualand, viewed in the context of palaeoceanographic records based on microfossil geochemistry.
- A brief account of the historical development of Namaqualand coastal stratigraphy.
- Outstanding concerns w.r.t. gaps in the fossil record hitherto obtained.

Section 7 presents brief observations made at a number of selected exposures during the "flying" pilot field study , with discussions and recommendations.

- **Recommendations for Mitigation**

Primary Palaeontological Mitigation - Current Exposures

It is advocated that all available pit faces be inspected for fossil content.

This process is to be prioritized in terms of the schedules for the filling the pits, including:

- Current pits that are being backfilled in the continued course of mining.
- Old pits that are being filled or due to be filled soon in terms of the rehabilitation program.

Requires liaison with a suitably-placed persons regarding backfilling and excavation schedules.

Sections must be described where fossil material is sampled. Additional observations of sedimentary features should be made where these inform about the origin of the deposits.

A prescribed data requirement is adequate 3D spatial referencing. For this the specialist would require the assistance of the surveyor w.r.t. co-ordinates and base maps.

Priority Fossil Exposures

These exposures should not backfilled and the exposed fossils should be collected as soon as possible.

- The apparent silicified bone and macrofossil plant material exposed in the "Megalodon" palaeochannel at KVS_E16 (Waypoint 137).
- The fossil wood pieces and plant debris from the "Langklip Channel Clays" in the LK_LK_22 exposures (Waypoint 51).
- The unique 90 m Package fossil shells occurrence in the Koingnaas KN_KLNA_15 exposure (Waypoint 56).

Contingent Archaeological Mitigation

In the process of scanning palaeosurfaces in the terrestrial sequences for fossil bones, buried occurrences of ESA and MSA implements are certain to be found. Significant finds are to be referred to the contracting archaeologist. For example:

- The Early Stone Age site at Waypoint 139 should be examined by the UCT Archaeological Contracts Office.

Dumps and Discarded Oversize Gravel

Overburden dumps, particularly after deflation, have provided valuable fossils. Discarded oversize gravel dumps have been the source of extremely valuable vertebrate teeth sourced from the basal petrified assemblage. In the process of backfilling from these dumps or regrading them it is possible that fossil material will be exposed.

Legacy Material

Compilation of a detailed inventory of existing fossil samples and their state of diagnosis, together with where they currently are stored/displayed, at company sample archives, local museums and various research institutions.

Existing descriptive documentation/projects should be reviewed where appropriate, in order that the fossil search and contexts of finds are informed by the prior observations of the deposits.

In the case of the Quaternary RETs and the BIC, any photographic records and sketches made when existing exposures were less covered would be useful.

Proprietary information concerns should be addressed, such as non-disclosure agreements and limitations/permissions for access to reports.

- **Geohistorical Heritage Sites**

There is considerable interest in the preservation of selected mine-pit exposures, both as:

- Type Sections for the formations of the Namaqualand coastal plain and the Buffels River.
- Geoheritage sites that will form the basis of geotourism routes on the Namaqualand coast.

It is predicted that there will be agreement and support from the geological community that Type Section sites be preserved among the DBNM exposures. The geological community is also increasingly engaging in geoheritage and geotourism e.g the Vredefort Dome World Heritage Site

Visit www.unesco.org/science/earth/geoparks.html).

The West Coast Fossil Park at Langebaanweg is the geotourism precedent on the West Coast.

The Namaqualand community has an interest in geoheritage and geotourism, as a potential sustainable, albeit minor, economic opportunity while the diamond-mining continues to decline into the future.

In the process of the comprehensive pit inspection, particular exposures can be earmarked and rated w.r.t. their value as a type section/geohistorical site that should be maintained in an accessible and meaningful condition.

Although the preservation of selected mine-pit exposures may reduce the costs of rehabilitation, there will obviously be costs incurred in keeping pits open and accessible, in stabilization of the faces and in safety concerns.

The following are initial proposals for potential Type Sections and geoheritage sites:

- The unique exposure of the highly plant-fossiliferous “Channel Clays” on Langklip (LK_LK_22 exposures, Waypoint 51).
- The “Megalodon” palaeochannel at KVS_E16 (Waypoint 137), including the contact between the edge of the “Megalodon” palaeochannel sediments and the 90 m Package.
- The 90 m Package remnant occurrence with unique shell fossils in the Koingnaas KN_KLNA_15 (Waypoint 56). Overlain by the 30 m Package.
- An exposure (unspecified, if one still exists?) of the BMC Upper Terrace and overlying 90 m Package where it is of typical aspect. Aspects could include the 95 m cliff, silcrete boulder conglomerates and the black, heavy-mineral beach zones.
- An exposure (unspecified, if one still exists?) of the BMC Middle Terrace where it is of typical aspect. Important aspects are the 65 m Cliff, the sedimentary architecture in relation to the 65 m Cliff and the transgressive maximum of the 50 mm Package overlying the lower Middle Terrace.
- An entire section (unspecified) through the Quaternary RETs.
- A suitable exposure (unspecified) of the Buffels deposits at Nuttabooi.

Additional Type Sections/geoheritage sites should be designated amongst the exposures at Alexkor, but Alexkor is yet to begin compliance with the National Heritage Resources Act. The exposures at Buffelsbank also require evaluation.

- **Additional Aspects of Geohistorical Note**

Evidence of Neotectonic Activity

An exposure showing faulting of the bedrock extending into the overlying Pliocene marine deposits has been seen previously (Langklip, Waypoint 50) and several exposures exhibit soft-sediment deformation features caused by earthquakes. This evidence of neotectonics or geologically-recent (Quaternary) faulting is very rare on the coastal plain. It is of considerable interest, for instance, in the site selection of nuclear power stations. The writer has been requested to propose such exposures for preservation (CGS).

Places of interest for the History of Mining

A good example is the early workings just to the south of Kleinzee. Additional sites could include "The Crater" and other areas of early workings. Kleinzee/DBNM historians should be consulted here. Similarly, sites should be designated amongst the exposures at Alexkor (Oyster Line?).

Natural Exposures

Here the issue is not preservation of pit exposures, but eventual facilitation of access for inclusion in a geotourism itinerary. For instance, occasional outcrops of poorly-represented formations occur, such as aeolian and fluvial quartzite sandstones on the flanks of drainages (e.g. Swartlintjies River at Waypoint 53). Such occurrences represent a largely-unknown period of geological history post-dating the 90 m Package. Other examples may be known of as a result of DBNM exploration of the area.

In this category may also be features of the Precambrian bedrock stratigraphy that could be included in a geohistorical route itinerary. Suggestions to be sought from relevant "hard-rock" researchers.

- **Palaeontological Monitoring**

It is suggested that a degree of monitoring be carried out during the making of excavations in the future.

At this stage it is perhaps premature to propose monitoring strategies in any detail. It is proposed that feasible and cost-effective strategies be discussed in the near future.

Next Steps

Discussion of this report, clarifications where required.

Drafting of the Terms of Reference for the palaeontological mitigation project.

Very Important Point

It is vital that it is understood by the depts. of Minerals and Energy, Environmental Affairs & Tourism, Arts & Culture and environmental lobbies that the process of full consultation with all the I&APs w.r.t. the filling or preservation of exposures still has to be carried out.

The backfilling of each exposure should be carefully considered first in terms of scientific and heritage value.

Some Interested and Affected Parties

- South African Heritage Resources Authority.
- Iziko South African Museum.
- Council for Geoscience.
- Geological Society of South Africa.
- South African Commission for Stratigraphy.
- Namaqualand communities and local government.
- Sustainable development NGOs.
- Namaqualand tourism I&APs.

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- **ABBREVIATIONS**

asl. above (mean) sea level.

BMC Buffels Marine Complex. Marine deposits on wave-cut terraces north of Kleinzee, extending towards Port Nolloth. Terraces are formed on somewhat schistoze quartz arenites of the Stinkfontein Subgroup and extend to ~100 m asl. Older palaeochannels occur.

BIC Buffels Inland Complex. Fluvial deposits of various ages preserved locally along the flanks of the Buffels Rivier.

BP Before Present. (Before AD 1950).

bsl. below (mean) sea level.

DBNM De Beers Namaqualand Mines.

EIA Environmental Impact Assessment.

EMP Environmental Management Plan.

ESA Early Stone Age.

Fm. Formation.

HIA Heritage Impact Assessment.

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. Generally not used for durations not extending from the Present. Sometimes “kyr” is used instead.

KC Koingnaas Complex. Marine deposits between the Hondeklipbaai area and Kleinzee, locally underlain by palaeochannels incised into the basement gneisses, with “Channel Clay” and quartz conglomerates.

k.y. Thousand years. Used for duration only *e.g.* the duration of the LIG was 10 k.y.

LGM Last Glacial Maximum. Interval of maximum “Ice Age” ice volumes ~30 to 19 ka.

LIG Last Interglacial. Warm period 128-118 ka BP. Relative sea-levels higher than present by 4-6 m. Also referred to as MIS 5e or “the Eemian”.

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. Generally not used for durations not extending from the Present.

MIS Marine Isotope Stage. Numbered stages of the marine oxygen-isotope record ($\delta^{18}O$) - see Figure 5.

MSA Middle Stone Age.

ODP Ocean Drilling Project.

PIA Palaeontological Impact Assessment.

RET Recent Emergence Terraces (Quaternary raised beaches).

SAHRA South African Heritage Resources Authority.

SST Sea-surface temperature.

m.y. Million years. Used for duration only *e.g*. the duration of the Eocene Epoch was ~22 m.y.

w.r.t. with respect to.

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- # 1. INTRODUCTION

- ## 1.1 CONTEXT OF THIS PALAEONTOLOGICAL ASSESSMENT

De Beers Namaqualand Mines (DBNM) is now in the "sunset" phase of diamond mining along the Namaqualand coast, after 80 years of activity. The intention of this report is to provide an assessment of the status of palaeontological scientific research along the Namaqualand coast, with particular reference to the DBNM exposures. The purpose is to provide the initial inputs to the palaeontological aspects of the Heritage Management Plan. The latter is part of the overall Environmental Management Plan (EMP) for the mine, of which the main focus now is the rehabilitation of the mine open-cast pits and overburden dumps. In essence, this is about the "last chance" opportunities to collect fossils from the remaining mine exposures, before they are finally backfilled.

Hitherto, heritage management has mainly involved the sampling and recording of archaeological occurrences on the land surface, prior to mining in an area. Fossils however, are exposed once overburden is being stripped. The opportunities in the past for fossil collection have not been fully exploited, for a variety of reasons. The mining environment is not favourable for spotting sparse fossils and there are the exigencies of production schedules that do not lightly brook interruptions. Valuable fossils such as bones are difficult to spot and if seen, are difficult to recover intact without specialized techniques. Necessary product security measures limit access to material, particularly basal units. There have been and still are few locally-based palaeontologists with funding to carry out long-term monitoring for fossil occurrences.

Notwithstanding, a considerable legacy of "in-house" scientific knowledge has accumulated over this period, much of it hinging on the finding and diagnosis of fossils. A portion of this knowledge resides in the public domain via the support of research projects such as DBNM-funded thesis projects, by the facilitation of research by external scientists and by the hosting of conferences and workshops. The current knowledge of the geological history of Namaqualand owes much to this support.

Although this report is primarily about fossils, there is overlap with archaeological interests. Buried, older archaeological material occurs within the upper parts of the terrestrial deposits, usually in association with fossil bones. The search for fossils will also include such finds.

Now that the value of fossils has been recognized legislatively, the process of compliance with the heritage legislation provides the opportunity to address outstanding concerns regarding the scope of fossils from coastal Namaqualand represented in existing scientific collections and the contingent scientific questions. There will be "spin-off" as inputs for the still-evolving geological model of the Namaqualand deposits, at the least as a confirmatory/auditing process for the interpretations of the stratigraphy of the exposures. Indeed, as the scale and intensity of exploitation is decreased into the future, in the process of eking out the remaining resource, it may now be opportune to undertake a field-based review process of the "anatomy" of the mine.

- ## 1.2 SIGNIFICANCE OF THE PALAEONTOLOGICAL HERITAGE RESOURCE

In terms of the National Heritage Resources Act No. 25 of 1999, Sections 35 & 38, palaeontological materials (fossils) are regarded as a heritage resource and appropriate actions are required to mitigate impacts from mining, construction and development on palaeontological heritage. If fossils are turned up in excavations, they must be rescued from destruction and loss.

The significance of fossils as natural heritage is primarily their scientific value. They contribute to the understanding of South Africa's geohistory, the progression through "deep time" of changing climates, oceanography and of the biota, both plant and animal, that lived on the land and in the sea. This history ultimately resulted in the landscapes and coasts and the resources that sustain us today. Generally-speaking they are scarce, non-renewable and irreplaceable when destroyed. Their value is also severely compromised when they are collected without proper recording of their geological context. Geological (sedimentological/palaeoecological) observations are indispensable for the interpretation of fossil finds.

The value of fossils extends far beyond the curiosity of palaeontological study in museums, for they provide the basis for biostratigraphy, the division of the sedimentary record into units of distinct ages that can be correlated both regionally and globally. The fossil content of strata is thus very important for understanding the genesis of exploitable mineral resources and for the geological models that furnish the basis for ongoing mineral exploration.

Moreover, there are the intersecting broader concerns of **GeoHeritage**, scientifically w.r.t. the preservation of Type Sections of the deposits and **GeoTourism** as a sustainable endeavour for the future.

- ## 1.3 PALAEONTOLOGICAL IMPACT ASSESSMENT AND MITIGATION

- ### Impact Assessment Criteria

The following criteria are a standard part of HIAs, herein briefly adapted to the DBNM context.

- *Extent*

The physical extent of impacts on potential palaeontological resources relates directly to the extents of subsurface disturbance. This will mainly be in the areas of quarrying, but also includes excavations for infrastructure.

- *Duration*

The duration of the impact has been long-term (80 years) and will continue to the end of the mine (10 years?).

- *Intensity*

The impact of mining on fossil resources is potentially high. This is because fossils are rare objects, often preserved due to unusual circumstances. This is particularly applicable to vertebrate fossils (bones), which tend to be very sporadically preserved.

While it is clear that fossils in the subsurface would remain there were it not for the mining activity, the failure to attempt to maximize the opportunities provided by the mining represents loss of such resources.

- *Probability of occurrence*

The probability of impact is definite. The area is known to have considerable fossil potential. Given the scale of machinery involved in mining, it is certain that fossils have been and will be destroyed, regardless of efforts in mitigation.

- *Significance (unmanaged)*

There is certainty of fossils being lost in the absence of management actions to mitigate such loss. Such loss would be of national and international significance. The area has already produced fossils of international scientific importance.

- *Significance (managed)*

There remains a medium to high risk of valuable fossils being lost in spite of management actions to mitigate such loss. Mitigation is the key concept and is all that can realistically be achieved.

- *Status of the impact*

The status of the impact for palaeontology is not neutral, but has duality From the fact that the “windows” into the coastal plain depository, that provide access to fossils, would not exist without the mining, the impact is positive for palaeontology. From the point of view that fossils are going to be destroyed, in spite of efforts at mitigation, the impact is negative.

- *Degree of confidence in predictions*

Certain.

- **Typical Mitigation Process**

The essentials of the palaeontological mitigation process, in “typical” circumstances such as coastal housing developments or industrial sites, involves:

- Compilation of the PIA outlining the potential fossils occurrences in the vicinity, with recommendations for the mitigatory actions to be taken.
- Terms of Reference of project drawn up. A site-specific permit is obtained from the relevant Provincial Heritage Resources Authority or SAHRA.
- Any exposed fossil occurrences threatened by activities are sampled and described.
- The digging of excavations is monitored. A reporting/action protocol for monitors is in place for finds uncovered.
- A primary fieldwork phase follows. The faces of excavations are closely inspected for fossils and recorded.
- A Final Report is compiled and rescued fossil material is deposited in the scientific institution.

2. SUMMARY OF COASTAL-PLAIN STRATIGRAPHY

Shown below (Fig. 1) is a proxy sea level/ice-volume record for the Cenozoic Era, annotated with the main elements of the stratigraphy of Namaqualand. The current geological time scale will accompany this report, for nomenclature reference purposes.

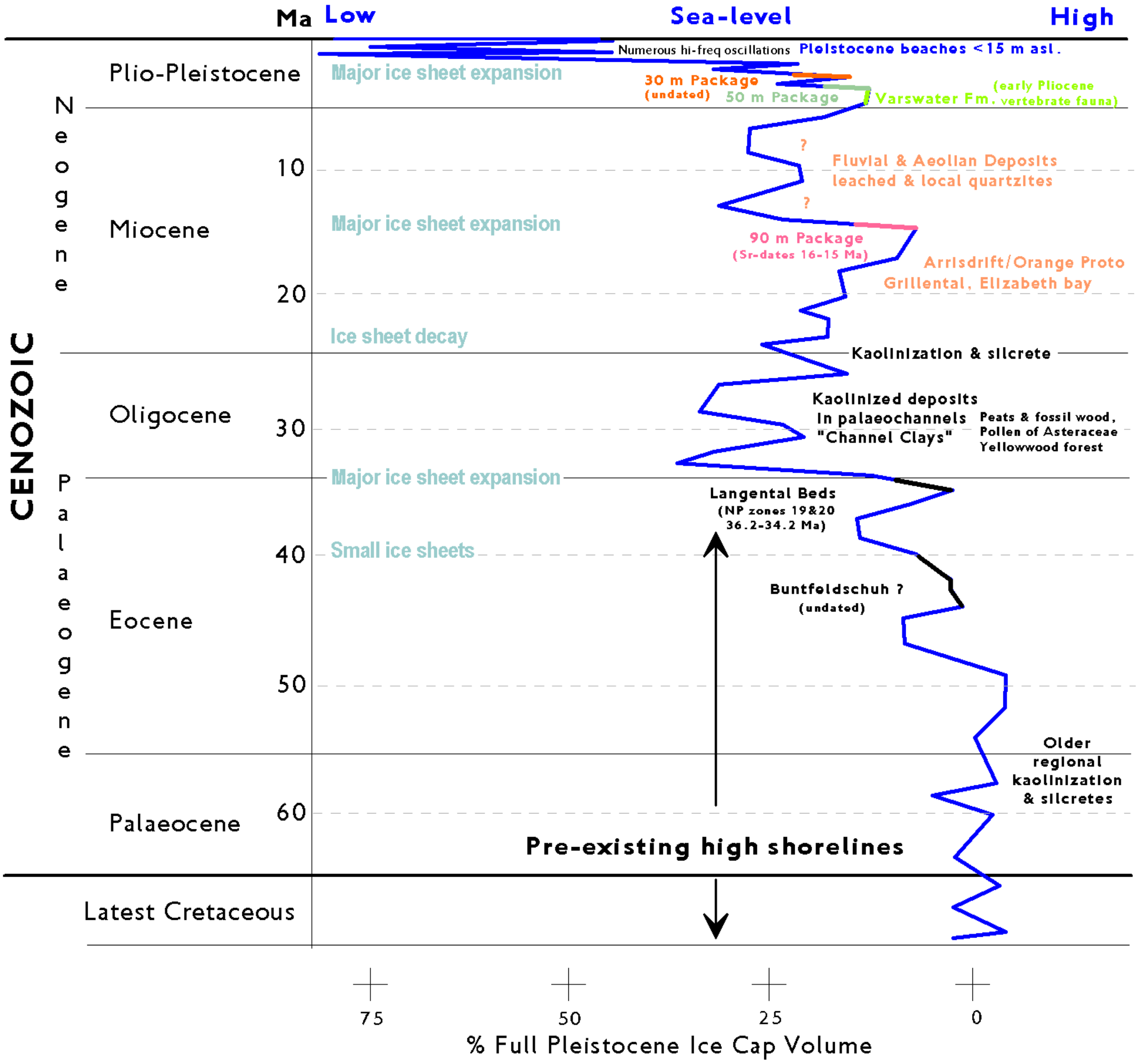


Figure 1. Deposits of the West Coast and sea-level history. Ice volume history modified from Lear *et al.*, 2000.

2.1 Early Post-Gondwana Events

During the early Cretaceous separation of Africa and South America, fault-bound grabens formed parallel to the approximately N-S basement structural grain during basement extension and collapse along the early coastline. Dolerite dykes intruded the faults and lineaments in the basement, with volcanic activity in places.

Vigorous erosion during the later Cretaceous exposed the coastal bedrock of metasediments and gneisses from beneath a cover of Nama and Dwyka rocks. Notwithstanding, large-scale topographic aspects of the coastal plain, its backing escarpment and major drainage lines still reflect persistence of the basal Dwyka topography, formed beneath huge glaciers ~300 Ma. In more detail, faulting during continental breakup affected coastal topography. Deposits from these times are only preserved in rare instances, One example, a graben preserved some distance to the north of Kleinzee, contains lacustrine deposits that have yielded Lower Cretaceous pollen (Molyneux, in Rogers *et al*., 1990), indicating deposition 145-130 Ma.

The coastal plain would have been transgressed during Cretaceous high sea-levels. Transgressive Eocene events also affected the coastal plain and deposits of this epoch are found in southern Namibia *viz*. at Buntfeldschuh and Langental (Fig. 1), but little evidence of this earlier marine history remains along Namaqualand. Rather, much of the further evolution of the coastal drainages took place during these times, with flushing of pre-existing deposits to the offshore depositories. The coastal plain bedrock became deeply weathered and kaolinized under the influence of the humid tropical climates of the later Cretaceous and early Tertiary, with silcrete duricrusts developing.

Remnants of the late Cretaceous African Surface have been preserved on the escarpment and coastal hinterland (Partridge and Maud, 1987) as silcrete-capped mesas underlain by deeply kaolinized bedrock. However, not all the weathering-profile silcretes are necessarily latest Cretaceous; those on valley flanks of current drainages are probably early Tertiary. Along the present coast these older weathering profiles have been truncated by marine transgressions.

- ## 2.2 EARLIER TERTIARY FLUVIAL DEPOSITS

Incised into this ancient, weathered land surface are remnants of fluvial palaeochannels, whose infills have also been kaolinized, disguising their presence (informally called the "Channel Clays"). These channel sediments consist of oligomictic, subangular quartz paraconglomerates, locally rich in diamonds, overlain by beds of clayey sand, clay and carbonaceous material containing plant fossils (Molyneux, in Rogers *et al*., 1990). Silcrete has also formed within the channels. Pether (1994b) has concluded that the conglomeratic and sandy beds were originally arkoses derived from the surrounding gneisses.

The deeply weathered nature of these channel infills suggests a considerable age, but their age has been controversial. Fossil pollen from the organic-rich beds fills has variously been interpreted as dating to the Palaeogene and the Neogene (de Villiers, 1997). In contrast, a mid-Cretaceous (Albian to Turonian) age was suggested by marginal-marine microfossils (I.K. McMillan, pers. comm.). Subsequently, he concluded that the maximum age must be late Cretaceous (late Campanian/early Maastrichtian (I.K. McMillan, in press).

Due to the economic importance of the "Channel Clays", additional samples were sent to analysts. The presence of Proteaceae indicates an age not older than Maastrichtian (end-Cretaceous), whilst Oleaceae (ironwoods) and Asteraceae (daisies) indicate an age not older than Oligocene (Muller, 1981). This suggests that the bulk of the infill is Oligocene/earliest Miocene, with humid weathering (kaolinization) continuing to ensue during the earliest Miocene. Sue de Villiers argues for a possible Palaeocene/Eocene age, but this would imply that the daisies and ironwoods evolved in South Africa quite early on, well before their radiation to larger Africa (and beyond). The possibility remains open that the stratigraphy of these deposits is more complex than thought and that the channels were active over a considerable time span.

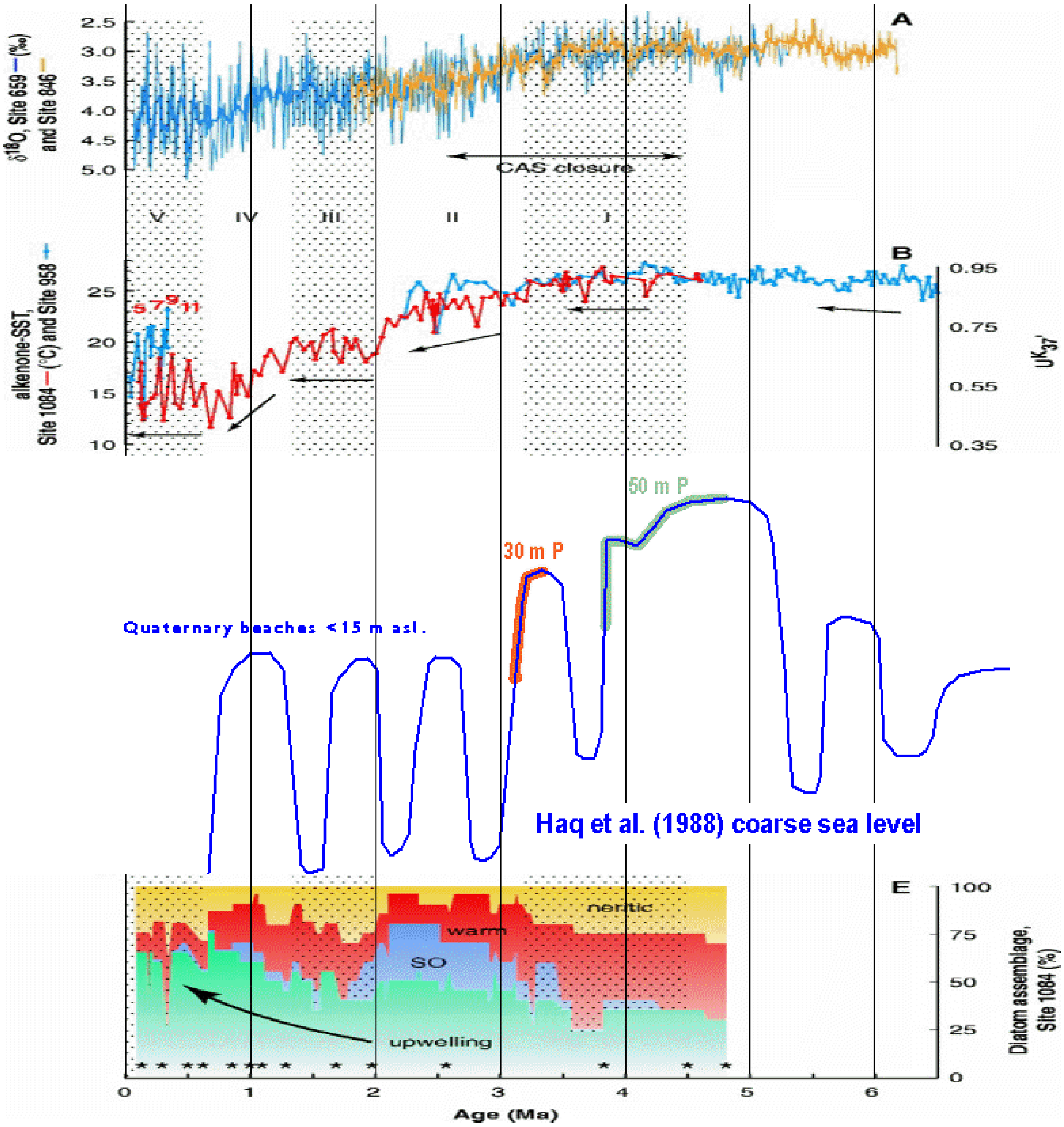
- ## 2.3 NEOGENE MARINE DEPOSITS

Consistently represented along the length of the coast are three extensive marine formations containing warm water mollusc assemblages. This older, Neogene , warm-water group includes the 90 m Package, the 50 m Package and the 30 m Package. The latter is transgressed by younger, Quaternary littoral deposits up to about 10 m asl. that include cold water shell assemblages similar to those inhabiting the coast today. This Quaternary, cold-water group comprizes the 8 - 12 m Package (~400 ka BP?), the 4 - 6 m Package (Last Interglacial (LIG) ~125 ka BP) and the 2 - 3 m Package (mid-Holocene 6-4 ka BP).

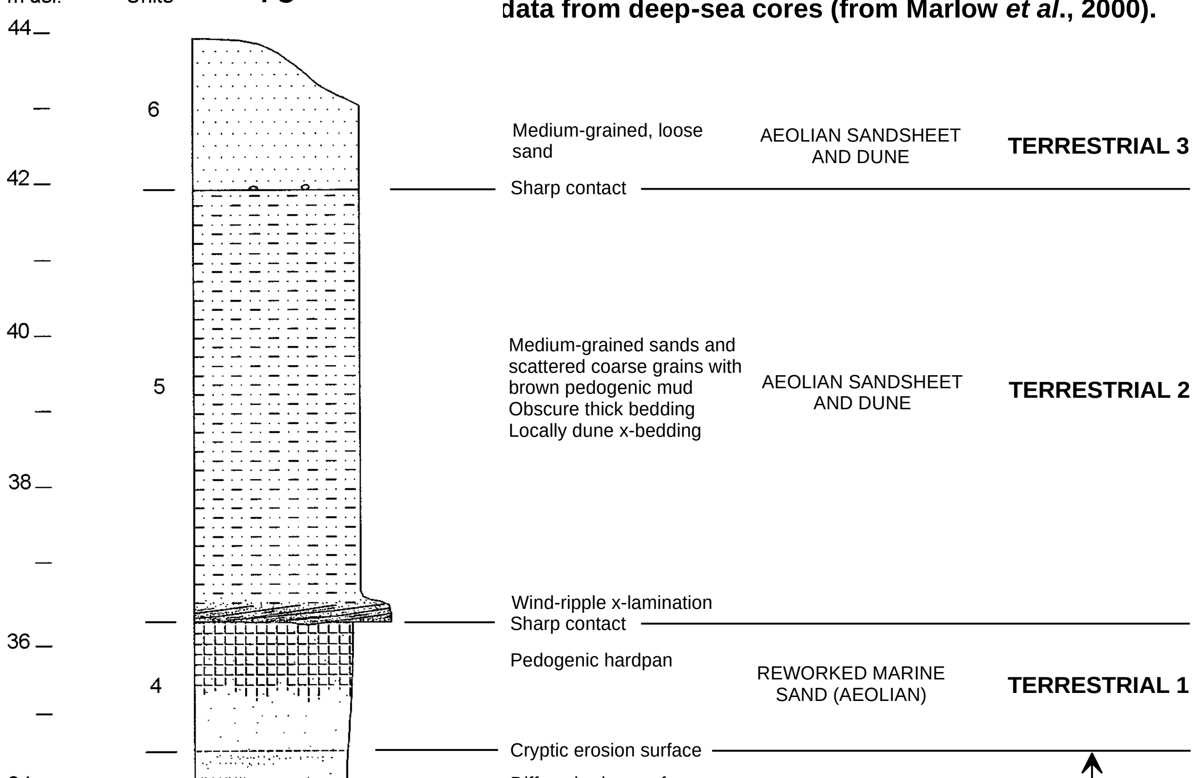
These packages are alloformations that are defined genetically, each being related to a cycle of marine transgression and regression. Each comprizes the package of marine sediments deposited during regressive progradation seawards from the maximum elevation reached by the transgression. The packages are arranged *en echelon* down the coastal bedrock gradient, from oldest and highest to youngest and lowest at the coast, each package truncating the preceding one at a lower elevation. Each package is named after the elevation of its transgressive maximum, as represented in the Hondeklip area. In terms of sequence stratigraphy they are highstand tracts, each comprizing only one parasequence. They are not marine terraces, which are geomorphological entities that may have developed over more than one sea-level cycle. In each case, their basal gravels locally contain exploitable reserves of diamonds.

From the biostratigraphic viewpoint, the 90, 50 and 30 m packages each contain their own unique suite of extinct fossil mollusc shells. Most well-known among these is *Donax haughtoni* (50 m Package) and *Donax rogersi* (30 m Package), whilst recent findings suggest that *Isognomon gariesensis* is a good zone-fossil candidate for the 90 m Package, previous finds from the basal 50 m Package having been reworked. The barnacles (Pether, 1990) and brachiopods (Brunton and Hiller, 1990) are also biostratigraphically useful. The microfossils from the packages have been investigated by Dr Ian McMillan and also exhibit distinct assemblages.

The extant warm water taxa present in the 50 and 30 m packages include species that today inhabit the east coast of southern Africa only and West African species. Chief among the warmer water indicators is the oyster *Crassostrea margaritacea*, which is abundant in both packages. Despite the intensification of upwelling along this coast from late Miocene times (Siesser, 1978), its influence was clearly not as great during late Neogene interglacials as at the present interglacial (Fig. 2). The explanation may be sought in latitudinal shifts and reduced intensity of the trade winds, which would have been associated with shifts in upwelling loci and reduced upwelling, as well as with an enhanced tendency for Agulhas water to round the southern tip of Africa and influence the Benguela system. (e.g. Pether, 1994a). Clearly too, tropical taxa from the West African province were not cut-off from the southern African coast by an upwelling barrier. The onset of bipolar glaciation and the Quaternary climatic mode impacted locally as considerable extinction and speciation in the shallow marine molluscan fauna, such that the post 30 m Package faunas are essentially modern.



F s 16 based on major margin unconformities (from Haq *et al*., 1988), data from deep-sea cores (from Marlow *et al*., 2000).



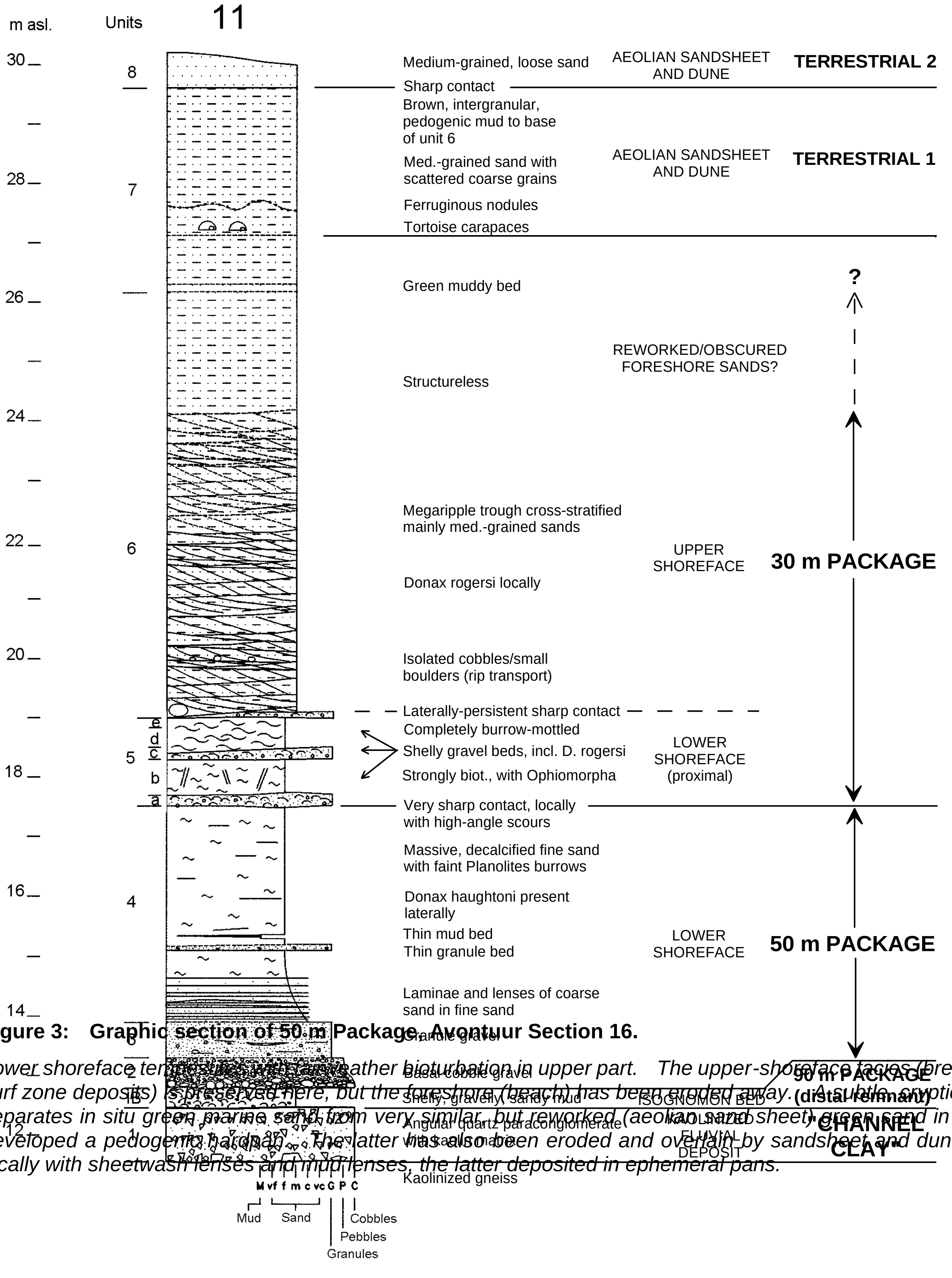


Figure 3: Graphic section of 50 m Package, Avontuur Section 16.

Lower shoreface temptestites with fairweather bioturbation in upper part. The upper-shoreface facies (breaker and surf zone deposits) is preserved here, but the foreshore (beach) has been eroded away. A subtle, cryptic contact separates in situ green marine sand from very similar, but reworked (aeolian sand sheet) green sand in which is developed a pedogenic hardpan. The latter has also been eroded and overlain by sandsheet and dune sands, locally with sheetwash lenses and mud lenses, the latter deposited in ephemeral pans.

Figure 4: Graphic section of 30 m Package and eroded, underlying 50 m Package. Hondeklip Section 11.

A thin remnant of the basal kaolinized deposits (Eocene-earliest Miocene) is also present at this site. The mid-Miocene Isognomon bed (distal 90 m Package remnant) has been inserted at the appropriate stratigraphic position, whereas it is actually preserved ~50 m away from the section site. The 50 m Package section has been eroded down to the lower-shoreface (storm deposits) facies and a sharp contact, locally with pots and gutters, is overlain by the 30 m Package. The section is not far seaward from the 30 m Package transgressive maximum, so that there was accommodation for only the "beginning" of a lower-shoreface facies. The megaripple bedforms of the 30 m Package upper-shoreface attest to high sediment supply.

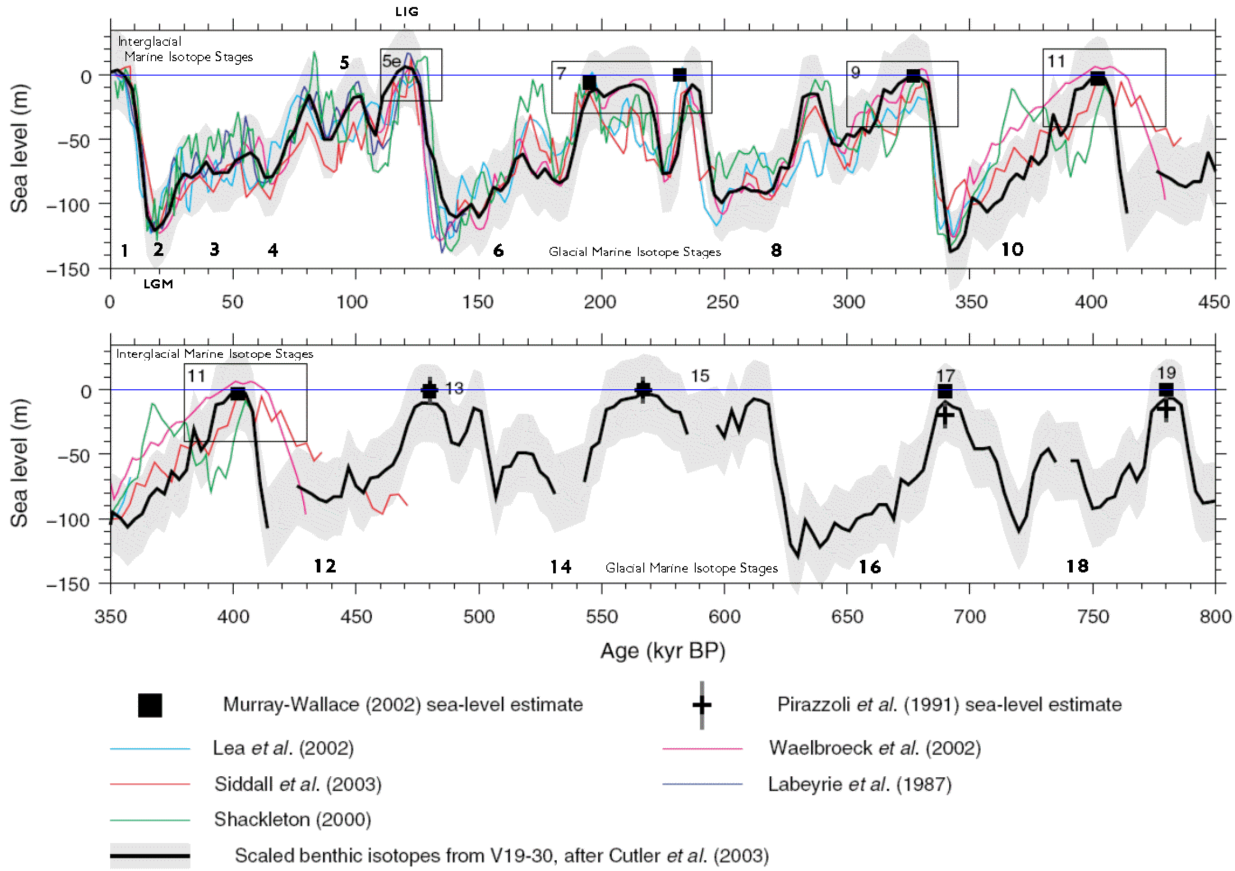
- ### 2.4 The 90 m Package

In the vicinity of Kleinzee a cliff line at 95 m is cut into the silcrete-capped bedrock and forms the landward edge of a wave cut platform down to ~75 m. Sediments comprize a basal gravel with abundant silcrete clasts and overlying, reddened sands with heavy mineral laminae (Rogers *et al*., 1990). Farther north the Grobler Terrace in the Alexander Bay area is at equivalent elevation. In the Hondeklip area, landwards above ~40 m asl., coarse sands and gravels of the truncated edge of the 90 m Package appear in bedrock lows beneath the over-riding 50 m Package.

These high-elevation 90 m Package deposits are decalcified and generally lack all but the most robust macrofossils. However, a shelly, more distal marine (shelf) facies of pebbly muddy sands and clays is very locally preserved at even lower elevations, beneath the 50 and 30 m packages (*Isognomon* bed, Fig. 4). Strontium isotope ages of 16-15 Ma have been obtained from foraminifera sealed in clay at one such occurrence in the Hondeklip area (Langklip), consistent with high sea levels during the warm mid-Miocene climatic optimum *ca*. 17 to 15 Ma (Fig.1).

- ### 2.5 The 50 m Package

This package was laid down in the course of shoreline progradation as the sea regressed from a maximum of ~50 m asl. It consists typically of fine green sands overlying basal gravels. The sands may exceed 8 m in thickness and were deposited at lower shoreface palaeodepths; they are not beach deposits. The basal gravels generally are not transgressive lags, but are tempestites swept from the foreshore and upper shoreface during extreme storm events to be deposited, at the foot of the prograding wedge and extending onto the inner shelf. The distal (inner-shelf) tempestites were lithified by impregnation of phosphorite and subsequent reworking and additional deposition during storms generated multiphase beds and phosphoritic intraclasts. As the regression advanced, deeper water facies were destroyed except for a few remnants preserved in depressions, which were overridden by the proximal gravel tempestites.



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As in the southwestern Cape, the most prominent of these deposits are the younger, LIG and mid-Holocene deposits. The older, 8-12 m Package could relate to a prominent middle Pleistocene interglacial called Marine Isotope Stage 11 (MIS 11) ~400 ka ago (Fig. 5). Alternatively, it is been argued on the basis of vertebrate evidence that this old shoreline is early Pleistocene, about 1.2 Ma (Hendey & Cooke, 1985).

Given that all of the pre-LIG Pleistocene highstand evidence is "subsumed" in the "8-12 m Package" deposits, at this stage, it quite feasible that the poorly-known "8-12 m Package" deposits could include units of differing age at various localities. It is clear that the record of Pleistocene high sea levels is very condensed along the west coast, with each highstand largely destroying deposits of the previous highstand. Low sediment supply for progradation and slow or negligible uplift contributed to this situation. However, it also seems that few later Quaternary highstands exceeded present sea level (Siddall *et al.*, 2007). Other complications are evidence of brief high spikes in sea-level during interglacials 5e and 11 (Siddall. *et al.*, 2007).

Figure 5. Approximations of sea-level history during the last ~0.8 Ma, from Siddall. *et al.*, 2007.

• 3. THE VERTEBRATE RECORD AND AGE CONSTRAINTS

The vertebrate fossils found in the coastal plain deposits are absolutely critical for the provision of age constraints. Sparse vertebrate fossils indicative of Neogene ages have been retrieved from various sites on the Namaqualand coast. From fluvial deposits at ~35 m asl. near Kleinzee, Stromer (1931) described a small vertebrate assemblage that included extinct hyaena, otter and mongoose bones. Thereafter, no major assemblages were recovered, but a trickle of finds were presented for identification through the many years of mining (Hendey, 1984). During research at Hondeklip mine, a special effort was made to improve the situation, involving painstaking scrutiny of the exposures. Some of this well-provenanced material, and new finds from the Hondeklip area, have now been examined systematically (Pickford and Senut, 1997), shedding new light on coastal plain history.

Fossilized teeth of suids and a hominoid tooth, recovered from 90 m Package gravels at ~50 m asl., are adjudged to be of latest early Miocene age (ca. 18 - 17.5 Ma) (Pickford & Senut, 1997). This range of ages places the 90 m Package sea-level high contemporaneous with the higher, or *proto* gravels of the lower Orange River valley. The latter deposits at Arrisdrift have evidence of an encroaching sea and were apparently aggraded in the vanguard of the mid-Miocene transgression (Fig. 1).

The 50 m Package contains a basal concentration of petrified and abraded vertebrate remains inherited from earlier periods. This “Basal, petrified, mixed assemblage” or remanié fauna includes shark teeth and the bones and teeth of extinct whales, proboscideans, rhinocerotids, bovids and equids (Pether, 1994b; Pickford and Senut, 1997). The oldest fossils present are the bear-dog *Agnotherium* sp. (13 - 12 Ma) and the gomphothere *Tetralophodon* (12 - 9 Ma), but the age indicated by most of the material is terminal Miocene (7.5 - 5 Ma) (Pickford and Senut, ibid.). These youngest taxa in the reworked basal assemblage constrain the maximum age of the 50 m Package. The important, unpetrified finds from within the package are the Langebaanian (Varswater) phocid (seal) *Homiphoca capensis* and the suid (bushpig) *Nyanzachoerus kanamensis*, the latter reported by Pickford & Senut (1997) to have an age of 5 - 7 Ma. Stromer’s (1931) assemblage includes Langebaanian carnivores (Hendey, 1984).

Linking of the 50m Package to the Varswater Formation and the early Pliocene (~5 Ma) high sea level of Haq *et al.* (1988) is therefore considered appropriate, but as the package is a regressive, prograded deposit it is correlated with the fall in sea level from the ~5 Ma highstand, *i.e*. only part of the Varswater Formation as currently defined.

The top of the 50 m Package in the Hondeklip area is eroded away and a cryptic contact separates pristine marine sediments and reworked marine sediments. On the cryptic surface are sparsely scattered bones (tortoise, zebra, ostrich, jackal, various antelopes, rhino). This erosion surface and the overlying terrestrial sediments must be younger than the ~2.6 Ma *Equus* (horses) dispersal in Africa because of the zebra (*Equus capensis*) bones.

• 4. OTHER AGE CONSTRAINTS

Many attempts at strontium-isotope dating of fossil shells have been done, but almost all age estimates from strontium isotopes have been bedevilled by the alteration of the original marine signatures that is typical of carbonate sequestered in arenaceous deposits. Notwithstanding, the strontium dates of 15-16 Ma for foraminifera from the 90 m Package (samples sealed in clay), are broadly consistent with local vertebrate evidence and global ice-volume proxies (Figure 1). Improvements in analytical equipment encourage continued efforts with this technique, using improved sample-volume selections in sectioned fossils.

Broad age constraints issue from palaeoceanographic/climatic reconstructions based on proxy data of global significance such as the oxygen-isotope records of deep-sea microfossils. The highest elevation marine deposits of the 90 m package have previously been considered early Pliocene. The evidence now that the 50 m Package is early Pliocene better fits the oxygen-isotope record, which negates major Pliocene deglaciation and very high sea levels (Hodell & Venz, 1992).

An age-diagnostic vertebrate assemblage associated with the 30 m Package has not yet been recovered and so its age is not constrained by vertebrate datums. Notwithstanding, it is the last, major formation of the coastal plain,

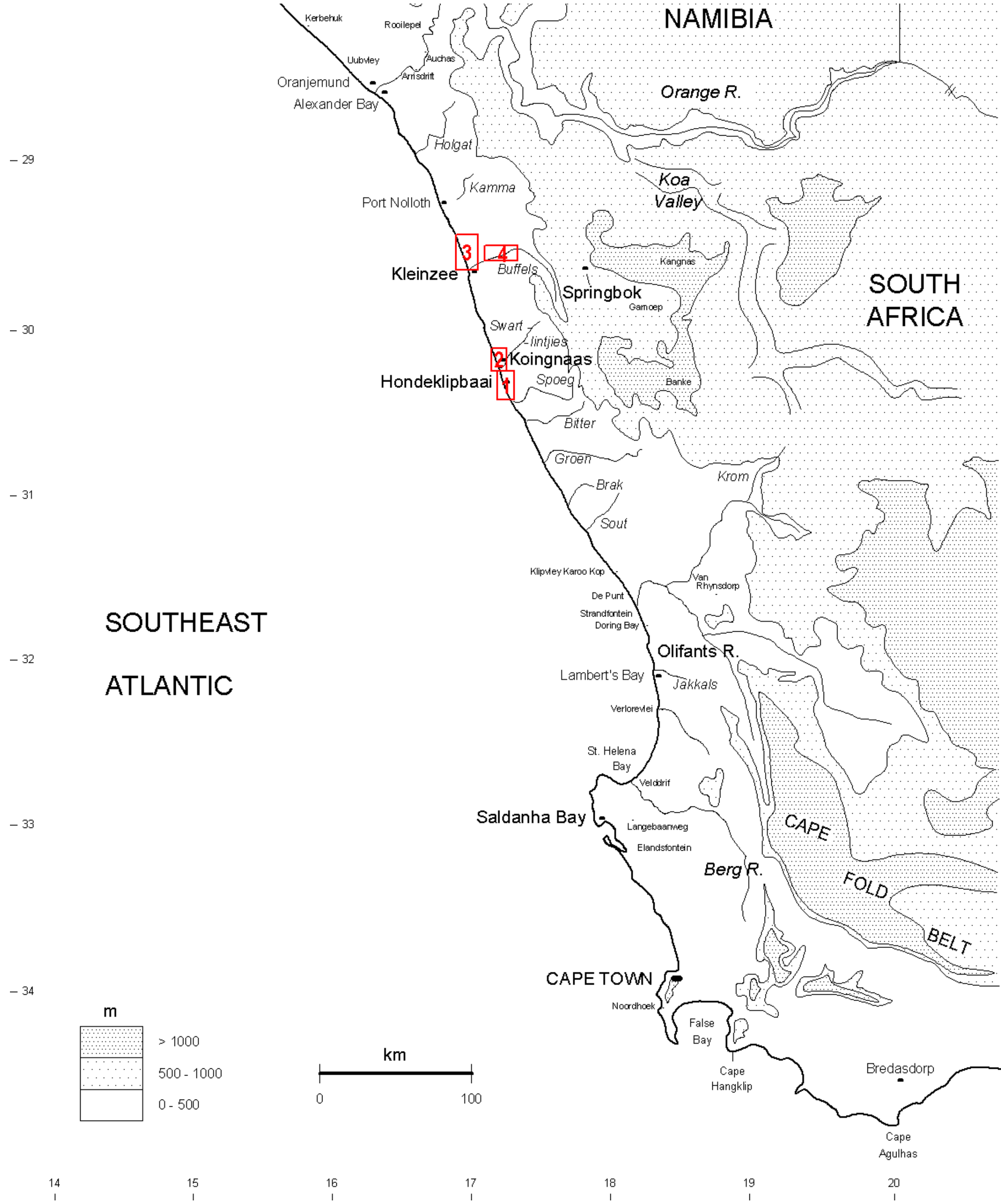

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Figure 6. West Coast localities and positions of Maps 1-4.

Significant diamond reserves in the marine gravels south of the Orange River became apparent by 1927 and these early prospects were examined by Wagner & Merensky (1928), Reuning (1931) and Haughton (1932). The profusion of fossil oysters in the deposits led to the popular perception of an “Oyster Line” associated with diamonds and the realization that sea temperatures along the west coast were once significantly warmer than at present.

In an appendix to Wagner & Merensky (1928), Haughton described the fossils they collected (Haughton, 1928). Wagner & Merensky (1928) recognized that “surface quartzites” or silcretes are the oldest stratigraphic unit on the Namaqualand coastal plain. On the basis of the molluscan fossils, Haughton (1928) recognized that the raised beaches are late Tertiary (Mio-Pliocene) to Pleistocene in age and identified three biostratigraphic units: the “Ostrea Bed” or “Oyster Line,” the “Operculum Bed” and the “Lowest terrace”.

The oysters in the “Ostrea Bed,” now identified as the living east coast species (*Crassostrea margaritacea*), but then called *Ostrea prismatica*, indicated sea temperatures higher than those now occurring on the west coast. Extinct species (e.g. *Donax rogersi*, *Chamelea krigei*) implied a Mio-Pliocene age (Haughton, 1928). In hindsight, the “Ostrea Bed” or “Oyster Line” probably involved exposures of both 50 and 30 m Package basal gravels. The “Operculum Bed” was regarded as an intermediate unit between the “Ostrea Bed” and “Lowest terrace”. This abundance of operculae is usually found in 30 m Package deposits. The “Lowest terrace” (= Quaternary Packages) enclosed an extant fauna and a younger, Pleistocene age with sea temperatures similar to the present was implied.

Haughton (1932) made observations from Bogenfels, Namibia, to Saldanha Bay. From his further collecting of fossils, he refined his initial biostratigraphy for west-coast deposits, erecting five faunal zones, from “Zone E” (oldest) to “Zone A” (youngest with extant fauna) (Haughton, 1932). Instead of being entirely superseded, Haughton's early biostratigraphic zonations (1928, 1932) are explained and enlarged upon from observations at Hondeklipbaai (Pether, 1994b).

Hallam (1964) wrote an account, wide-ranging in areal coverage (from northern Namibia to Kleinzee) and subject matter, of the west coast, its raised beach deposits and its diamonds. As a synthesis of west coast economic geology of the 1950s, after a period during which little published information was forthcoming, this remains a useful resource.

The growth of data during the 1970s prompted a number of syntheses emphasizing Cenozoic palaeoclimates, biogeography and sea-level history (Tankard & Rogers, 1978; Siesser & Dingle, 1981; Hendey, 1983a, 1983b, 1983c; Dingle *et al*., 1983), wherein which the coastal-plain history of Namaqualand, as then understood, was discussed.

In a recent summary (Coastal Cenozoic Deposits, Roberts *et al.*, 2006), alternative names conventionally based on “type areas” were proposed for the 90, 50 and 30 m Packages and the combined Quaternary raised beaches (Table 1), but at the rank of members of an overarching Alexander Bay Formation. It is the writer’s opinion (Sect. 2.3) that these packages, of disparate ages and faunal contents, are of formation rank.

5.2 State Alluvial Diggings (Alexkor)

De Villiers & Söhnge (1959) provided a valuable description of the marine terraces and deposits of the State Alluvial Diggings (Alexander Bay to Port Nolloth, Fig. 2), as seen in 1944. The significance of their observations on sedimentary geometry in relation to cliffed bedrock is contextualized by observations from Hondeklipbaai.

Keyser (1972) provided the most detailed, extant description of the terraces in the State Alluvial Diggings (SAD) area (Alexander Bay to Port Nolloth). Marine deposits are present to high elevations and four terraces were recognized. In order of descending elevation, these are the Grobler Terrace (64-84 m asl.), SAD Upper (34-47 m asl.), SAD Middle (17-26 m asl.) and SAD Lower (0-9 m asl.). The three higher terraces rise gently in elevation to the south. These marine deposits have been named the Alexander Bay Formation (Kent and Davies, 1980).

Gresse (1988) has described sections and listed fauna from the terrace deposits, suggesting correlations with the Hondeklip sequence. Subsequently, (Hill, in Rogers *et al.*, 1990), the altimetric definitions of the terrace elevations have been altered: 75-90 m asl. (Grobler), 30-60 m asl. (SAD Upper), 15-30 m asl. (SAD Middle) and 0-15 m asl. (SAD Lower) (Table 1). Extinct taxa occur in the older, higher terraces, whereas the SAD Lower Terrace deposits enclose extant molluscan fauna.

Importantly, De Villiers & Söhnge (1959) showed that the bedrock topography, with its terraces and cliffs, predates the marine deposits that overlie these geomorphic, erosional features. The 50 m Package overlies the Upper Terrace (30-60 m asl.), but it extends seawards over the cliff onto the Middle Terrace, where it is truncated and overlain by the 30 m Package. This emphasizes that the record of bedrock terraces is separate from the depositional record of covering marine sands and gravels.

5.3 Kleinzee (Buffels Marine Complex)

Elevations of platforms, stormbeach ridges and cliffs in the Kleinzee area were provided by Hallam (1964) and Davies (1973). The sequence of terraces currently recognized is provided by Molyneux (in Rogers *et al.*, 1990). Notably, although the terrace nomenclature at Kleinzee also employs Upper, Middle and Lower appellations, the terraces to which these apply are at elevations different from those at the State Alluvial Diggings (Table 1).

The Kleinzee Upper Terrace at 75-95 m asl. (corresponding altimetrically with the SAD Grobler Terrace) terminates landward in a marked cliff cut into silcrete-capped hills. The Kleinzee Middle Terrace (≈SAD Upper) is at 30-65 m asl. and is subdivided into upper and lower parts. The Kleinzee Upper Middle Terrace (K-UMT) terminates landward in another well-developed cliff at 65 m asl., whilst a break in bedrock gradient at ~45 m asl. generally marks the boundary between the K-UMT and Kleinzee Lower Middle Terrace (K-LMT). The 65 m asl. cliff is considered to have been produced at a transgressive maximum, whilst the K-LMT represents a stillstand at ~45 m asl. during the subsequent regression. This stillstand was succeeded by renewed transgression that overlapped the seaward edge of the K-UMT sediments (Molyneux, in Rogers *et al.*, 1990).

The separation of the K-LMT and the Kleinzee Lower Terrace (≈SAD Middle) is not clearly defined by bedrock topography, but an extent between 10-30 m asl. is indicated and is supported by inflexions of bedrock gradient at ~30 m asl. in some profiles (Molyneux, in Rogers *et al.*, 1990). Late Quaternary beach deposits occur below ~10 m asl. and three units (6-8, 4-5 and 2 m asl. are recognized (≈SAD Lower) and enclose an extant, cold-water fauna.

As mentioned, an interesting development was the discovery by drilling of a deep depression north of Kleinzee (on Karreedoornvlei) that is infilled with carbonaceous, fluvial sediments, dated palynologically as Lower Cretaceous (Molyneux, in Rogers *et al.*, 1990).

Table 1

Depositional Record - Coastal progradation during sea-level falls.			
Koingnaas/Hondeklipbaai		Alexander Bay	Age
C & K, 1969[1]	Current[2]	Group[3]	
~2 m T.C. ~5 m T.C. 7-8 m T.C.	2-3 m Package. 4-6 m Package. 8-12 m Package.	Curlew Strand Fm. (Strandfontein), equiv. to Velddrif Fm.	Quaternary <2.6 Ma.
17-21 m T.C. 29-34 m Beach.	30 m Package.	Hondeklip Fm.	Middle Pliocene >3 Ma.
45-50 m T.C. Phosphatic siltstones.	50 m Package. (includes shell phosphorite)	Avontuur Fm.	Early Pliocene 4-5 Ma.
75-90 m T.C.	90 m Package.	Kleinzee Fm.	Middle Miocene 15-16 Ma.

Terrace Record - Erosion mainly during sea-level rises.		
Alexkor (SAD)[4]	Kleinzee[5]	Overlying Deposits
SAD Lower 0-15 m asl.	Recent Emergence Terraces (RETs) <10 m asl.	
SAD Middle 15-30 m asl.	Lower Terrace Local slopebreaks at ~30 m asl.	Trangressed by 30 m P. Overlain by 50 m P. Patches of 90 m P.
SAD Upper 30-60 m asl.	L. Middle Terrace 30-45 m asl. U. Middle Terrace 45-65 masl.	Trangressed by 50 m P. Partly overlain by 90 m P.
Grobler Terrace 75-90 m asl.	Upper Terrace 75-95 m asl.	90 m Package.

1. Carrington and Kensley, 1969. T.C. = "Transgression Complex".
2. Pether, current. Approximate highstand maxima, with regressive, prograded deposits extending seawards.
3. Roberts *et al.*, 2006 (modified to formation rank).
4. Hill, in Rogers *et al.*, 1990.
5. Molyneux, in Rogers *et al.*, 1990.

- ### 5.4 HONDEKLIPBAAI AREA (KOINGNAAS COMPLEX)

Little information was forthcoming from the Hondeklip area of central coastal Namaqualand until Tankard (1966) described aspects of the succession revealed by prospecting. At that stage, the sequence was seen in terms of the preliminary biostratigraphy erected by Haughton (1932) (Zones E to A). Significantly, Tankard (1966) reported the presence of channel-infilling, kaolinitic, non-marine sediments overlying kaolinized gneiss (the “Channel Clays”). The occurrence of abundant phosphatic nodules was observed. Tankard encountered difficulties in the application of Haughton's (1932) biostratigraphic zones to the more extensive prospecting exposures he saw (*i.e.* the “megatrenches”).

An important advance for the stratigraphy of Namaqualand coastal deposits was Carrington & Kensley's (1969) article describing new molluscan fossils from the central Namaqualand area in which a summary stratigraphic column was presented. Channel-infilling, unfossiliferous, fluviatile clays and clayey sands, considered Mio-Pliocene in age, were recognized as the oldest unit, which was succeeded by remnants of phosphatic beds with abundant shell moulds, considered Pliocene in age.

In contrast to the earlier suggestions of a Mio-Pliocene age for the higher elevation coastal-plain deposits (Wagner & Merensky, 1928; Haughton, 1932), Carrington & Kensley (1969) considered the bulk of the succession to be of Pleistocene age. They identified “transgression complexes” at 75-90, 45-50, 17-21, 7-8, ~5 and ~2 m asl. and a 29-34 m Beach. Importantly, they found that the bivalve *Donax rogersi* Haughton, 1926, actually subsumed two species; the thick-shelled, robust *D. rogersi* “proper” and a thin-shelled, generally smaller species (thought by Haughton to be juveniles), which they named *Donax haughtoni*. The latter species occurred only in the fine-grained, usually laminated, sands of the “45-50 m complex,” whilst *D. rogersi* occurred only in the coarse, usually cross-bedded, sediments of the younger “17-21 m complex”. This finding constituted a major advance in the biostratigraphic subdivision of the older coastal-plain marine deposits. Additionally, species obtained from the “45-50 m complex” suggested a fauna of warm-water affinity.

Further notes on the deposits of central Namaqualand were provided by Davies (1973) and by Tankard (1975a, 1975b). Tankard (1975a) differed from Carrington & Kensley (1969) in regarding the phosphatic beds in the Hondeklip area as older than the “channel clays”. However, Carrington & Kensley (1969) were correct and the “channel clays” are older than the phosphatic beds. Tankard provided some information on the phosphatic beds that infill hollows in the bedrock and which had come to be known as “E stage,” from Haughton‘s oldest biostratigraphic unit, ”E Zone”. Tankard (1975a, 1975b) proposed correlations of lower, middle and upper “E stage” sub-units with the succession in the Varswater Quarry near Langebaanweg. Kent & Davies (1980) informally named the coastal-plain deposits between the Olifants River and Kleinzee the “Hondeklipbaai sandy gravels”.

Pether (1986) provided a summary of the main findings of his research on the succession at Hondeklipbaai, including suggested correlations farther afield. More intensive faunal sampling carried out during this study led to considerable additions to the marine molluscan fauna of Namaqualand coastal deposits (Kensley & Pether, 1986). The first extinct Tertiary barnacle recorded from South Africa was described from Hondeklip by Pether (1990). Brunton & Hiller (1990) have described the fossil brachiopods collected by the writer in the Hondeklip study area. Pether (1994b) provided detail on the exposures and palaeontology at Hondeklipbaai.

- ### 5.5 BUFFELS RIVIER DEPOSITS (BUFFELS INLAND COMPLEX)

Published information on the exploited Buffels river terraces and deposits, and other prospects on Namaqualand river terraces (e.g. Spoeg, Groen), is minimal.

Keyser (1976) reported that the diamondiferous terrace gravels of Namaqualand river valleys are lithologically distinct and appear to occupy a single terrace within the terrace sequence preserved. The basal layer is the main diamondiferous horizon, is best developed in channels incised into the main level of the terrace, and is a poorly-sorted, massive gravel with clasts of decomposed bedrock (Keyser, 1976). These "white quartz" gravels are patchily preserved in the rivers south of the Buffels River. Overlying sediments are "clean-washed to clayey (kaolinitic), reasonably sorted, and sometimes cross-bedded sands incorporating thin, disjunct, lensiform, very well-rounded ("golfball") and well-sorted quartz and quartzitic pebble gravels".

Molyneux (in Rogers et al., 1990) similarly describes the deposits as consisting of a basal, indurated, oligomictic gravel of sub-angular to sub-rounded vein-quartz clasts. This is only preserved in deeper bedrock depressions; in most instances only remnants are preserved due to reworking.

The basal, poorly sorted, vein-quartz gravels in the terrace depressions may be equivalent to the coastal kaolinized fluvial deposits, or may represent their reworking. Evidence of *in situ* kaolinization or the presence of silcrete clasts might resolve these alternatives. The overlying fluvial terrace deposits with "clean-washed" sands and lenses of very well-rounded, "golfball" gravels are difficult to reconcile with the kaolinitized, angular, basal fluvial conglomerates at the coast and are probably younger. The interpretation of Keyser (1976) is that the "white quartz" terrace gravels have been derived from the kaolinized terrain *i.e.* post-date the regional kaolinization.

Considerable thicknesses of sands and silts overlie the lower gravels, with features such as buried pedogenic profiles, erosion surfaces and channels. Variations in these aspects of this overburden at different localities along the Buffels Rivier suggests deposits of varying ages occur. As is apparently the case with the lower Orange River, the local Namaqualand rivers can be expected to have undergone aggradation within their valleys during transgressions in the mid-Miocene and Pliocene. However, more localized, West Coast palaeoclimates very likely overprinted or partly modified deposits relating to the broader-scale base-level controls, such as the later Miocene and Pliocene record of progressive aridification, likely interspersed with wet or pluvial phases. This makes direct analogies between the lower Orange River record and the Buffels River incautious, especially if detailed fieldwork and some age control is lacking.

The local occurrence of kaolinitic, oligomictic, quartz gravels and kaolinitic weathering profiles on the flanks of the present-day, “oversize” rivers in Namaqualand suggests that later Miocene to Recent fluvial history of the Namaqualand coastal plain involved only modification of the preceding, early to middle Tertiary drainage patterns on the African surface. The progressive aridification since the middle Miocene concentrated drainage modification along fewer channels, resulting in the preservation of ancient palaeochannels in the intervening areas. Many of these evidently still retain Oligocene/early Miocene kaolinized deposits. Some other channels continued as active drainages for longer, with upper fills of later Miocene sands and clays, before finally being covered. In the remaining, present-day drainages, patches of silicified sandstones occur that are evidently remnants of these deposits, both fluvial and aeolian in origin.

• 6.0 PALAEONTOLOGICAL STATUS AND CONCERNS

Palaeontological endeavours in the De Beers Namaqualand exposures will contribute to addressing the following concerns regarding the scope of sampling of fossil shells and bones in existing scientific collections and the contingent scientific questions. The status w.r.t. botanical fossils is covered under the “Earlier Tertiary Fluvial Deposits” sections.

• 6.1 INVERTEBRATES

Despite there being a considerable sample of fossil molluscs, brachiopods and barnacles from Namaqualand in the South African Museum collections, it is by no means a thorough collection. The bulk of the collecting has been quite localized, *viz*. from the excavations made at the Transhex mine on the properties Hondeklip and Avontuur (*e.g*. Image 1). The collection is also restricted palaeoenvironmentally *viz*. mainly from shallow-water shoreface facies. These shortcomings are illustrated by the fact that several taxa found by Carrington & Kensley (1969) have not been found again. These are of uncertain location and stratigraphic provenance. By further example, while briefly “passing through” an exposure of lower-shoreface facies of the 50 m Package on Swartlintjies (Feb., 2006), previously unrecorded taxa were readily seen by the writer.

Previous fossil shell sampling undertaken under the auspices of the SA Museum in De Beers excavations has been limited to the occurrences of the more rare facies very locally preserved in bedrock depressions, *viz*. the “E Stage” or “E Zone” deposits. The “E Stage” appellation stems from the perceived correlation with the oldest of Haughton’s (1931) biostratigraphic units, “E-Zone”, now shown to be problematic (Pether, 1994b). These “E Stage” facies were not well-developed in the Hondeklip mine.

It is now appreciated that the “E-Stage” involved different stratigraphic entities, but broadly similar deeper-water facies (inner shelf), of the 90 and 50 m packages, and possibly also the 30 m Package.. The faunas are different because they are from the deeper-water environment. They are also confusing because of the large extent of reworking. These deeper facies are preferentially preserved in the bedrock depressions and this was repeated during each sea-level cycle, with mixing of shelf faunas of differing ages. The shells are poorly preserved due to persistent residence in groundwater pooled in the bedrock depressions.

In the Koingnaas Complex, thin remnants of 90 m Package deposits bearing fossil shells have been preserved in bedrock depressions associated with exhumed palaeochannels at a number of localities. The main area where encountered in the past is within the area of exhumed, confluent palaeochannels that occurs north and south of the boundary between Hondeklip and Langklip (Map 1, general area of Waypoint 50). Here the deeper-water shelf deposits are interbedded, yellow, sandy muds and green clays in patches beneath lower shoreface sands of the 50 m Package. The very fragile shell content has not yet been studied in detail, due to the requirement of painstaking preparation.

Existing scientific samples in the S.A. Museum are “lumps” from the “Isognomon Bed” on Hondeklip (Figure 4) and one small bulk sample of shelf-facies fauna from De Beers exposures, *viz*. from KN_1. Some specimens were collected on Swartlintjies SL 20 and “blocks” of this facies, collected by the writer from LKN_10-02, are in the De Beers Marine sample collections and intended for transfer to the S.A. Museum.

More samples are highly desirable to facilitate the unravelling of these interesting faunas (and stratigraphy).

Due to the poor preservation of shell in most of the decalcified 30 m Package, the total faunal sample from this formation is relatively small. Certainly efforts to increase the overall fossil sample size from wider afield in the 30 m Package are worthwhile.

In the Quaternary beaches, one extinct slipper limpet is known from LIG deposits, but its range further back in the Quaternary is not established. Although the fossil shells in these youngest deposits are mainly modern species living today (extant species), unexpected taxa sometimes occur. Mostly these are warm-water, subtropical West African taxa that lived in LIG embayments. These are recorded from deposits of the western and southern Cape, from St. Helena Bay around to the Port Elizabeth area. However, the Quaternary beaches north of St. Helena Bay are very poorly sampled.

Further collection of samples for microfossils is desirable. The microfossil record has been sampled at few localities and the results w.r.t. age diagnosis are controversial, at least partly due to the fact that most taxa are benthic and conservative and not well correlated with the oceanic (planktonic) biochronostratigraphy. This again emphasizes a need to focus on the deeper-water facies, wherein planktonics are most likely to occur.

• 6.2 VERTEBRATES

The sample of identifiable fossil bones and teeth from coastal Namaqualand is small (see tables in Pickford & Senut, 1997) and currently is just sufficient to provide age constraints that support correlations with gross sea-level/ice-volume history (Section 2, Figures 1 & 2). Nevertheless, study of the Hondeklip exposures have demonstrated that there are more bone/teeth fossils in the deposits than is generally perceived, as has been revealed by dedicated searching. These occur in the following contexts:

- **Basal, petrified, mixed assemblage:** petrified (phosphatized), variously abraded, <u>reworked</u> fossils found the basal gravels and that predate the enclosing marine deposits. Includes both terrestrial and marine vertebrates. See Images 2 & 3.
- **The marine assemblage:** cetacean, seabird and seal fossils contemporaneous with the enclosing marine deposits. Input of terrestrial bones is associated with local back-barrier environments (lagoons, tidal channel lags). See Images 4 & 5.
- **The capping, terrestrial assemblage:** Bones of land animals on the extensive palaeosurface erosively formed on the marine deposits and within the overlying terrestrial deposits. See Images 6 to 8.
- **Overlying aeolianites and sheetwash:** Rare bones occur on palaeosurfaces within these sequences.

Currently, vertebrate fossils have not been found within or closely associated with the following formations and therefore age constraints of the desired accuracy are lacking for:

- The Earlier Tertiary Fluvial Deposits. This includes both the lower, kaolinized deposits and the younger fluvial deposits locally in “reoccupied” palaeochannel complexes such as the “Megalodon”.
- The Buffels River Deposits (BIC).
- The 30 m Package.
- The 8-12 m Package.

- # 7. FIELD VISIT OBSERVATIONS

- ## 7.1 EARLIER TERTIARY FLUVIAL DEPOSITS

- **KC, Map 1, Mitchell's Bay, Waypoint 51, LK_LK_22 exposures**

This formation, the "Channel Clay", is classically preserved in a narrow, coast-parallel, bedrock palaeochannel debouching into Rooiwalbaai. It has been mined away, remaining outcrop being the "seawall" at the south end of the pit (Image 9).

These deposits, as seen elsewhere along the coast, are known for their organic content of carbonaceous sediments and lignitic/peaty beds with both plant microfossils (pollen) and "charcoal" macrofossils and plant impressions. More specifically, this exposure is the most pervasively organic-rich and fossiliferous w.r.t. macroscopic plant material that the writer has seen. The preservation is likely due to oxygen-poor groundwater ponding at this location. In less favourable locations the organic matter is largely lost.

Very disturbed material is accessible along the western side of the palaeochannel exposure. Large pieces of fossil wood are readily found (Image10). Friable, carbonized, smaller plant fragments occur abundantly as local masses or more distributed in the clayey sands.

- **BMC, Map 3. Kareedoornvlei, Waypoint 137, KVS_E16 area**

An exposure of this formation in the context of the "Megalodon Palaeochannel Complex". Here the formation has been eroded into and overlain in the west by the mid-Miocene 90 m Package. In contrast to the Mitchell's Bay exposure, here this formation is dry and oxidized. Considerably complexity is seen in sedimentary structures and local deformations.

Patches and stringers of black organic matter are readily seen (Image 11). Closer examination shows the occurrence of plant material with enigmatic vermicular structure (Image 12).

Most importantly, silicified nodules were readily noticed and these appear to be petrified fossil bone (Images 13 & 14). To the writer's knowledge, no bone fossils have ever been recovered from this formation before.

- **Discussion**

  - The formation remains poorly described and understood, in spite of its supreme economic importance as the local palaeoplacer source of diamonds in younger deposits. Any detailed work that has been done is not in the scientific literature, but presumably exists in DBNM archives.
  - The age of the deposits has been controversial (Section 2.2). Traditionally, the deposits were long regarded as late Cretaceous, but several microfossil pollen studies have rendered this untenable. Nevertheless, the fossil pollen work is not unproblematic. The deposits are of international scientific importance w.r.t. the evolution/biostratigraphy of plants in Africa.
  - There are few natural exposures of this formation available. Known natural exposures are at Rooiwalbaai where it is cliffed (*i.e.* the other side of the "seawall") and in the seacliffs at Geelwal Karoo just north of the Olifants River. These weathered/oxidized exposures are unfossiliferous. Some other exposures occur in Namaqualand drainages, but are surficial outcrops, lacking vertical section.
  - No Type Sections have been erected in Namaqualand.
  - Importantly, the Mitchell's Bay exposure is incomparably fossiliferous w.r.t. plant macrofossils. This provides an opportunity for comparison of these different, separate fossil records of micro and macrofossils from the same deposit. The preservation of the fossil wood is remarkable for deposits of this age! A chunk of wood from the "Channel Clay" 6869 exposures remained unstudied until a drive to obtain more data on these deposits prompted its despatch to a fossil wood anatomist for study. It has been identified as mahogany (Meliaceae) and not yellowwood as would have been expected from the pollen data. The wood is similar to the extant tropical African mahogany that grows in dense, wet, tropical forest, but it is an extinct new species. A comprehensive collection of the fossil wood would be scientifically invaluable.
  - The finding of probable petrified bone material *in situ* in the KVS_E16 area is unprecedented. The Palaeogene land-vertebrate record is poorly preserved in southern Africa. The writer has previously seen extremely rare pebbles of grey, silicified bone in marine gravels and wondered if these were perhaps derived from this formation. The recovery of fossil bone from this formation holds the promise of age constraints independent of the pollen chronology.

- **Recommendations**
  - A large sample of wood and other macro plant debris from the LK_LK_22 exposure must be collected. The more friable plant-fragment material is degrading and oxidizing with exposure. Sampling should take place in the near future.
  - All exposures of the “Channel Clays” and “Megalodon” palaeochannel fills must be scanned for bone and plant fossils, as well as sedimentary features of palaeoenvironmental utility.
  - Sections must be described where material is sampled. Additional observations of sedimentary features should be made where these inform about the origin of the deposits.
  - The LK_LK_22 exposures should be considered as a geohistorical heritage site and type-section locality.
  - An exposure like that in the KVS_E16 area should be considered as a geohistorical heritage site and type-section locality.
  - As mentioned in Section 2.2, these ancient palaeochannels may sequester deposits of differing ages. The previous palynological and wood-anatomy work and sampling status of the “Channel Clays” and “Megalodon” palaeochannel fills needs compilation and review (unpub. reports to DBNM).

7.2 THE 90 M PACKAGE

- **BMC, Map 3, Dreyers Pan, Waypoint 134, DL92F area**

Upper Middle Terrace, 65 m Cliff area. Residual basal marine gravel overlying weathered bedrock with microrelief. The thick overburden section is decalcified and pedogenically reddened (Image 15). Most of overlying section is of terrestrial origin, with features such as isolated, angular clasts and “stone lines” marking the more obvious palaeosurfaces. Smoothed, “re-absorbed”, pedogenetically-cemented burrows prominent in lowermost section. It is possible that marine deposits are preserved in the lowermost section, but recognition of such and its upper contact requires careful scrutiny.

- **BMC, Map 3, Dreyers Pan, Waypoint 135, DP_114 area**

Upper Terrace at foot of Wolfberg, 80-90 m asl. Section evidently as previous (Image 16).

- **BMC, Map 3, Dreyers Pan, Waypoint 136, DP_133Q area**

A limited exposure of terrestrial deposits with two distinct units (Image 17). In a bedrock gully feature incised in the 95 m cliff, edge of Upper Terrace.

- **BMC, Map 3, Kareedoornvlei, Waypoint 137, KVS_D16 area**

Upper Terrace. Of note is the contact between the edge of the “Megalodon” palaeochannel sediments and the oldest marine formation, the 90 m Package.

- **BMC, Map 3, Kleinzee, Waypoint 140, AK_52T area**

Upper Terrace ~90 m asl.. Thin deposits overlying kaolinized bedrock (Image 18). Much exhumed silcrete in evidence. Likely only residual marine gravels under reworked marine sands. Possibly also residual “Channel Clay” basal conglomerates present here and at AK_34V ~2 km farther south.

- **KC, Map 2, Koingnaas N boundary, Waypoint 56, KN_KLNA_15 area**

In contrast to the preceding, high-elevation exposures, this instance of the 90 m Package occurs close to the sea near Visbeenbaai. The deposits are shelly and pebbly marine calcarenites preserved beneath the 30 m Package in a bedrock depression (Image 19). They are recognized as older, Miocene deposits solely on the basis of the enclosed shells that are quite distinct from the Pliocene faunas.

- **Discussion**
  - Deposits of the mid-Miocene 90 m Package, where they “classically” occur on the higher bedrock terraces of the BMC, are extensively decalcified and thus largely unfossiliferous. However, fossil shells have occasionally been found, usually those of thick-shelled species such as *Isognomon* and oysters. The writer’s impression is that these fossils are sporadically preserved in the basal gravels, in crevices and small gullies, and seldom occur in the main bulk of the overlying reddened sands.
  - Vertebrate fossils also occur mainly in the basal gravels and these are mainly undiagnostic petrified bone pebbles, but fossil teeth occur. The latter are mostly fish teeth, but occasionally the teeth of terrestrial

animals are found by diligent searching of gravel concentrates and "small" oversize, such as by Wessels, Pickford and Senut (1997) at Ryskop, where a small assemblage now supports the Miocene age of the 90 m Package. In the BMC, the occurrence of fossils mainly in the gravel ore has meant that very few have ever been saved, as a result of diamond security concerns w.r.t. access to gravels and concentrates. Perhaps some 90 m Package fossil material resides in the Kleinzee geological collection?

- The "new" exposure of 90 m Package shelly sands on Koingnaas (Waypoint 56) is different from these previous occurrences. It is a shallower facies, of shoreface palaeodepth, and thus samples littoral taxa that are rare or absent in the shelf facies. Furthermore, its fossil content has stratigraphic "integrity" in that it was apparently cemented prior to the Pliocene transgressions.
- In 1985, the late Brian Kensley and the writer sampled some "anomalous" species from 30 m Package lower shoreface sands exposed in an excavation then known as "KL, south face". These were described and listed as from the 30 m Package (Kensley & Pether, 1986), but hitherto have remained unique finds not found again. It is now apparent that these taxa were reworked from these Miocene deposits nearby.
- There are reported stratigraphic aspects of the deposits overlying the Kleinzee Middle Terrace (Section 5.3, Table 1) that have not been independently verified and for which biostratigraphic evidence is lacking. The implication of De Beers observations is that there is a "65 m Package" on the Kleinzee Upper Middle Terrace that is not recognized in the south in the "Koingnaas Complex". Notwithstanding, the writer's observations at ~65 m asl. on Sandkop, just to the south of Kleinzee, indicate a deeper-water shoreface deposit of 15-20 m palaeodepth (Image 20). This would be consistent with the older deposits on the Kleinzee Upper Middle Terrace actually being the 90 m Package.

- **Recommendations**

- It is proposed that the existing exposures of the 90 m Package in the BMC must be scanned for rare fossils.
- This task should include the overlying terrestrial sequence, wherein scattered vertebrate material on major contacts (palaeosurfaces) is more common than generally held.
- Consideration should be given to the preservation of type section localities/geohistorical sites where the BMC 90 m Package is of typical aspect. Aspects could include the 95 m cliff, the contact between the edge of the "Megalodon" palaeochannel sediments and the 90 m Package, silcrete boulder conglomerates and the black, heavy-mineral beach zones (e.g. Image 21).
- The unique shell fossils occurrence in the Koingnaas KN_KLNA_15 area must be thoroughly sampled.
- An exposure like that in the KN_KLNA_15 area should be considered as a geohistorical heritage site and type-section locality.
- Additional observations of sedimentary features should be made where these inform about the origin of the deposits (*e.g.* Image 20). Important observations include the sedimentary architecture in relation to the 65 m Cliff.

7.3 THE 50 M PACKAGE

BMC, Map 3, Kleinzee/Dreyers Pan boundary, Waypoints 131 &132, AK75_LM area

The eastern part of the trench exposes the 50 m Package (Image 22). It is decalcified, but pervasive crossbedding indicates upper shoreface palaeodepths (Image 23). A pedogenic profile/duripan is developed in the upper part of the section. The 30 m Package also occurs in this exposure - see below.

BMC, Map 3, Kleinzee, Waypoint 133, AK70_MN area

The surface here is ~57 m asl. and a much thicker section is present. The faces could not be inspected in detail, but it is likely that only the lowermost portion is *in situ* 50 m Package, the remainder above the more pale unit being terrestrial in origin (Image 24).

BMC, Map 3, Kareedoornvlei, Waypoint 139, KV_174_KL area

At ~40 m asl., this site was visited to view the large midden deposit present there. A small exposure nearby shows only terrestrial deposits (Image 25) and evidently only residual 50 m Package deposits remain at depth. A prominent, white, cemented unit occurs and is in a state of "retrograde" dissolution. It is possibly a pan carbonate. Overlying this are deposits wherein ESA tools and bone material occurs on palaeosurfaces.

- **KC, Map 1, Langklip, Waypoint 52, LKC_2B area**

- **KC, Map 1, Zwartlintjies Rivier, Waypoint 54, SL_20_09 area**

At both these localities, deeper-water deposits were observed in February, 2006 (*e.g*. Image 26). Shells are more common in the exposure at Waypoint 54 and included species not previously sampled. Also at this locality the 50 m Package section appears to be more complete, as opposed to the usual situation where several metres are missing due to erosion, and unusually it is overlain by pale aeolianite (Image 27) rather than reddened sheetwash and sandsheets. These and other "additional" sites, not seen during the Feb. 2008 field visit, are flagged by an ampersand (&).

- **KC, Map 2, NW Koingnaas and SW Somnaas**

As above, with extended sections of the deeper-water 50 m Package in the area.

- **Discussion**
  - As it happened, not many 50 m Package exposures were inspected during the field visit. However, this formation, known also as the FGS or Fine Green Sands, has been extensively exposed during mining of its basal gravels in the past. It has mainly been described from exposures in the Hondeklipbaai Transhex mine where most palaeontological sampling has taken place.
  - Notwithstanding, other aspects of this formation and its fossils have been seen in past years during fleeting visits to De Beers exposures of the "Koingnaas Complex". Particularly important has been the occurrence of more extensive, deeper-water facies, both as extended/distal lower shoreface facies and as shelf deposits, that were deposited in the areas of accommodation provided by exhumed palaeochannels. As mentioned (Section 6.1), a main complication is the reworking of the Miocene fauna into the similar muddy shelf deposits of the 50 m Package that are also just locally preserved in the same locales.
  - In the BMC it appears that 50 m Package deposits are largely decalcified, but fossil shells or shell moulds probably occur sporadically. As mentioned above, there are stratigraphic aspects of the deposits overlying the Kleinzee Middle Terrace (Section 5.3, Table 1) that require further investigation. For instance, the Lower Middle Terrace must be overlain by the 50 m Package, but the contact zone with the deposits on the Upper Middle Terrace is not described in the available literature.
  - The reported transgression overlapping the seaward edge of the Lower Kleinzee Middle Terrace is evidently the 30 m Package, but this also needs verification. This transgressive maximum is largely eroded away by deflation in the KC, but its geometry is presumably preserved in the BMC.

- **Recommendations**
  - It is proposed that the existing exposures of the 50 m Package in the BMC must be scanned for rare fossils.
  - Additional observations of sedimentary features and geometry should be made where these inform about the origin of the deposits.
  - Consideration should be given to the preservation of type section localities/geohistorical sites where the 50 m Package is of typical aspect. Important exposures include the transgressive maximum of the 50 mm Package, overlapping older deposits on the Upper Middle Terrace.
  - Sampling of the fossil content of deeper 50 m Package lower-shoreface facies, that were deposited after underlying 90 m P shelf facies were "sealed", is important for the unravelling of the basal, condensed and mixed shelf faunas.
  - The fossil search should include the overlying terrestrial sequence, wherein scattered vertebrate material occurs on major contacts (palaeosurfaces), e.g. Waypoint 139.

- ### 7.4 THE 30 M PACKAGE

- **BMC, Map 3, Kleinzee/Dreyers Pan boundary, Waypoints 131 &132, AK75_LM area**

The 50 m Package deposits mentioned above are eroded to the immediate west and overlying the gently seaward-dipping contact are pebbly deposits of the 30 m Package (Image 28). Notably, the pedogenic profile developed in the upper part of the 50 m Package is truncated by the 30 m Package lower contact. The elevation of the surface here is estimated from the 1:50000 map at ~35 m asl.

- **BMC, Map 3, Kleinzee, Waypoint 127, AK_45H area**

- **BMC, Map 3, Kleinzee, Waypoint 128, AK_45B area**
- **BMC, Map 3, Kleinzee, Waypoint 130, AK_61H area**

These are three shallow trench exposures of cobbly material, at quite low elevations (10-15 m asl.?), decalcified and with a well-developed pedogenic (calcrete?) capping (*e.g*. Image 29). Would appear to be 30 m Package deposits. The original thickness has evidently been reduced by substantial deflation.

- **KC, Map 2, Somnaas, Waypoint 55, SN_SN_23 area**

An interesting exposure of the 30 m Package where unusually it overlies a terrestrial, colluvial deposit instead of the marine 50 m Package (Image 30).

- **KC, Map 2, Koingnaas, Waypoint 124, KN_7 area**
- **KC, Map 2, Koingnaas, Waypoint 125, KN_R8 area**

Exposures of decalcified 30 m Package (Image 31), with upper shoreface at section top and thin calcrete capping.

- **KC, Map 2, area at seaward end of Koingnaas 6869 orebody**

Extensive exposures of decalcified 30 m Package, effectively a cliff *cf.* at Rooiwalbaai. However, no clear exposures of onlapping Quaternary beaches were seen.

- **KC, Map 1, Hondeklip/Langklip boundary, LK_N6 area**

Lower shoreface of the , with transgressive contact and overlying 30 m P deposits. See Figure 4 for the graphic section of these exposures. A similar exposure is at Waypoint 50 (Image 32). Further seawards, the thickness of 50 m Package lower-shoreface sands diminishes and the 30 m Package lower-shoreface facies is increasingly developed (*e.g*. Image 33).

- **KC, Map 1, Langklip, Waypoint 141, north from LK_LK_08 area**

North of Waypoint 141 are partial exposures of decalcified 30 m Package shoreface sediments. Clear examples of onlapping Quaternary "raised beaches" were not seen in the vicinity of 141.

- **Discussion**
  - Exposures at Waypoints 131 and 132 show the transgressive maximum of the 30 m Package. This important stratigraphic feature is not often seen. It is consistent with the feature called the "29-34 m Beach" by Carrington & Kensley (1969). Likewise to the 50 m P in the Hondeklip area, the actual transgression maximum (or thinnest inland edge) of the 30 m Package was eroded away. Instead, the transgression maximum had to be estimated at about 33 m asl. by projecting the transgressive contact farther inland and assuming a thickness for the missing foreshore deposits.
  - In the past, admittedly in the earlier stages of the work at Hondeklip, a criticism had been levelled that "an exposure showing a pedogenic profile developed in the 50 m P and subsequently eroded by the 30 m P is not present", this casting doubt on these formations being related to discrete, separate sea-level cycles. This exposure confirms that this relationship exists.
  - On the same topic, the exposure of the 30 m P at Waypoint 55 might well be rare evidence for considerable erosion of the 50 m P during the intervening regression. However, the possibility that the colluvium predates the 50 m P cannot be excluded.
  - Exposures at Waypoints 127, 128 and 130 need a more thorough inspection to look for fossil content (oysters, *D. rogersi*), diagnostic sedimentary structures and confirmatory evidence of deflation on top (wind polishing, etching of clasts).
- **Recommendations**
  - Although the 30 m Package is largely decalcified, occasional lenses with shells are found. It is proposed that the existing exposures of the 30 m Package in the BMC and KC must be scanned for rare fossils. Thicker 30 m P sections with lower-shoreface facies, developed in areas of relatively lower bedrock, should especially be targeted.
  - The fossil search should include the overlying terrestrial sequence, wherein scattered vertebrate material occurs on major contacts (palaeosurfaces) *e.g*. Figure 4.

- Additional observations of sedimentary features and geometry should be made where these inform about the origin of the deposits., for example the waypoints 131/132 exposure where preservation of a type section locality/geohistorical site is recommended.

- ### 7.5 The Quaternary Packages

- **KC, Map 1, Langklip, Waypoint 142, LKC5-2 area**

In the east, relatively thin upper-shoreface exposures of the decalcified 30 m Package are seen. These appear to be overlain seaward by pale, boulder-bearing deposits of the Quaternary beaches (Images 34 and 35). The south faces are obscured, limiting scope for laterally-continuous observations.

Potentially a very informative exposure, but requires “cleanup” to provide some clearer vertical sections.

- **KC, Map 1, Langklip, Waypoint 126, LKC_R1B area**

A lateral section exposed by mining of the Quaternary “RETs”. Under ~1.6 m of grey, aeolian sand, a thick unit of pale, calcareous, marine sand with a capping, karstic pedogenic profile is ostensibly the LIG highstand (Image 36). Towards the east, its boulder-bearing lower contact is exposed and is formed on reddened, pebbly sands with pedogenic features and a basal boulder-cobble gravel on bedrock, probably 30 m P deposits. The exposure does not extend sufficiently far inland to reveal a pre-LIG highstand.

- **KC, Map 2, Koingnaas, Waypoint 122, KN_15A area**

Appears to be early? Quaternary beach deposits cresting out on the underlying 30 m Package (Image 37).

- **BMC, Map 3, Kleinzee, Waypoint 129, AK_61A area**

A basal boulder and cobble unit and pebbly sands are exposed in a slit trench within an old prospecting trench (Image 38). Shells of modern taxa suggest it is attributable to an earlier Quaternary transgression. Just nearby and farther east the exposure appears to be 30 m P deposits like those at 127 and 128 (Image 39). At the seaward end of the trench a thin, near-surface unit of cobbly gravel (LIG?) overlies pedogenically-reddened, decalcified sands, but closer examination is required to ascertain if it is “real” or not.

Potentially a very informative exposure, but requires “cleanup” to provide some clearer vertical sections.

- **BMC, Map 3, Tweepad, Waypoint 138, TP_240_J**

These trenches in the “RETs” are now incomplete exposures due to blown-in sand and collapse. An uppermost transgressive surface that extends inland is partially exposed (LIG?) in the northern trench (Image 40). It is underlain by pale, compact-cemented sands.

In a trench to the south of the previous exposure is a “shingle” unit of discoidal cobbles with a superimposed pedogenic profile, very likely the LIG beach (Image 41).

Again, potentially very informative exposures, but requiring “cleanup” to provide some clearer vertical sections and indications of lateral extents.

- **Discussion**

Section 2.7 refers. The significance of sampling and documentation of the Quaternary coastal deposits involves:

- History of global sea-level change and geodynamic crustal responses.
- Record of changes in local faunal communities/environments with time.
- Maximum ages of archaeologically-occupied surfaces.
- For future radiometric and chemical dating purposes (rates of coastal change).
- Preservation of fossils for future palaeo-oceanographic research *e.g.* stable isotope/palaeotemperature analysis etc.
- Preservation of fossils for the application of yet unforeseen investigative techniques.

- **Recommendations**

- Representative collections should be made from the Quaternary deposits, with documentation of their contexts.
- Photographic records and sketches made when the exposures were less covered would be useful.

- Rehabilitation of trenches directly next to the coast might be seen as mandatory by some. Poor exposures could be temporarily uncovered for study prior to rehabilitation. However, an entire section through the Quaternary should be preserved as a type locality/geohistorical site.

- ### 7.6 BUFFELS RIVIER DEPOSITS

- **BIC, Map 4, Nuttabooi, Waypoint 145**

- **BIC, Map 4, Mannels Vley, Waypoint 144**

- **BIC, Map 4, Dikgat, Waypoint 143**

- **Discussion**

  - These exposures exhibit the basic features mentioned in Section 5.5. At Nuttabooi, pale grey and white, compact to cemented deposits comprise the greater part of the exposures (Images 42 and 43) and it appears that these are more extensively preserved older deposits *cf.* those at Dikgat and Mannels Vley whicher appear to be mainly younger deposits. The lower, pale formation seems absent at Mannels Vley, or is disguised by weathering (Image 44). It is probable that the lowest gravels at Dikgat (Image 45) represent reworking of the older sequence. Prominent palaeosurfaces and channels are noticeable both within the older, pale, lower formation and the younger fluvial deposits.
  - To the writer's knowledge no fossil bones have ever been reported from the Buffels deposits and age constraints are thus lacking. However, it is possible that fossil material may have been noticed or collected in the past by DBNM personnel (*e.g*. fossil wood, plants?).

- **Recommendations**

  - These exposures should be diligently scanned for fossil material.
  - Existing descriptive documentation/projects should be reviewed beforehand, in order that the fossil search is informed by the prior observations of the deposits.
  - Existing descriptive documentation could compiled and considered for publication by their authors and De Beers, as little information on these deposits is available in the literature.
  - Consideration should be given to the preservation of type section localities/geohistorical sites where these fluvial sequences are of typical aspect and encompassing lateral variations.

8. RECOMMENDATIONS FOR MITIGATION

8.1 PRIMARY PALAEONTOLOGICAL MITIGATION - CURRENT EXPOSURES

It is advocated that all available mine pit faces be inspected for fossil content.

The extensive scale of the DBNM operation and exposures might appear to present special challenges for palaeontological mitigation. However, the main requirements are the time and requisite experience w.r.t. where to look more closely and where to scan briefly.

This process is to be prioritized in terms of the schedules for the filling the pits, including:

- Current pits that are being backfilled in the continued course of mining.
- Old pits that are being filled or due to be filled soon in terms of the rehabilitation program.

For the purposes of planning and costs containment, the contracted specialist must be informed on the scheduled excavation and filling planning and the progress being made *i.e*. would need to establish liaison protocols with a suitably-placed persons.

A prescribed data requirement is adequate 3D spatial referencing. For this the specialist would require the assistance of the surveyor w.r.t. co-ordinates and base maps, to plot the locations of finds during monitoring, the measured sections, samples and other observations.

In the process of the comprehensive pit inspection, particular exposures can be earmarked and rated w.r.t. their value as a type section/geohistorical site that should be maintained in an accessible and meaningful condition.

- Sections must be described where material is sampled. Additional observations of sedimentary features should be made where these inform about the origin of the deposits.
- This task should include the overlying terrestrial sequence, wherein scattered vertebrate material on major contacts (palaeosurfaces) is more common than generally held.

8.2 PRIORITY FOSSIL EXPOSURES

These exposures should not backfilled and the exposed fossils should be collected as soon as possible.

- The apparent silicified bone and macrofossil plant material exposed in the "Megalodon" palaeochannel at KVS_E16 (Waypoint 137).
- The fossil wood pieces and plant debris from the "Langklip Channel Clays" in the LK_LK_22 exposures (Waypoint 51).
- The unique 90 m Package fossil shells occurrence in the Koingnaas KN_KLNA_15 exposure (Waypoint 56).

8.3 CONTINGENT ARCHAEOLOGICAL MITIGATION

Buried Archaeological Material

In the process of scanning palaeosurfaces in the terrestrial sequences for fossil bones, further occurrences of ESA and MSA implements are certain to be found. The following procedure is proposed:

- If the occurrence is isolated, such as just one or two implements, these will be collected and the context in the section duly recorded, as for a fossil occurrence.
- If the occurrence comprises several implements and bone and/or shell material is associated, as in the case above, these will be left alone and the position and context will be recorded and the information relayed to the contracted archaeologist.

An Early Stone Age Site - Kareedoornvlei, Waypoint 139, KV_174_KL

The Early Stone Age site, found near the "Tortoise Midden" during the pilot fieldwork, should be examined by the UCT Archaeological Contracts Office. See comment in Section 7.3.

8.4 DUMPS AND DISCARDED OVERSIZE GRAVEL

Overburden dumps, particularly after deflation, have provided valuable fossils. Although provenance is no longer exact, they can be related to the relevant pit and also, in the case of shells, the accompanying shell assemblage provides biostratigraphic context. Because the shells are scattered over a large area, specimens of less common taxa are often revealed.

Discarded oversize gravel dumps have been the source of extremely valuable vertebrate teeth sourced from the basal petrified assemblage. Examples are massive teeth and bone parts from ancient, predatory "killer-whales and the teeth and bones of large land mammals such as the elephant-like gomphotheres, large bovids and the rhinos. The petrified teeth that support the mid-Miocene age of the 90 m P come from dumps of smaller oversize gravel wherein the fossil teeth found are in the 1-3 cm size range (*e.g*. the Ryskop specimens collected by Wessels and Pick & Senut, 1977).

In the process of backfilling from these dumps or regrading them it is possible that fossil material will be exposed.

8.5 LEGACY MATERIAL

Existing fossil collections of DBNM are a further resource. Another result emerging from heritage legislation compliance is the obligatory compilation of a detailed inventory of existing fossil samples and their state of diagnosis, together with where they currently are stored/displayed, at company sample archives, local museums and various research institutions.

The fossil plant samples from the Kareedoornvlei Cretaceous lake, the "Channel Clays", the "Megalodon" palaeochannels and probably the Buffels deposits are of particular importance. In this process, the status of previous palynological and wood-anatomy work on these deposits should be compiled and reviewed (unpub. reports to DBNM).

Existing descriptive documentation/projects should be reviewed where appropriate, in order that the fossil search and contexts of finds are informed by the prior observations of the deposits.

In the case of the Quaternary RETs, any photographic records and sketches made when existing exposures were less covered would be useful.

Proprietary information concerns should be addressed, such as non-disclosure agreements and limitations/permissions for access to reports.

Existing descriptive documentation could compiled and considered for publication by DBNM, with due acknowledgement to the original authors, as little information on the DBNM deposits is available in the literature.

9 GEOHISTORICAL HERITAGE SITES

There is considerable interest in the preservation of selected mine-pit exposures, both as:

- Type Sections for the formations of the Namaqualand coastal plain and the Buffels River.
- Geoheritage sites that will form the basis of geotourism routes on the Namaqualand coast.

A Type Section is an officially-designated reference locality, endorsed by the South African Commission for Stratigraphy (SACS), where a particular formation is exposed in its typical aspect. In the case of the otherwise-buried coastal plain formations, the preservation of Type Section pit exposures provides the opportunity to return for additional observations and sampling, for instance for the application of new diagnostic insights and analytical techniques.

It is predicted that there will be agreement and support from the geological community that Type Section sites be preserved among the DBNM exposures. If necessary, this could be endorsed in a more official way, such as by responses elicited from SACS, the Council for Geoscience and the members of the Geological Society of South Africa. The geological community is also increasingly engaging in geoheritage and geotourism.

The Namaqualand community has an interest in geoheritage and geotourism, as a potential sustainable, albeit minor, economic opportunity while the diamond-mining mainstay continues to decline into the future.

The West Coast Fossil Park at Langebaanweg is the geotourism precedent on the West Coast.

Although the preservation of selected mine-pit exposures may reduce the costs of rehabilitation, there will obviously be costs incurred in keeping pits open and accessible, in stabilization of the faces and in safety concerns.

The following are initial proposals for potential Type Sections and geoheritage sites:

- The "Channel Clays" and the overlying 30 m Package in the Langklip LK_LK_22 exposures (Waypoint 51).
- The "Megalodon" palaeochannel at KVS_E16 (Waypoint 137), including the contact between the edge of the "Megalodon" palaeochannel sediments and the 90 m Package.
- An exposure (unspecified, if one still exists?) of the BMC Upper Terrace and overlying 90 m Package where it is of typical aspect. Aspects could include the 95 m cliff, silcrete boulder conglomerates and the black, heavy-mineral beach zones.
- The 90 m Package remnant occurrence with unique shell fossils in the Koingnaas KN_KLNA_15 (Waypoint 56). Overlain by the 30 m Package.

- An exposure (unspecified, if one still exists?) of the BMC Middle Terrace where it is of typical aspect. Important aspects are the 65 m Cliff, the sedimentary architecture in relation to the 65 m Cliff and the transgressive maximum of the 50 mm Package overlying the lower Middle Terrace.
- An entire section through the Quaternary RETs
- A suitable exposure (unspecified) of the Buffels deposits at Nuttabooi.

Additional Type Sections/geoheritage sites should be designated amongst the exposures at Alexkor, but Alexkor is yet to begin compliance with the National Heritage Resources Act. The exposures at Buffelsbank also require evaluation.

10. ADDITIONAL ASPECTS OF GEOHISTORICAL NOTE

Although not within the direct brief of palaeontological mitigation, the following may be considered whilst on the topic of geoheritage.

10.1 EVIDENCE OF NEOTECTONIC ACTIVITY

On Langklip, in the vicinity of Waypoint 50, is a small scarp in the basement gneiss that is a fault (Image 46). Movement on this fault, now dubbed the Langklip Fault, displaces and thus post-dates the overlying Pliocene marine deposits. Some exposures seen previously exhibit extensive soft-sediment deformation features caused by shaking during earthquakes (Images 47 and 48). This evidence of neotectonics or geologically-recent (Quaternary) faulting is rare on the coastal plain. It is of considerable interest, for instance, in the site selection of nuclear power stations. The writer has been requested to propose such important exposures for preservation (C. de Beer, CGS).

Site	Lat (S)	Long (E)	Reason
Mining pit LKN-10-03	30˚ 21.336'	17˚ 18.843'	Location of Langklip fault
Exploration trench SLT-16	30˚ 16.190'	17˚ 18.433'	Strong ground motion faults
Mining pit KN/41A	30˚ 11.931'	17˚ 14.633'	Fluidisation pillar

10.2 PLACES OF INTEREST FOR THE HISTORY OF MINING

A good example is the early workings just to the south of Kleinzee. Additional sites could include “The Crater” and nearby exposures of silcrete cappings. Perhaps too, classic examples of deeply-gullied bedrock. DBNM personnel and accounts of the mine’s history to be consulted.

Similarly, sites should be designated amongst the exposures at Alexkor.

10.3 NATURAL EXPOSURES

An example of which the writer is aware occurs at Waypoint 53 (Map 2) on the north bank of the Swartlintjies Rivier. Here is a low outcrop of silicified sandstone (not weathering-profile silcrete) that has features suggesting it is an aeolianite (Image 49). Other examples may occur. It is thought that these and other examples are remnants of more extensive deposits, both fluvial and aeolian in origin, that filled the extant drainages and their buried tributaries during the upper Miocene 15-5 Ma (Figure 1) and represent a largely-unknown period of geological history post-dating the 90 m Package.

In this category may also be features of the Precambrian bedrock stratigraphy that could be included in a geohistorical route itinerary. Suggestions to be sought from relevant researchers.

Here the issue is not preservation of pit exposures, but eventual facilitation of access for inclusion in a geotourism itinerary.

11. PALAEONTOLOGICAL MONITORING

It is suggested that a degree of monitoring be carried out during the making of excavations in the future.

In general, fossil bones are sparsely scattered in coastal deposits and much depends on spotting them as they are uncovered during stripping.

Fossil shelly layers, when preserved, are usually more extensive and normally are exposed in the sides of the finished excavation, when they can be documented and sampled easily e.g in some of the KC exposures. However, this does not seem to be the case in much of the 30 m P exposures and generally shells seem very sparse in the BMC.

In archaeologically-sensitive areas, monitoring by a qualified archaeologist of excavations as they are made might be a requirement stipulated by the provincial heritage authority. In such cases the archaeologist is likely to spot, investigate and report fossil material and separate monitoring by a palaeontolgist should not be necessary.

Most areas have relatively low potential for fossil bone material and it is expensive and impractical to have excavations constantly monitored by a professional during the construction phase. Notwithstanding, the sporadic fossil occurrences are then particularly important and efforts made to spot them are often rewarded.

In order to spot the rare occurrences, it is very desirable to have the co-operation of the people "on the ground". By these are meant personnel in supervisory/inspection roles, such as geologists, surveyors, pit bosses etc., who are willing and interested to look out for occurrences of fossils. These personnel are also critical in informing excavator operators and manual workmen, whom being close to the sediments, would be more likely to spot fossils. Successful and cost-effective monitoring depends a lot on this goodwill and co-operation of managers and on-site people. To aid this process, a general background information document is useful.

There should also be guidelines for potential finds and a reporting/action protocol in place when finds are uncovered.

Isolated finds that are turned up should be handed over to a designated person for safekeeping, noting as far as possible where they came from. Excavated material with a clump of bones included can be stockpiled temporarily for safekeeping, until the site visit by the palaeontologist.

If major bone finds are encountered, the contracted specialist should be immediately informed. A temporary pause in activity at the limited locale will be required. The strategy is to "rescue" the material as quickly as possible. The method would be to remove representative samples and "best" material in encased blocks. In the case of considerable occurrences of bones, the methods could include the removal of a large, disturbed sample by excavator and conveying this by truck from the immediate site to a suitable place for "stockpiling". This material could then be processed locally, by sieving and further preparation.

At this stage it is perhaps premature to propose monitoring strategies in any detail.

It is suggested that feasible strategies be discussed in the near future.

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12. REFERENCES

Brunton, C.H. C. and Hiller, N. 1990. Late Cainozoic brachiopods from the coast of Namaqualand, South Africa. *Palaeontology,* **33,** 313-342.

Carrington, A.J. and Kensley, B.F. 1969. Pleistocene molluscs from the Namaqualand coast. *Annals of the South African Museum,* 52, 189-223.

Davies, O. 1973. Pleistocene shorelines in the western Cape and South West Africa. *Annals of the Natal Museum,* **21** (3): 719-765.

De Villiers, J. and Söhnge, P.G. 1959. Geology of the Richtersveld. *Memoirs of the Geological Survey of South Africa,* **48**, 295 pp.

De Villiers, S.E. 1997. *The palynology of Tertiary sediments from a palaeochannel in Namaqualand.* (Ph.D. thesis unpubl.), Univ. Witwatersrand, Johannesburg, South Africa, 281 pp

Dingle, R.V., Siesser, W.G. and Newton, A.R. 1983. *Mesozoic and Tertiary Geology of Southern Africa*. Rotterdam: A.A. Balkema.

Forbes, V.S. and Rourke, J. 1980. *Paterson's Cape Travels, 1777 to 1779*. Johannesburg: The Brenthurst Press.

Gresse, P.G. 1988. Washover boulder fans and reworked phosphorite in the Alexander Bay Formation. *South African Journal of Geology,.* **91**, 391-398.

Hallam, C.D. 1964. The geology of the coastal diamond deposits of southern Africa (1959). In: Haughton, S.H. (ed.), *The Geology of some Ore Deposits in southern Africa*. Vol. **2**: 671-728. Johannesburg: Geological Society of South Africa.

Haq, B.U., Hardenbol, J. and Vail, P.R. 1988. Mesozoic and Cenozoic chronostratigraphy and cycles of sea-level change. In: *Sea-level Changes: an Integrated Approach*. Special Publication of the Society for Economic Paleontologists and Mineralogists, **42**, 71-108.

Haughton, S.H. 1926. On some new mollusca from Tertiary beds in the west of the Cape Province. *Transactions of the Royal Society of South Africa*, **13**, 159-162.

Haughton, S.H. 1928. Appendix: The palaeontology of the Namaqualand coastal deposits. *In:* Wagner, P.A. and Merensky, H. The diamond deposits on the coast of Little Namaqualand. *Transactions of the Geological Society of South Africa*, **31**, 1-41.

Haughton, S.H. 1932. The Late Tertiary and Recent deposits of the west coast of South Africa. *Transactions of the Geological Society of South Africa,* **34**: 19-58.

Hendey, Q.B. 1981a. Palaeoecology of the Late Tertiary fossil occurrences in "E" Quarry, Langebaanweg, South Africa, and a re-interpretation of their context. *Annals of the South African Museum,* **84**: 1-104.

Hendey, Q.B. 1981b. Geological succession at Langebaanweg, Cape Province, and global events of the Late Tertiary. *South Africaan Journal of Science,* **77**: 33-38.

Hendey, Q.B. 1983a. Cenozoic geology and palaeogeography of the Fynbos region. *In*: Deacon, H.J., Hendey, Q.B. and Lambrechts, J.J.N. (Eds.), *Fynbos palaeoecology: a preliminary synthesis*. S. Afr. Nat. Sci. Progrs. Rep.,**75**, 35-60.

Hendey, Q.B. 1983b. Palaeontology and palaeoecology of the Fynbos region: an introduction. *In*: Deacon, H.J., Hendey, Q.B. and Lambrechts, J.J.N. (Eds.), *Fynbos palaeoecology: a preliminary synthesis*. S. Afr. Nat. Sci. Progrs. Rep.,**75**, 87-99.

Hendey, Q.B. 1983c. Palaeoenvironmental implications of the Late Tertiary vertebrate fauna of the Fynbos region. *In*: Deacon, H.J., Hendey, Q.B. and Lambrechts, J.J.N. (Eds.), *Fynbos palaeoecology: a preliminary synthesis*. S. Afr. Nat. Sci. Progrs. Rep.,**75**, 100-115

Hendey, Q.B. 1984. Southern African late Tertiary vertebrates. In: Klein, R.G. (ed.), *Southern African Prehistory and Paleoenvironments*: 81-106. Rotterdam, A.A. Balkema.

Hendey, Q.B. and Cooke, H.B.S. 1985. Kolpochoerus paiceae (Mammmalia, Suidae) from Skurwerug, near Saldanha, South Africa, and its palaeoenvironmental implications. *Annals of the South African Museum,* **97:** 9-56.

Hodell, D.A. and Venz, K. 1992 . Toward a high-resolution stable isotopic record of the Southern Ocean during the Pliocene-Pleistocene (4.8 to 0.8 MA) . *Antarctic Research Series,* **56**: 265-310.

Kent, L.E. and Davies, O. 1980. Tertiary and Quaternary Periods. In: Kent, L.E. (comp.), Stratigraphy of South Africa. Part 1. Lithostratigraphy of the Republic of South Africa, South West Africa/Namibia and the

Republics of Bophuthatswana, Transkei and Venda. SACS. (South African Commitee for Stratigraphy), *Handbook of the Geological Survey of South Africa* **8**: 603-628.

Kensley, B. and Pether, J. 1986. Late Tertiary and Early Quaternary fossil Mollusca of the Hondeklip, area, Cape Province, South Africa. *Annals of the South African Museum,* **97** (6): 141-225.

Keyser, U. 1972. The occurrence of diamonds along the coast between the Orange River, estuary and the Port Nolloth Reserve. *Bulletin of the Geological Survey of South Africa,* **54**: 1-23.

Keyser, U. 1976. Namaqaland river deposits. In: Coetzee, C.B. (ed.), Mineral resources of the Republic of South Africa. *Handbook of the Geological Survey of South Africa* **7**: 25-27.

Krige, A.V. 1927. An examination of the Tertiary and Quaternary changes of sea-level in South Africa, with special stress on the evidence in favour of a Recent world-wide sinking of ocean-level. *Annals of the University of Stellenbosch*, **5**, (Sect. A, No. 1), 1-81.

Lear, C.H, Elderfield, H. and Wilson, P.A. 2000. Cenozoic Deep-Sea Temperatures and Global Ice Volumes from Mg/Ca in Benthic Foraminiferal Calcite. *Science* **287**: 269-272.

Marlow, J.R., Lange, C.B., Wefer, G., and Rosell-Melé, A. 2000. Upwelling intensification as part of the Pliocene-Pleistocene climate transition. *Science*, **290**: 2288-2291.

Muller, J. 1981. Fossil pollen records of extant angiosperms. *The Botanical Review* **47**:1-142.

Partridge, T.C. and Maud, R.R. 1987. Geomorphic evolution of South Africa since the Mezozoic. *South African Journal of Geology* **90**: 179-208.

Pether, J. 1983. The Lithostratigraphy of Hondeklip Bay: A Reconnaissance. *Unpublished B.Sc. Honours Project. University of Cape Town.*

Pether, J. 1986. Late Tertiary and Early Quaternary marine deposits of the Namaqualand coast, Cape Province: new perspectives. *South African Journal of Science* **82**: 464-470.

Pether, J. 1990. A new *Austromegabalanus* (Cirripedia, Balanidae) from the Pliocene of Namaqualand, Cape Province, South Africa. *Annals of the South African Museum,* **99**, 1-13.

Pether, J. 1994a. Molluscan evidence for enhanced deglacial advection of Agulhas water in the Benguela Current, off southwestern Africa. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 111, 99-117.

Pether, J. 1994b. *The sedimentology, palaeontology and stratigraphy of coastal-plain deposits at Hondeklip Bay, Namaqualand, South Africa.* M.Sc. thesis (unpubl.), Univ. Cape Town, South Africa, 313 pp.

Pether, J, Roberts, D.L. and Ward, J.D. 2000. Deposits of the West Coast (Chapter 3). In: Partridge, T.C. and Maud, R.R. eds. *The Cenozoic of Southern Africa*. Oxford Monographs on Geology and Geophysics No. 40. Oxford University Press.

Pickford, M. and Senut, B. 1997. Cainozoic mammals from coastal Namaqualand, South Africa. *Palaeontologia Africana*., 34, 199-217.

Raper, P.E. and Boucher M. (eds.) 1988. *Robert Jacob Gordon, Cape Travels, 1777 to 1786.* Vol.**2**. Johannesburg: The Brenthurst Press.

Rebesco, M., Camerlenghi, A., Geletti R. and Canals M. 2006. Margin architecture reveals the transition to the modern Antarctic ice sheet ca. 3 Ma. *Geology* **34**: 301-304.

Rebesco, M. and Camerlenghi, A. 2008. A Late Pliocene margin development and mega debris flow deposits on the Antarctic continental margins: Evidence of the onset of the modern Antarctic Ice Sheet? *Palaeogeography, Palaeoclimatology, Palaeoecology* **260**: 149-167.

Reuning, E. 1931. The Pomona-quartzite and oyster-horizon on the west coast north of the mouth of the Oliphants River, Cape Province. *Transactions of the Royal Society of South Africa* **19**: 205-214.

Roberts, D.L., Botha, G.A., Maud, R.R. and Pether, J. 2006. Coastal Cenozoic Deposits (Chapter 30). In: Johnson, M. R., Anhaeusser, C. R. and Thomas, R. J. (eds.), *The Geology of South Africa*. Geological Society of South Africa, Johannesburg/Council for Geoscience, Pretoria: 605-628.

Rogers, A.W. 1904. Geological survey of parts of the division of Piquetberg, Clanwilliam and Van Rhyn's Dorp. *Annual Report of the Geological Commission 1903*, Cape of Good Hope, Department of Agriculture: 141-167.

Rogers, A.W. 1905. *An Introduction to the Geology of the Cape Colony*. Longmans, Green and Co., London, 463 pp.

Rogers, J., Pether, J., Molyneux, R., Hill, R.S., Kilham, J.L.C., Cooper, G. and Corbett, I. 1990. Cenozoic geology and mineral deposits along the west coast of South Africa and the Sperrgebiet. *Guidebook Geocongress '90 Geological Society of South Africa*, **PR1**: 1-111.

Siddall, M., Chappell, J. and Potter, E.-K. 2007. Eustatic sea level during past interglacials. *The Climate of Past Interglacials: Developments in Quaternary Science* **7**: 75-92.

Siesser, W.G. 1978. Aridification of the Namib Desert: evidence from oceanic cores. In: Van Zinderen Bakker, E.M. (ed.), *Antarctic glacial history and world palaeoenvironments*. Rotterdam: Balkema: 105-113.

Siesser, W.G. and Dingle, R.V. 1981. Tertiary sea-level movements around southern Africa. *Journal of Geology* **89**: 83-96.

Tankard, A.J. 1966. The Namaqualand Coastal Deposits with special reference to the area between the Groen and Buffels rivers. *Unpublished B.Sc Project. University of Natal*.

Tankard, A.J. 1975a. The late Cenozoic History and Palaeoenvironments of the coastal margin of the south-western Cape Province. *Unpublished Ph.D. thesis. Rhodes University, Grahamstown*.

Tankard, A.J. 1975b. The marine Neogene Saldanha Formation. *Transactions of the Geological Society of South Africa*, **7**, 257-264.

Tankard, A.J. and Rogers, J. 1978. Late Cenozoic palaeoenvironments on the west coast of southern Africa. *Journal of Biogeography,* **5**, 319-337.

Visser, H.N. and Toerien, D.K. 1971. Die geologie van die gebied tussen Vredendal en Elandsbaai. *Explanation of sheets* **3118C** *(Doring Bay) and* **3218A** *(Lambert's Bay)*. Geological Survey of South Africa.

Wagner, P.A. and Merensky, H. 1928. The diamond deposits on the coast of Little Namaqualand. *Transactions of the Geological Society of South Africa*, **31**, 1-41.

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14 APPENDIX D: List of Figures

15 APPENDIX E: List of Tables