REPORT:

THE ARCHAEOLOGICAL AND PALAEONTOLOGICAL IMPORTANCE OF THE ALEXKOR DIAMOND MINING AREA NORTHERN CAPE PROVINCE

Prepared for

SITE PLAN CONSULTING
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EXECUTIVE SUMMARY

Archaeological impacts assessment undertaken in the rich diamond-mining regions on the Cape West coast of South Africa has shown that shore based mining operations impacts severely negatively on archaeological heritage sites. Mining operations over the last 80 odd years by Alexkor Limited, has unquestionably destroyed many sites in the Alexkor mining area.

Important vertebrate fossils (bone) and extinct marine molluscs have also been documented buried under many meters of overburden, in deep open cast mining operations and prospecting trenches. The reasons for the abundance of fossil palaeontological remains, is in part related to the highly calcareous character of the aeolianites (fossil dunes) and shallow marine sediments.

Alexkor Limited has recognised the threat that shore based mining operations have on non-renewable archaeological and palaeontological sites and a new Environmental Management Programme Report (EMPR) is currently being updated and revised by Site Plan Consulting, and will be implemented for all proposed future mining operations in the Alexkor concession area. The archaeological information that currently exists for the Alexkor mining area will form part of the new EMPR, which is a tool used to manage and assist the mining operations, and minimise any possible negative impacts.

The aim of this report is:

- To verify the presence of archaeological and palaeontological sites and historical graves, at specifically, Boegoesberg, The Cliffs, Rietfontein, Visagiepan and Muisvlakte;

- To identify `Red Flag' or archaeologically sensitive areas, for future planned mining operations in the Alexkor mining area;

- To develop an archaeological component of an environmental awareness programme for the inclusion into the overall environmental awareness to be compiled by Site Plan Consulting, and

- To develop and help implement operating procedures in terms of the National Heritage Resources Act for the reporting, identification, recording and safekeeping of material following an archaeological find by a staff member

It is important to note that the study **did not** entail a detailed and systematic survey of the Alexkor diamond mining area.

The archaeological investigation has shown that, despite the destruction and damage of archaeological and palaeontological heritage remains caused as a result of historical mining operations, there are still likely to be in tact and relatively well preserved sites in the Alexkor mining area.

It is also highly probable that important vertebrate fossils and marine molluscs will be exposed below the overburden in deeper excavations and prospecting trenches.

Given the known archaeological and palaeontological sensitivity of the study area, the following recommendations, to be included in the EMPR are made.

- Proposed future shore-based diamond mining operations must be subject to a Phase 1 Archaeological and Palaeontological Impact Assessment, in terms of Section 37 of the National Heritage Resources Act (No. 25 of 1999).

  This must entail:

  a) A detailed archaeological survey of each of the proposed mining blocks, prior to any prospecting and earthmoving operations. Archaeological surveys must be planned well in advance of earthmoving operations taking place, in case mitigation programmes are required.

  b) All deep excavations such as trenching and prospecting must be inspected by a professional palaeontologist.

  c) An archaeological and palaeontological awareness programme must be implemented prior to any earthmoving operations taking place on the site. This is in order to sensitise contractors and plant operators to the archaeological and palaeontological importance of the region.

- In the case of off-shore diamond mining, Alexkor must obtain the advice and assistance of a suitably qualified maritime archaeologist. It is important to note that historical shipwreck material has been recovered from the rocks near the harbour at Alexander Bay. In addition, several shipwreck graves have also been documented south of Alexander Bay Harbour.

- A further recommendation includes the relocation of the existing (and underutilised) Alexkor Museum, to a new existing community facility at the Delwers Camp in Alexander Bay. This will enable display material to be more accessible to local communities and visitors. In addition, several job opportunities (in an economically) depressed area will also be created. There are several archaeological sites close to Delwers Camp and visitors could also be taken there by trained local guides.

1. INTRODUCTION

1.1 Background and brief

South Africa's archaeological heritage is extensive, fragile and internationally significant. It is the evidence of human evolution and settlement in the country which spans nearly 2 million years. Development (including mining operations) of the coastal zone has had an irreversible negative impact on this heritage as archaeological sites are a non-renewable resource.

It is important to consider these human processes when planning for the coastal zone, considering that some of the oldest coastal sites in the world, dating back as much as 500 000 years, can be found along the South African coastline. Archaeological sites that have remained more or less intact for thousands of years are destroyed in just a few days of modern earthmoving operations and excavations.

It has been shown that large-scale shore based diamond mining operations impacts negatively on archaeological heritage remains (Parkington 1993 and personnel observation). Shore based mining operations by Alexkor Limited on the West coast of South Africa, has unquestionably destroyed many archaeological sites. These include not only important surface sites such as ancient shell middens and camp sites, but also important vertebrate fossils (bone) in deeper, open cast mining operations and prospecting trenches.

There, is on-going degradation of archaeological and palaeontological sites and the natural environment at Alexkor Limited, due to diamond mining operations

Alexkor Limited has recognised the threat that shore based diamond mining operations have on non-renewable archaeological and palaeontological sites.

A new Environmental Management Programme Report (EMPR) is currently being reviewed and updated by Site Plan Consulting, and will be implemented for all proposed future mining operations in the Alexkor concession area. The new EMPR replaces the 1994 Alexkor EMPR designed by the CSIR (CSIR report 1994). The current study represents a refinement and expansion of the 1994 baseline data sets.

The archaeological information that currently exists for the Alexkor mining area and that generated by the current study, will form part of the new EMPR, which is a tool designed to manage and assist the mining operations and minimise any possible negative (archaeological and palaeontological) impacts. The archaeological information generated by the current study has also been fed into Site Plan Consulting GIS programme and forms part of a number of environmental overlay maps of the area that includes vegetation and soil quality.

The aim of this report is:

- To verify the presence of archaeological and palaeontological sites and historical graves, at specifically, Boegoesberg, The Cliffs, Rietfontein, Visagiepan and Muisvlakte;

- To identify `Red Flag' or archaeologically sensitive areas, for future planned mining operations in the Alexkor mining area;

- To develop an archaeological component of an environmental awareness programme for the inclusion into the overall environmental awareness to be compiled by Site Plan Consulting, and

- To develop and help implement operating procedures in terms of the National Heritage Resources Act for the reporting, identification, recording and safekeeping of material following an archaeological find by a staff member

It is important to note that the study **did not** entail a detailed and systematic survey of the Alexkor diamond mining area.

2. TERMS OF REFERENCE

The Term of Reference for the archaeological and palaeontological heritage stud is:

- To verify the presence of archaeological and palaeontological sites and historical graves, at Boegoesberg, The Cliffs, Rietfontein, Visagiepan and Muisvlakte, in the Alexkor holdings area. Specific sites in these areas were first documented by Parkington (1993) during a specialist study on the importance of the Alexkor mining area;

- To identify `Red Flag' or archaeologically sensitive areas, for future planned mining operations in the Alexkor mining area[1], and

- To develop pro-active procedures with regard to identifying and reporting of archaeological and palaeontological sites in the Alexkor holdings area.

[1] The archaeologist will also develop an archaeological awareness programme for mining contractors, which will form part of the EMPR for the proposed project

3. THE STUDY AREA

The study area is situated between Alexander Bay in the north and Port Nolloth in the south, on the West coast, in the Northern Cape Province (Figure 1).

Figure 1. Locality map

4. APPROACH TO THE STUDY

4.1 Method of survey

A site took place over three days, between 14th and 16th November, 2007.

It is important to note that the study **did not** entail a Phase 1 Archaeological Impact Assessment (AIA) of the Alexkor west coast holding operations.

The archaeologists brief was very clear – i.e. to locate, verify and record the sites identified during a 1993 archaeological study (Parkington 1993) and to identify possible `Red Flag', or archaeologically sensitive areas.

Archaeological and palaeontological heritage remains, including historical and shipwreck graves, recorded during the site visit, were described, recorded, photographed and mapped using a hand-held Garmin Geko 201 GPS unit set on map datum wgs 84.

The archaeologist also met with several Alexkor employees, including Chief geologist Mr Geoff Davies and Marine HSE Officer Mr Kinnear Landers, who assisted the archaeologist during his fieldwork programme.

The archaeologist also consulted with consulting palaeontologist Dr John Pether, a specialist on the West Coast fossil history. A report on the fossil history and importance the Namaqualand coastal plain is included with this report (see Appendix I and II).

As part of the archaeologists brief, the archaeologist also assessed the current Alexkor mine museums archaeological and palaeontological collection.

A desk top study was also undertaken.

4.2 Assumptions

The study site is located within a known archaeologically sensitive area (see for example Kaplan 1993; Parkington and Hart 1991).

The assessment therefore assumes that:

- Damage to heritage resources potentially will occur during mining operations.
- Unmarked human burials may also likely be exposed or uncovered during mining operations

4.3 Constraints and limitations

There were no constraints or limitations associated with the study.

4.4 Identification of potential risk sources

Possible sources of risk in terms of archaeological and palaeontological impacts arising from the proposed mining operations are listed below.

Risk sources apply to both the planning and operational phase of the proposed project.

- Archaeological sites such as shell middens, and palaeontological (fossil) sites will very likely be negatively impacted by diamond mining operations

- Unmarked pre-colonial burials, historical graves and graves of shipwreck victims may also be negatively impacted by mining operations and associated activities.

- Historical shipwrecks and/or shipwreck material may be negatively impacted by off-shore mining operations.

5. RESULTS OF THE DESK TOP STUDY

The Namaqualand coastal strip of the Northern Cape Province is an arid marginal landscape, receiving less than 150 mm of rain a year. Its rocky coastline and shoreline environment, however, is extremely productive, teeming with shellfish, crayfish, marine birds and mammals such as seals. This semi-arid environment also supports a variety of terrestrial animals that are available for human subsistence.

Despite its (seemingly) marginal landscape, the rocky shoreline acted as foci that attracted Stone Age hunter-gatherers, as it offered greater opportunities for the exploitation of marine foods, particularly shellfish (Kaplan 1993). Shellfish meat was either cooked in pots or on open fires, but there is also evidence from the Southern and Western Cape coasts to suggest that meat was also dried and smoked. Other marine resources exploited included sea birds, fish, crayfish, seal, dolphin and even occasionally whales.

Archaeological evidence indicates that the West Coast region of South Africa (incorporating the Namaqualand coast) was occupied from the Early Stone Age (more than 1 million years ago) through to the Middle Stone Age and Later Stone Age, up until the arrival of early Trekboers in the 18th century.

Little published archaeological research has been conducted on the Northern Cape Namaqualand coast, with most of the work done near Spoegrivier and Groenrivier further to the south of the Alexkor study area. A human burial was also found at the mouth of the Groen River (Jerardino et al. 1992). Much of the diamond mining areas have been closed to the public for most of the last century, resulting in excellent preservation of sites not affected by mining activities. Research has shown that more than 99% of coastal sites mapped in South Africa are located in the first 300 m from the high water mark and that most of these sites are situated close to rocky shorelines and wave cut headlands (Kaplan 1993). Recent studies, however, also indicate that the dunes aligned alongside sandy beaches support many archaeological sites as well (Jerardino 2003; Kaplan 2006).

Since 1991, the Archaeology Contracts Office at the University of Cape Town have been conducting archaeological surveys in the Northern Cape coast ahead of open-cast diamond mining on land owned by the De Beers Mining Company. To date more than 1300 sites have been documented (Dewar 2006; Halkett 2002; Halkett and Hart 1997; Orton and Halkett 2004; Parkington and Hart 1991). A number of sites have also, been excavated and sampled in subsequent mitigation programmes (Dewar 2004; Halkett 2003; Orton and Halkett 2005a; Orton et al 2005 b), adding significantly to our bocy of knowledge (albeit limited) of the region. Their survey studies have shown that there is an almost continuous distribution of shell midden and wind-deflated sites along the rocky shoreline, and adjacent to dune ridges and sandy beaches. The fact that sites are spread out all along the coastline suggests that people were able to gain access to water through other means than estuarine and riverine systems. The most obvious answer is that people had access to springs.

A `brief' archaeological inspection of the Alexkor diamond mining area was undertaken by Professor John Parkington in 1993, as part of the 1994 CSIR, EMPR for the concession area. Several focussed localities were visited, while representative stretches of near shore dune, the lower course of the Holgat River and inland dune swarms were also inspected. Parkington (1993:5) noted that archaeological and palaeontological sites are very common, though often buried under many metres of overburden. Parkington (1993:5) also observed that mining and associated earthmoving activities `has clearly impacted on the archaeological record'.

6. LEGISLATIVE REQUIREMENTS

The following section provides a brief overview of the relevant legislation with regard to the future planned diamond mining operations in the Alexkor mining area.

6.1 The National Heritage Resources Act (No. 25 of 1999)

The National Heritage Resources (NHR) Act requires that "…any development or other activity which will change the character of a site exceeding 5 000m², or the rezoning or change of land use of a site exceeding 10 000 m², requires an archaeological impact assessment"

In addition to the above, the Act also requires that "…the construction of a road, wall, powerline, pipeline, canal or other similar form of linear development exceeding 300 m in length, requires an archaeological impact assessment".

The relevant sections of the Act are briefly outlined below.

6.2 Archaeology (Section 35 (4) of NHR)

Section 35 (4) of the NHR stipulates that no person may, without a permit issued by Heritage Western Cape (HWC), destroy, damage, excavate, alter or remove from its original position, or collect, any archaeological, palaeontological material or object.

6.3 Burial grounds and graves (Section 36 (3) of NHR)

Section 36 (3) of the NHR stipulates that no person may, without a permit issued by the SAHRA, destroy, damage, alter, exhume or remove from its original position or otherwise disturb any grave or burial ground older than 60 years, which is situated outside a formal cemetery administered by a local authority.

In addition to the above legislation, the South African Heritage Resources Agency (SAHRA) – the statutory authority responsible for protecting, conserving and managing South Africa's national heritage assets, have produced a document titled `Assessment and mitigation of archaeological and palaeontological heritage resources as pre-requisites **for mining and prospecting** (my emphasis). The pamphlet is designed to advise mining companies of the process required to comply with the NHRA

7. RESULTS OF THE ARCHAEOLOGICAL STUDY

The archaeological sites described below are illustrated in Figures 2 and 3. Most of the sites described have been identified by Parkington (1993), but several more, new sites have also been documented. Unfortunately, the sites described by Parkington (1993) were not mapped, photographed or assigned GPS co-ordinates. However, all the sites were subsequently relocated, documented in detail and assigned GPS readings.

A1 (**S 28° 39 008 E 16° 29 090**)

The site is located at the old HMS mine on the coast in the northern portion of the concession area (Figure 4). Shell midden remains occur at the bottom of the old tailings on the north facing slopes. The site has been severely damaged by mining related activities. Shellfish is associated with rusted metal and old mining equipment. The shellfish is dominated mainly by limpet species such as Scutellastra argenvillei, Cymbula granatina and C. miniata. Black mussel (Choromytilus meridionalis) and some whelk were also noted. Later Stone Age (LSA) tools include chips, chunks, flakes, cores, broken cobbles, manuports and hammerstones, in quartzite, indurated shale, quartz, silcrete and chalcedony. One Middle Stone Age flake was also noted. One piece of ostrich eggshell was found.

Figure 4. A1 HMS midden

A2 (**S 28° 49 106 E 16° 35 756**)

The site is located directly alongside the road on the way to the Rietfontein South mine. Shellfish is scattered alongside the powerline servitude on low, hummocky dunes (Figure 5). The shellfish is dominated almost entirely by large whole limpets, including S. argenvillei, C. granatina and C. miniata. Some of the shellfish is burnt. Lithics include several quartz and quartzite flakes and chunks, broken and smashed pebbles. One broken grindstone fragments was also counted. Four or five large pieces of ostrich, and one crayfish mandible were found. A marginal scatter of charcoal was also noted, but not evidence of a hearth was found.

A3 (**S 28° 49 340 E 16° 36 017**)

The site is located alongside an old sand road on the way to Rietfontein Pan. A relatively large, but dispersed scatter of shellfish occurs on the low, east facing, partially vegetated, hummock dunes (Figure 6). The shellfish is dominated by limpets. Stone tools densities are very low, and include several quartz flakes and chunks. Some charcoal bits were also noted. Four large pieces of ostrich eggshell was counted.

Figure 5. A2 Rietfontein view facing west

Figure 6. A3 Rietfontein view facing north west

A4 (**S 28° 50 371 E 16° 36 629**)
A5 (**S 28° 50 536 E 16° 36 785)**

The site is located on a series of fairly low, east facing dune ridges overlooking Rietfontein Pan, and most likely comprises one very large, extensive site, spread over a wide area. The dunes are covered in large amounts of shellfish, as well as many stone tools, pieces of ostrich eggshell and pottery sherds (Figures 7-9). The shellfish is dominated by limpets including S. argenvillei and C. granatina with large numbers of whole shell occurring. The site is relatively undisturbed and several discreet activity areas appear to be present. The location of the site to the Pan was clearly a very desirable location for the Later Stone Age people that inhabited the area, with access to water and animals for hunting. A range of lithics occur over the site, including quartz cores, flakes, chunks and modified flakes including a utilised quartz crystal flake. Silcrete flakes, cores, chunks, scrapers and two adzes were also counted. Grindstone fragments and at least three hammerstones were also found. There are discreet areas on the site where large numbers of ostrich eggshell were noted, probably a workshop area of sorts.

It is interesting to note that relatively large amounts of red and black burnished, thin-walled pottery was also noted, including at least three decorated pieces and one lug. Some charcoal was also noted.

Figure 7. A4 Rietfontein view facing north west

Figure 9. A5 Rietfontein view facing south east

Figure 8. A5 Rietfontein view facing south east

A6 (**S 28° 50 826 E 16° 36 979**)

The `site' comprises a high-domed sand dune overlooking Rietfontein Pan and an old stone walled kraal. The dune is covered in extremely large amounts of quartz chips, flakes and chunks. An outcropping of quartz on the hill was the most likely source of raw material (Figure 10). Very little artefactual material was found, but the hill must have been targeted by LSA people in the past. One shale flake and three chunks were also found, as were large numbers of glass fragments.

Figure 10. A6 Rietfontein view facing south

A7 (**S 28° 50 888 E 16° 37 074**)

The remains of a dry-packed stone built kraal occur about 200 m south of A6 at Rietfontein Pan (Figure 11). An inscription on one of the mudstone blocks reads 7.4.1911 (Figure 12). The stone built feature includes a circular kraal, a dipping tank, and two rectangular enclosures, most likely drying-off areas after the sheep/goats were dipped. The feature is in relatively good condition. A small, partially fenced off, fresh water spring is also located nearby. This is one of the very few more recent built structures documented during the study, and precedes official diamond mining operations by nearly 15 years.

Figure 11. A7 Rietfontein view facing west

Figure 12. A7

A8 (**S 28° 48 377 E 16° 37 998**)

A very thin scatter of weathered and fragmented shellfish occurs in a deep, sandy jeep track alongside the fence line at Visagiepan, about 300 m from the tar road between Port Nolloth and Alexander Bay (Figure 13). The dispersed scatter of shellfish is dominated by limpets. A few pieces of Black Mussel were also counted. One silcrete flake, one flat quartz core and one small bone shaft of a bovid was also found.

Figure 13. A8 Visagiepan view facing north west

A9 (**S 29° 12 045 E 16° 50 759**)

A human burial, most likely that of a Later Stone Age hunter-gatherer was exposed in the dune cutting, during prospecting operations at Muisvlakte several years ago. The skeleton was subsequently removed by SAPS in Port Nolloth but unfortunately, the whereabouts of the skeletal remains are unknown.

Large amounts of shell midden material occur on both slopes of the prospecting trench at Muisvlakte (Figure 14). The remains are dominated by limpets (S. argenvillei, C. granatina,) with relatively large amounts of Black mussel also occurring. Lithics are numerous on the site, and include flakes, chunks, hammerstones, grindstone fragments and manuports, in quartz, quartzite, indurated shale and chalcedony. A few pieces of haematite were also found. Relatively large numbers of ostrich eggshell is also present, while two ostrich eggshell beads were counted. Several sherds of pottery were found, while charcoal is also scattered about. Terrestrial fauna, including tortoise and small bovid was noted, as well as bird. Unfortunately, the site has been badly damaged by prospecting. However, an extensive scatter of seemingly well-preserved surface shellfish and stone tools was noted on wind blown sands directly south of the prospecting trench.

Fossil shell was also noted embedded in orange coloured, compact marine sediments and calcrete and cobble layers several metres below the overburden in the far eastern portion of the prospecting trench.

Figure 14. A9 Muisvlakte view facing north west

A10 (**S 29° 12 029 E 16° 50 794**) car park midden

The remains of a large shell midden occur at the car park at Muisvlakte. The site has been destroyed by the car park, but scatters of shellfish (mainly limpets) and stone tools occur on the margins of the car park and in the surrounding veld

A11 (**S 29° 06 037 E 16° 49 174**)

This is the well-known `The Cliffs' site, described by Parkington (1993), although it is unclear whether this site was actually visited or not. The Cliffs is a large prospecting trench north of Muisvlakte. Extensive scatters of shellfish, stone tool assemblages, terrestrial and marine fauna, many pieces of ostrich eggshell and pottery occur mainly on the north facing sand dunes overlooking the prospecting trench. Much shellfish has also spilled over the edges of the trench and into the excavation. Shellfish and stone tools also occur on some of the flatter south facing slopes nearer to the coast (Figures 15-17).

The shellfish is dominated by large whole and fragmented limpets (S. argenvillei and C. granatina) but Black Mussel also occurs. The lithics are characterised mainly by quartz flakes, chips, chunks and irregular cores. Hammerstone and grindstones and grindstone fragments are present. Silcrete flakes, chunks, cores and several scrapers and adzes were also counted. Chalcedony flakes and chunks were also found. Much tortoise bone is represented, as is seal, bird, small bovid and large unidentifiable bone. Many small weathered bone fragments were also counted. Large numbers of pottery (some decorated) including rims sherds, several lugs and bosses and a number of refits were also found. The pottery is mainly thin walled, burnished both red and black. The temper is clay in a quartz and shell matrix. Some red haematite was also found.

Large amounts of weathered and bleached fossil shell were also noted in the aeolianites (fossil dunes) about 2 meters below the sand overburden in the large prospecting trench (Figure 18). The shell is very visible in some of the cuttings. The shell is dominated by large Trough shells (Lutreria lutraria), clams, Ribbed Mussel and Black Mussel.

It is also important to note that numerous remains of large vertebrate fossil (bone) were also found in weathered aeolianite and orange coloured sands, more than 4 meters below the overburden. Parkington (1993) describes how a large elephant tusk, bone and `superabundant' ESA stone tools, occurs at The Cliffs site, but these remains were not re-located by the archaeologist and therefore could not be verified. However, much friable and weathered bone (including the remains of several large tusks) occur in-situ, while some bone has been displaced by collapsed sections of deposit (Figures 19 & 20).


Figure 15. A11 Shellfish scatters


Figure 16. A11 Shellfish scatters


Figure 17. A11 Shellfish scatters


Figure 18. A11 fossil shell in aeolianites


Figure 19. A11 arrow indicates fossil bone

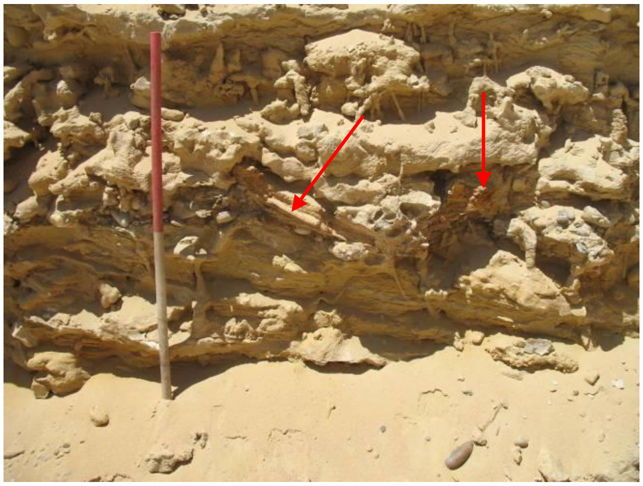
Figure 20. A11. Arrow indicates fossil bone

A12 (**S 29° 10 361 E 16° 50 456**)

Large scatters of shellfish were documented on a series of shifting and wind-deflated dunes about 500 m east of the `spring' at Muisvlakte (Figure 21). The shellfish is dominated by both marine species, as well as freshwater shell. Very few flakes were documented, but several large grindstone fragments and manuports were noted.

Figure 21. A12 Muisvlakte view facing west

A13 (**S 28° 47 774 E 16° 34 931**)

This most impressive of shell middens is located at the coast between Boegoeberg and Rietfontein North (Figures 22 & 23). The site, known as `Kenny's Midden', is highly visible from the road and has already been severely damaged as a result of road works cutting through the dunes to gain access to the beach. The large, shifting dunes are covered in large numbers of marine shell and many stone tools, pieces of ostrich eggshell and large numbers of Cape coastal pottery. According to Mr Kenny Landers (pers. comm.), this midden is one of the last remaining coastal shell middens in the northern concession area.

The shellfish on the site is dominated by limpets (<u>S. argenvillei</u> and <u>C. granatina</u>), with large numbers of whole shell occurring. It is estimated that the shellfish deposits below the dunes are several meters deep, representing several thousand cubic meters of archaeological deposit.

Many stone tools also occur over the site, with discreet and coherent stone working activity areas also present. Many quartz and quartzite flakes, cores, chunks and chips were found, as well as chalcedony, indurated shale and silcrete flakes, retouched pieces and tools, including wood working adzes and scrapers. Large lower grindstones, manuports, grindstone fragments, upper grindstones, hammerstones and several anvils were counted.

Many pieces of ostrich eggshell cover a large area of the site. Several possible activity areas were also found. These comprise patches of many pieces of ostrich eggshell, including the remains of water containers openings, as well as several beads.

Large numbers of pottery was documented on the site, including bosses, lugs, nipple base and several large refits (of bowls and cups), as well as decorated rim and body sherds. Most of the pottery is thin walled with a temper and matrix of clay, shell and grit. Many pieces are also burnished both red and black.

Bone, including tortoise, bird, seal, bovid, fish, crayfish and unidentified bone was also found on the site

Figure 22. A13. Kenny's midden. Boegoes-berg can be seen in the distance

Figure 23. A13 Kenny's midden

A14 (**S 28° 46 405 E 16° 34 844**)

Two historical graves were documented at the foot of Boegoesberg south (Figures 24 & 25). The elders among the Richtersveld community speak of several graves at the site. Two large piles of stone mark the graves, surrounded by shifting sands and scrub. No headstones or footstones mark the graves, and no grave goods such as marine shell, glass jars, etc mark the site. It is clear that the graves have not been maintained nor visited for many years. Despite a fairly detailed search of the surrounding area, no other graves were found. No stone walling, indicating possible stock enclosures were found, either. An old river bed is located further to the north.

Figure 24. A14 Historical grave at Boegoesberg

Figure 25. A14 Historical grave at Boegoesberg

A15 (**S 28° 40 556 E 16° 30 793**)

The graves of two shipwreck victims are situated alongside a long, shallow trench, very close to the rocky shoreline, about 1 kilometre south of the Alexander Bay Harbour (Figures 26 & 27). The two graves are covered with large slabs of mudstone and shale. Some skeletal remains have already eroded from one of the graves. No grave goods, or shipwreck material was found. The sites are very visible and the surrounding area is severely disturbed and degraded. According to Mr Jonathan Sharfman (pers. comm.), maritime archaeologist at the South African Heritage Resources Agency (SAHRA), it is unclear which historical shipwrecks occur in the Alexander Bay area. According to a mining contractor historical shipwreck material, including brass items, glass and porcelain, has been recovered from the rocks near the harbour at Alexander Bay.

Figure 26. A15. Shipwreck grave south of Alexander Bay Harbour

Figure 27. A15. Shipwreck grave south of Alexander Bay Harbour

A16 **(No GPS reading taken)**

The site is a small schist cave in a coastal gulley west of the smaller Boegoesberg Noord inselberg. Since it was recorded by Parkington (1993), the cave has become almost completely buried by Aeolian sand. Parkington (1993:10) describes the deposits as comprising various marine gravels and cobble beach levels with fossil shell and lenses of organic material. In the top 30 cm there are many bones (including seal, carnivores, bovid and even possibly human) embedded in a schist scree formed by roof deterioration. The bone is well preserved and Parkington believes the cave to be that of an ancient hyena lair.

Figure 28. A16. Arrow indicates cave

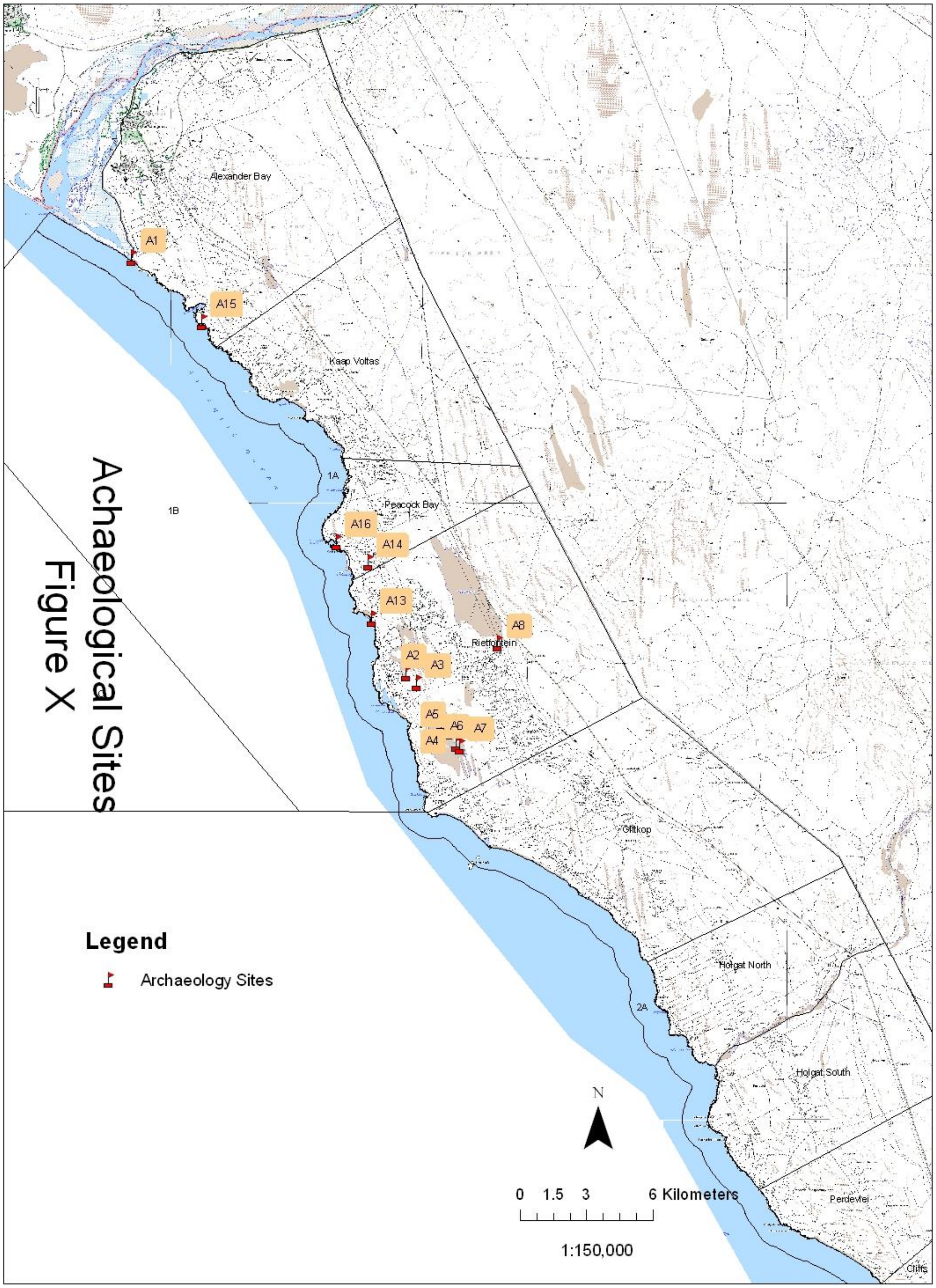

Figure 2. Study area and location of archaeological sites

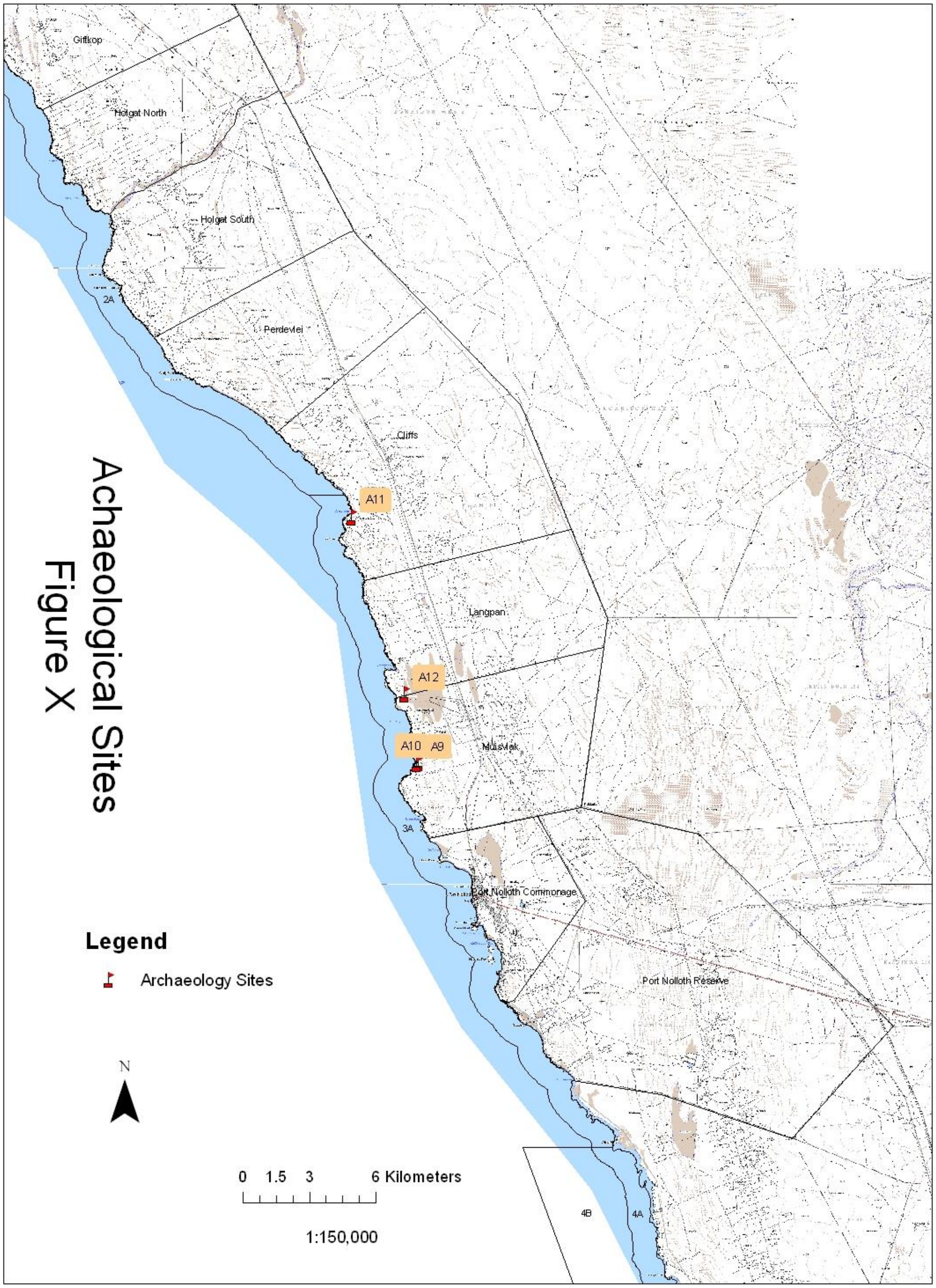

Figure 3. Study area and location of archaeological sites

8. RED FLAG AREAS

Research has shown that the majority of archaeological sites occur within about 300 m of the high water mark, with most of these sites situated close to rocky shorelines and wave cut headlands. Recent studies, however, also indicate that the dunes aligned alongside sandy beaches support many archaeological sites as well. Surveys undertaken by the Archaeology Contracts Office at the University of Cape Town south of Port Nolloth has shown that there is an almost continuous distribution of shell midden and wind-deflated sites along the rocky shoreline, and adjacent to dune ridges and sandy beaches. The entire coastal plain can therefore be considered a `Red Flag' area. According to Mr K. Landers (pers. comm.), several shell middens and sites also occur about one kilometre upstream from the Holgat River. This suggests that the inland area, at least around rivers, streams, ancient pans and springs, may also reveal the presence of important archaeological heritage remains.

According to Dr John Pether (2007), fossiliferous material (including marine and mammal bone) is abundant in the Namaqualand coastal plains deposits, but most of the existing information is sketchy and without adequate sampling control or provenance. Extinct fossil mollusc shell has been identified in clay channels, raised beach deposits and shoreline cliffs, as well as from marine terraces and deposits from alluvial diggings between Port Nolloth and Alexander Bay. Vertebrate fossils have also been found and collected from the coastal plain deposits. Many of these collections were unfortunately, not accompanied by detailed logging of vertical sections.

It goes without saying, therefore, that the inland coastal plain deposits in the Alexkor diamond mining area must also be considered a `Red Flag' area.

9. MUSEUM COLLECTION

The archaeologist assessed the archaeological and palaeontological collections currently housed at the Alexkor Museum, within the mine precinct. The museum is open to the public, but has not been opened to visitors for several years. Both collections are quite impressive and include archaeological remains, such as Early Stone Age, Middle Stone Age and Later Stone Age implements, well preserved pots, ostrich eggshell water containers, bow and arrows and quivers and wooden spears.

The palaeontological exhibit includes a fairly large collection of fossil marine and estuarine shell, marine fauna such as sharks teeth and terrestrial deposits associated with preserved teeth, and bone of Rhinoceros, extinct giant horse, bovid and carnivores. An impressive part of the exhibition is the large well preserved elephant tusk collected from The Cliffs site. Fossils on display also come form the Muisvlakte area. The jaw of an extinct zebra from the dunes terraces near Rietfontein is also on display.

10. RECOMMENDATIONS

Given the known archaeological and palaeontological sensitivity of the study area, the following recommendations, to be included in the EMPR are made.

- Proposed future shore-based diamond mining operations must be subject to a Phase 1 Archaeological and Palaeontological Impact Assessment, in terms of Section 37 of the National Heritage Resources Act (No. 25 of 1999).

  This must entail:

  a) A detailed archaeological survey of each of the proposed mining blocks, prior to any prospecting and earthmoving operations. Archaeological surveys must be planned well in advance of earthmoving operations taking place in case any mitigation programmes are required.

  b) All deep excavations such as trenching and prospecting must be inspected by a professional palaeontologist (refer to Appendix 2).

  c) An archaeological and palaeontological awareness programme must be implemented prior to any earthmoving operations taking place on the site. This is in order to sensitise contractors and plant operators to the archaeological and palaeontological importance of the region.

- In the case of off-shore diamond mining operations, Alexkor must obtain the advice and assistance of a suitably qualified maritime archaeologist[2]. It is important to note that historical shipwreck material has been recovered from the rocks near the harbour at Alexander Bay. In addition, several shipwreck graves have been documented south of Alexander Bay Harbour.

- A further recommendation includes the relocation of the existing (and underutilised) Alexkor Museum, to a new existing community facility at the Delwers Camp in Alexander Bay. This will enable display material to be more accessible to local communities and visitors. In addition, several job opportunities (in an economically) depressed area will also be created. There are several archaeological sites close to Delwers Camp and visitors could also be taken there by trained local guides.

[2] SAHRA maritime archaeologist, Mr Jonathan Sharfman can be contacted at (021) 462 4502

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APPENDIX 1

COASTAL PLAIN DEPOSITS OF NAMAQUALAND

HISTORICAL PALAEONTOLOGY AND STRATIGRAPHY

COASTAL PLAIN DEPOSITS OF NAMAQUALAND

HISTORICAL PALAEONTOLOGY AND STRATIGRAPHY

John Pether

Historical Palaeontology and Stratigraphy

The first recorded references to the raised beaches of Namaqualand (and probably also the first recorded mention of fossils in South Africa) are in the journals of the explorers R.J. Gordon (Raper and Boucher, 1988) and W. Paterson (Forbes and Rourke, 1980). En route to the "Great River" (Gariep) in 1779, they headed towards the Holgat River (Fig. 3.1) in search of water. There they noted the presence of fossil marine shells in marine deposits on top of the cliffed shoreline (Forbes and Rourke, 1980; Raper and Boucher, 1988). They also made the distinction between raised beach deposits and shell middens of anthropogenic origin.

One and a quarter centuries after Gordon and Paterson's explorations, Rogers (1904, 1905) made observations on marine gravels and sands on the cliffs at ~25 m asl. between the Olifants River and Doring Bay (Fig. 3.1). He noted their apparent geomorphological association with the occurrence of siliceous and ferruginous duricrusts in the area. Krige, during his survey of raised beaches around South Africa, published in 1927, made observations on the occurrence of low-elevation (<20 m asl.) marine terraces and deposits along the Namaqualand coast, his "Major Emergence" (15-18 m asl.) and "Minor Emergence" (5-8 m asl.) (Krige, 1927). He provided Haughton with fossil shells from the cliffs at Doring Bay, which resulted in the first descriptions of Tertiary fossil molluscs from Namaqualand (e.g. *Donax rogersi* Haughton, 1926; *Chamelea krigei*, Haughton, 1926).

Significant diamond reserves in the marine gravels south of the Orange River became apparent by 1927 and these early prospects were examined by Wagner and Merensky (1928), Reuning (1931) and Haughton (1926; 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 and Merensky (1928), Haughton described the fossils they collected (Haughton, 1928). Wagner and 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," identified as the living east coast species (*Crassostrea margaritacea*), 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). The "Lowest terrace" enclosed an extant fauna and a younger, Pleistocene age with sea temperatures similar to the present was implied. The "Operculum Bed" was regarded as an intermediate unit between the "Ostrea Bed" and "Lowest terrace".

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 enlarged upon from observations at Hondeklip Bay (Pether, 1994).

De Villiers and Söhnge (1959) provided a valuable description of the marine terraces and deposits of the State Alluvial Diggings (Alexander Bay to Port Nolloth, Fig. 3.1), as seen in 1944. The significance of their observations on sedimentary geometry in relation to cliffed bedrock is revitalized by observations from Hondeklip Bay.

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.

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). Extinct taxa occur in the older, higher terraces, whereas the SAD Lower Terrace deposits enclose extant molluscan fauna.

From the Kleinzee area, an interesting development was the discovery of a deep depression north of Kleinzee that is infilled with carbonaceous, fluvial sediments, dated palynologically as Lower Cretaceous (Molyneux, in Rogers *et al.*, 1990). 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. 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 the 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 at ~8, ~5 and ~2 m asl. are recognized (≈SAD Lower) and enclose an extant, cold-water fauna.

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 and the occurrence of phosphatic nodules. He also encountered difficulties in the application of Haughton's (1932) biostratigraphic zones to the more extensive prospecting exposures.

An important advance for the stratigraphy of Namaqualand coastal deposits was Carrington and 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 and Merensky, 1928; Haughton, 1932), Carrington and Kensley (1969) considered the bulk of the succession to be Pleistocene in 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 and Kensley (1969) in regarding the phosphatic beds in the Hondeklip area as older than the "channel clays". However, Carrington and 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 and Davies (1980) informally named the coastal-plain deposits between the Olifants River and Kleinzee the "Hondeklipbaai sandy gravels".

The results of initial work on the "Hondeklipbaai sandy gravels" were presented by Pether (1983). Pether (1986a) provided a summary of the main findings of his research on the succession at Hondeklip Bay (Transhex exposures), including suggested correlations farther afield. Information was also disseminated at a number of conferences (Pether, 1986b, 1986c, 1987; Pether, in Rogers *et al.*, 1990). Fossil shell is well-preserved in the Hondeklip area and more intensive faunal sampling carried out during this study has led to considerable additions to the marine molluscan fauna of Namaqualand coastal deposits (Kensley and Pether, 1986). The first extinct Tertiary barnacle recorded from South Africa was described from Hondeklip by Pether (1990). Brunton and Hiller (1990) have described the fossil brachiopods collected by the writer in the Hondeklip study area.

The growth of data during the 1970s prompted a number of syntheses emphasizing Cenozoic palaeoclimates, biogeography and sea-level history (Tankard and Rogers, 1978; Siesser and Dingle, 1981; Hendey, 1983a, 1983b, 1983c; Dingle *et al.*, 1983), the latter work including offshore data and thus dealing with the evolution of the continental margin as a whole.

Summary Stratigraphy

Early Post-Gondwana Events

Following the separation of Africa and South America between 121 and 129 Ma small grabens formed parallel to the structural grain which defined the early coastline. One of these, a short distance to the north of Kleinzee, contains lacustrine deposits that have yielded Lower Cretaceous pollen (Molyneux, in Rogers *et al.*, 1990). Vigorous erosion during the Cretaceous exposed the coastal metasediments and gneisses from beneath a cover of Nama and Dwyka rocks. Large-scale topographic aspects of the coastal plain, its backing escarpment and major drainage lines still reflect the basal Dwyka topography. The coastal plain would have been trangressed during Cretaceous high sea-levels. Transgressive Eocene events also affected the coastal plain, 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 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.

Earlier Tertiary Fluvial Deposits

Incised into this ancient, weathered land surface are remnants of fluvial paleochannels, whose infills have also been kaolinized, disguising their presence (informally called the "Channel Clays"). These channel sediments consist of oligomictic, subangular quartz paraconglomerates, usually 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 Paleogene 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 timespan.

Neogene Deposits

Consistently represented along the length of the coast are three extensive 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, Pleistocene littoral deposits up to about 10 m amsl which include cold water shell assemblages similar to those inhabiting the coast today. This Pleistocene, cold-water group comprizes the 8 - 12 m Package, the 4 - 6 m Package (Last Interglacial ~125 kyr BP) and the 2 - 3 m Package (mid-Holocene 6-4 kyr 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 (Figures 1 and 2) 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. 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 Pleistocene 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.

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 amsl, 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 such as oysters and thick-shelled *Isognomon*. 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, Figure 2). A strontium isotope age of ~16 Ma has been obtained from forams sealed in clay at one such occurrence in the Hondeklip area (Langklip).

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 amsl. It consists typically of fine green sands overlying basal gravels. The sands may exceed 8 m in thickness and were deposited at lower shoreface paleodepths; 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 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. The proximal gravels were also repeatedly reworked by storms until they were finally buried by the advancing fine sands of the lower shoreface. These fine sands exhibit hummocky and swaley stratification, quasi-planar lamination and interbedded coarse-grained wave ripples (CGR) that attest to storm deposition, whilst fair weather conditions are reflected by rippled sand, mud drapes and bioturbation. A cross-bedded, coarse-sandy upper shoreface facies sometimes overlies the fine sands of the lower shoreface, but has mostly been lost to erosion. A unit of wind-reworked marine sand and calcrete overlies the marine section and this is sharply overlain by several meters of pedogenically-reddened eolian and sheetwash sands.

The 30 m Package

The 50 m Package was truncated by the next major transgression, which reached ~30 m amsl and another progradational wedge then built out seawards from the ~30 m transgressive maximum, forming the regressional 30 m Package. The package extends to near the present day shoreline, where it is overlain by deposits relating to a ~10 m high sea level. An important contrast between the 50 m and 30 m packages is that usually only the foreshore facies of the latter has been variously subjected to terrestrial reworking and its upper shoreface facies is extensively preserved. However, this facies has over large areas been affected by decalcification and pedogenic reddening, superficially causing it to resemble terrestrial deposits. The 30 m Package upper shoreface is typically dominated by thick megaripple troughsets, whereas trough-lag amalgamation typifies the 50 m Package upper shoreface. There are more coarse-grained beds in the proximal lower shoreface of the 30 m Package, as thin gravelly units entirely reworked after deposition as CGR fields and thicker, poorly-bedded units debouched from rip channels which have only their upper portions reworked as CGR. These aspects support a greater sediment supply to the littoral and faster progradation during 30 m Package times relative to 50 m Package times.

The Pleistocene

Very little descriptive information is available for the Pleistocene "Recent Emergence Terraces", the 8-12 m Package, the 4-6 m Package and the 2-3 m Package, along the Namaqualand coast. For instance, the 8-12 m Package could relate to a prominent middle Pleistocene interglacial called Marine Isotope Stage 11 (MIS 11) ~400 kyr ago. 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). At this stage, it quite feasible that the poorly-known "8-12 m Package" deposits could include units of differing age at various localities.

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 masl, are adjudged to be of latest early Miocene age (ca. 18 - 17.5 Ma) (Pickford and 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 latest early Miocene transgression.

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 suid *Nyanzachoerus kanamensis* which is considered by Pickford and Senut (1997) to have an age of 5 - 7 Ma and the Varswater phocid (seal) *Homiphoca capensis*. Linking of the 50m Package to the Varswater Formation and the early Pliocene (~5 Ma) high sea level of Haq *et al.* (1987) 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 evidence 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 and Venz, 1992).

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 horse dispersal in Africa because of the zebra (*Equus capensis*) bones.

The age of the 30 m Package is not well constrained since a satisfactory associated vertebrate assemblage has not been recovered yet. However, given its warm-water molluscan fauna, it is likely to predate the onset of bipolar glaciation ~2.6 Ma and the Pleistocene climatic mode. It may correspond with the next major sea level highstand in the Pliocene at ~3 to 3.4 Ma (TB3.6 of Haq *et al.*, 1988).

Many attempts at strontium dating 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. Improvement in sample selection (samples sealed in clay) and in analytical techniques encourages continued efforts.

Some Concerns

Below are some concerns that might benefit by palaeontological endeavours in the diamond-mine exposures.

Invertebrates

Although there is a considerable sample of molluscs, brachiopods and barnacles in the South African Museum collections, it is not a complete collection. For instance, several taxa found by Carrington have not been found again.

The bulk of the collection is quite localized, viz. from the excavations made at the Transhex mine on the properties Hondeklip and Avontuur. It is also restricted palaeoenvironmentally viz. from shallow-water shoreface facies. Furthermore, even while briefly "passing through" an excavation of shoreface facies of the 50 m Package on Koingnaas earlier this year, previously unrecorded taxa were readily seen.

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

Sampling in De Beers excavations has been limited to the occurrences of the more rare facies very locally preserved in bedrock depressions, the "E Stage" deposits, at 4 localities. 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 probably 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. The deeper facies are preferentially preserved in the bedrock depressions and this tended to repetition. The shells are poorly preserved due to persistent residence in groundwater. More samples are highly desirable to facilitate the unravelling of these interesting faunas (and stratigraphy).

Further collection of samples for microfossils is desirable. The microfossil record has been sampled at few localities and the results wrt. 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.

Vertebrates

The example of the Hondeklip exposures pertains, viz. that there are more bone fossils in the deposits than is generally perceived. Nevertheless, the sample of identifiable material is small: see tables in Pickford and Senut, 1997.

Vertebrate age constraints on the 30 m Package currently do not exist.

Similarly, the is no convincing age constraint for the 8-12 m Package.

The terrestrial record of aeolianites and sheetwash is poorly constrained. Nevertheless, rare bones do occur on palaeosurfaces in these sequences.

Comment

It must be noted that palaeontological collecting must necessarily be accompanied by detailed logging of vertical sections, with adequate positioning and elevation control. In the process of compliance with heritage legislation, there could be some spinoff as input for the geological model of the mines, at least in confirmatory/auditing aspects.

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

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

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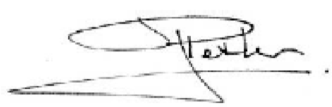

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APPENDIX 2

PALEONTOLOGICAL HERITAGE IMPACT ASSESSMENT AND MITIGATION APPROACHES

PALAEONTOLOGICAL HERITAGE IMPACT ASSESSMENT AND MITIGATION APPROACHES

PREPARED FOR GENERAL INFORMATION PURPOSES

By John Pether

Significance of the 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 and palaeontological objects 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 and fossil-fuel exploration.

The Palaeontological Heritage impact Assessment

The request for a palaeontological HIA should arise in the screening/scoping phase of an Environmental Impact Assessment (EIA), but may arise later in the process.

The main purposes of this assessment are to:

1. Outline the nature of palaeontological heritage resources in the vicinity of the site.
2. Suggest the mitigatory actions to be taken prior to and during the excavation phases at the site with respect to the occurrence of fossils.

The document also serves as the basis for the Agreed Terms of Reference for the heritage impact management part of the project.

Although fossiliferous strata may already be exposed at some sites, in most situations the fossils will be exposed in the excavations made for mining/construction. Palaeontological interventions mainly happen once fossil material is exposed at depth, i.e. once the EIA process is done and mining/construction commences.

The action plans and protocols for palaeontological mitigation must therefore be *included in the Environmental Management Plan (EMP)* and embodied in the Agreed Terms of Reference for the appointed heritage assessment/mitigation practitioner.

Therefore, although the Palaeontology HIA submission occurs at the screening/scoping phase, it may be already be regarded as the draft input for the EIA and EMP phases.

The Palaeontological HIA includes:

Desktop Study. Expected palaeontology/geology. Existing scientific literature and collection holdings of relevance to the palaeontological/geological record of the site will be reviewed, assessed and summarised. On this basis the general expectations wrt. potential fossil occurrences will be outlined.

Specific site features. Identification and basic description of significant features wrt. palaeontological heritage *currently exposed* in the site area. Some of these features may be affected by the proposed works; either directly by potential destruction, or less directly by potential degradation as a result of increased traffic, access, visibility , etc.

The object here is the advance earmarking of fossil sites of such importance that they may constitute a permanent No-Go site, necessitating revision of the siting of the envisaged installations. Alternatively, that the outcrop/exposure is sufficiently important that mitigation measures should be carried out *before* the commencement of construction activities on the site.

Outcome: Initial HIA Palaeontological Report for the site, with mitigatory recommendations.

EIA Phase

At this stage, any additional information arising and issues from discussions with interested parties wrt. recommendations for mitigatory actions for the selected site-will be elaborated for inclusion in the finalized EIA Report, for the input to the EMP.

EMP Phase

Mitigatory recommendations to be carried out.

Monitoring protocols as agreed in place.

Mitigation during a primary fieldwork phase at the selected site.

Outcome: Final Report.

Rescued fossil material deposited in the appropriate scientific institution.

MITIGATION APPROACHES

First, any exposed fossil occurrences threatened by mining/construction should be sampled and described.

It is suggested that an acceptable degree of monitoring be carried out during the making of excavations.

The primary mitigation task of the specialist entails the inspection of larger, deeper excavations made for mining or infrastructure installations. This activity should co-incide with the time of maximum exposure of the faces of the excavations, for best cost-effectiveness.

Monitoring

In general, fossil bones are sparsely scattered in coastal deposits and much depends on spotting them as they are uncovered during digging. In contrast, shelly layers are usually fairly extensive and normally are exposed in the sides of the finished excavation, when they can be documented and sampled easily.

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 engineers, surveyors, site foremen, 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 smaller 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.

Primary Mitigation

When the excavations are near or at completion:

The excavation faces will be inspected for fossil content.

Any already-rescued material as above will be examined, processed and packaged.

Representative samples of fossils will be collected. In the case of shelly beds, bulk samples will be taken. If material is delicate/poorly-preserved, it will be removed within blocks of the enclosing sediment, reinforced if required by encasement.

Key vertical sections representative of the exposures will be identified. These will be described in detail sedimentologically (logged), photographed and sampled, to fully record the contexts of the fossils.

For the purposes of planning and costs containment, the contracted specialist must be informed on the scheduled excavation 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 wrt. co-ordinates and base maps, to plot the locations of finds during monitoring, the measured sections, samples and other observations.

The Report

At the end of the task a detailed report will be submitted.

This report is in the public domain and copies of the report must be deposited at the Heritage Resources authority and/or SAHRA. It must fulfil the reporting standards and data requirements of these bodies.

The report will be in standard scientific format, basically:

A summary/abstract.
Introduction.
Previous work/context.
Observations (incl. graphic sections, images).
Palaeontology.
Interpretation.
Concluding summary.
References.
Appendices

The draft report may be reviewed/screened by the client, or reviewed externally, before submission of the Final Report.

Application for Palaeontological Permit from SAHRA/Provincial Heritage Authority

The specialist is required to obtain a palaeontological permit from the Provincial Heritage Resources Authority or SAHRA in order to carry out the work. For this is needed details of the registered owners of the sites, their permissions and a site-plan map. A permit fee of R150 is now operative.

All samples of fossils and sediments will be deposited at a curatorial institution approved by SAHRA or the appropriate provincial heritage resources authority.

The client might desire a local display/exhibition of findings and features: out of a combination of interest, public-mindedness and to demonstrate diligence w.r.t. heritage/science resources. This would have to be at a location and under conditions approved under the auspices of the Heritage Resources Authority.

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