REPORT ON PILOT EXCAVATIONS AT "E" QUARRY LANGEBAANWEG FOSSIL PARK LANGEBAANWEG

Prepared for

Earth Sciences Division
South African Museum

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Prepared by

Archaeology Contracts Office
Department of Archaeology
University of Cape Town
Private Bag
Rondebosch
7701

Phone (021) 650 2357
Fax (021) 650 2352
Email TJG@beattie.uct.ac.za

1. INTRODUCTION

The Archaeology Contracts Office (ACO) of the University of Cape Town was commissioned by the Earth Sciences Division of the South African Museum to undertake a pilot excavation at the "E" quarry in the decommissioned Chemfos Ltd. phosphate mine, Langebaanweg, South Western Cape Province. Figure 1 shows the location of Langebaanweg.

The mining operation exposed fossiliferous sediments, which were the focus of a major rescue and research project during the 1960s and 1970s. The site is now recognised as being of international importance on account of the diversity and quantity of Miocene, Pliocene and Pleistocene faunal material found there. The South African Museum has been given an area of the mine for the establishment of the West Coast Fossil Park. It is envisaged that the park will incorporate educational trails, static displays, a site museum, and a research facility, and will promote further excavation and study of the remaining fossiliferous deposits.

1.1 Terms of reference

Members of the South African Museum identified the site of a previous excavation in "E" quarry as a potential site for the establishment of a site museum which is envisaged as consisting of a palaeontological excavation with fossil bones exposed *in situ*. The concept involves putting a structure over the site equipped with walkways and educational displays to facilitate public viewing of the finds. The Archaeology Contracts Office was requested to identify and expose fossil bearing deposits that could form the focus of the site museum. To achieve this the ACO undertook to:

1. Consult field notes and published material to obtain an understanding of the context of the fossil deposits and site layout.

2. Set up a baseline and grid, and then sink a pattern of trial excavations to locate any remaining fossil deposits.

3. Having located fossil material, conduct an excavation to expose bone *in-situ* for purposes of a temporary site display.

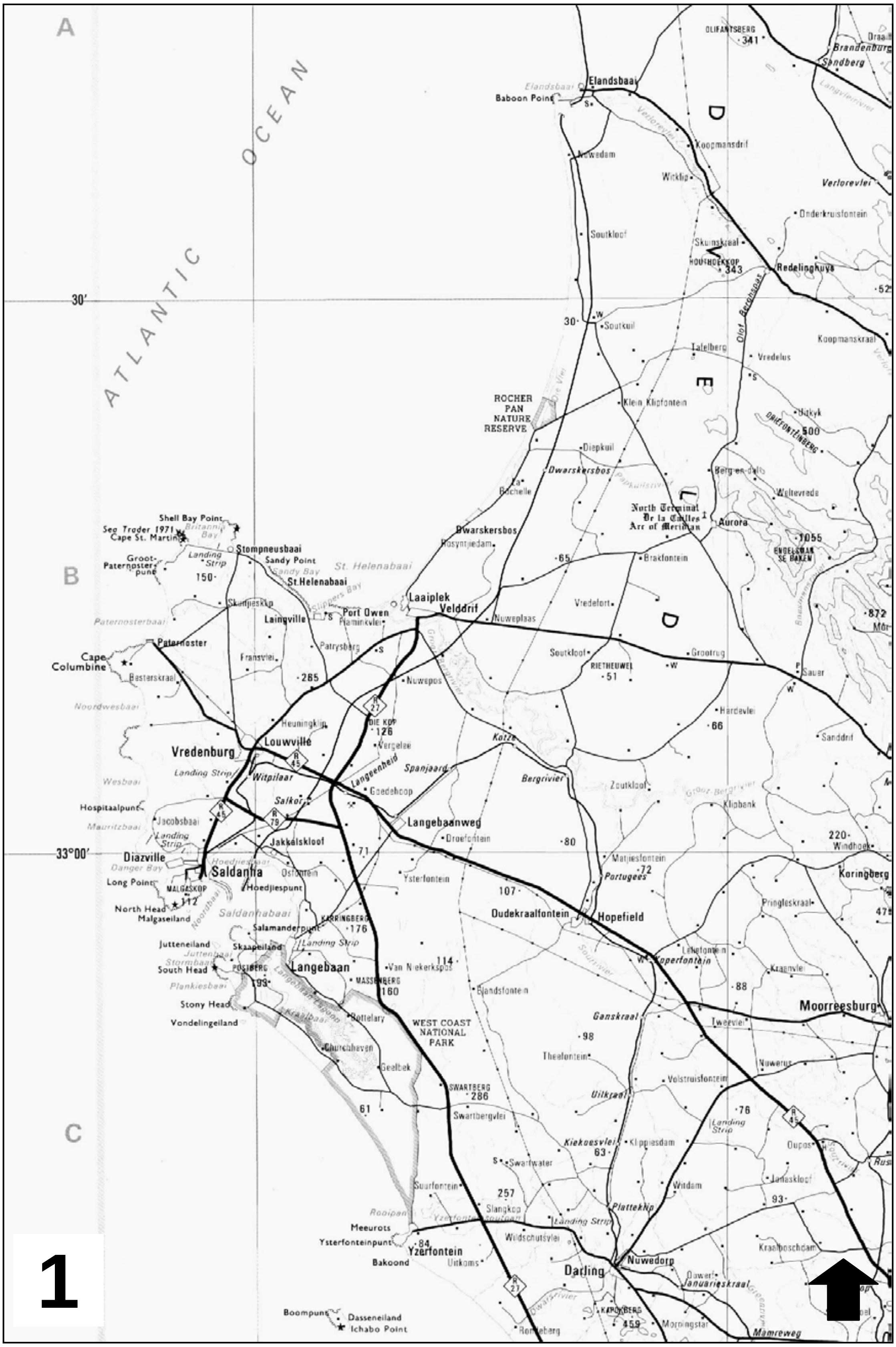
4. Schedule the excavations to coincide with a ceremony to launch the development of the fossil park, and guide invited guests around the site.

5. Sieve and bag excavated material for curation in the fossil park laboratory.

6. Produce a report describing the methods employed, the findings of the project and provide recommendations to guide future work.

1.2 Background

The existence of fossils at Langebaanweg was first brought to the attention of the scientific community in 1958 when an employee of a small scale phosphate mine showed two fossils to visiting scientists. These fossils were donated to the museum and formed the beginning of



Location of Langebaanweg in the Western Cape, South Africa.

what was to become one of the largest fossil collections in the world deriving from a single context (Hendey 1982).

After 1965 the mining company, Chemfos Ltd, expanded its operation to begin large scale open cast mining. This involved expanding the mine to the adjacent farm Varswater, and extending "E" quarry. It soon became apparent that the area was extremely rich in fossil material. This motivated the South African Museum to set up a formal research program on the mine. The project began in 1968 and continued through to the 1980s under the leadership of Dr Q.B. Hendey (Cenozoic Palaeontology Department of the South African Museum). In the following years, thousands of specimens were recovered and analysed. This resulted in the publication of a multitude of papers and articles describing the fauna (including new species), the geology and palaeoenvironments of the area.

1.2.1 Geological setting

The geology of Langebaanweg and the circumstances that lead to the formation of the fossil-bearing deposits are largely due to changes in sea level and the effects this had on the proto-Berg River. Successive alternating patterns of marine transgression and regression have resulted in the accumulation of a sequence of water-borne sediments dating from the early Miocene (25ma) through to more recent quaternary sands. The most important portion of the sequence for both economic and scientific reasons is the Varswater Formation, which is highly fossiliferous and contains the greatest concentration of phosphate ore (Tankard 1975, Hendey 1976).

The first of the three members of the Varswater formation were laid down during an early Pliocene marine trangression which caused estuarine conditions such as mud flats and salt marshes where the mine now lies. During this time the non-phosphatic fossiliferous sediments of the Quartzose Sand Member (QSM) were deposited. Further rising sea levels resulted in the deposition of the Peletal Phosphorite Member (PPM). Waterborne phosphorite particles previously deposited off the coast, as well as sediments washed down the Berg River settled in the sea channel covering the QSM with a thick layer of phosphorite and fossil rich deposits. Stratified within the PPM are two ancient river beds that contain dense concentrations of fossils dating to the Pliocene. Hendey has recovered bones of numerous mammalian species, marine vertebrates and microfauna from the riverine sediments. As the early Pliocene marine transgression reached its climax, the depositional environment changed from estuarine to shallow ocean resulting in the deposition of the calcareous sand member (CSM) of the Varswater formation. As the sea level was higher at this time, concentrations of terrestrial animal bones no longer accumulated. Instead the sediments contain micro-marine fossils characteristic of the shallow ocean conditions that prevailed at the time (Tankard 1975, Hendey 1976, 1982)

When the sea level regressed after the mid-Pliocene, most of the early deposits elsewhere on the coast were washed away by erosion. However, the remnants of the early Berg River sand bar and the topography of the area protected the early pliocene deposits in the Langebaanweg area resulting in the preservation of a unique palaeontological resource (Hendey 1982).

Although all the quarries and a number of prospecting trenches on Varswater farm produced fossils, the greatest concentration was found in the "E" quarry associated with an old river channel in the PPM member. Hendey conducted extensive excavations at this site in 1976 while mining was in progress and recovered the remains of some 200 species of fauna. By the time that the mine was closed, "E" quarry was almost 40 m deep having penetrated through the surface layers to reach the phosphorite rich Varswater formation (Hendey 1982). Quarrying ceased at the non-phosphatic underlying QSM which makes the present quarry bottom. In recent years the quarry has been rehabilitated. This has involved contouring off the quarry edges and replanting indigenous vegetation.

2. METHOD

2.1 Target area

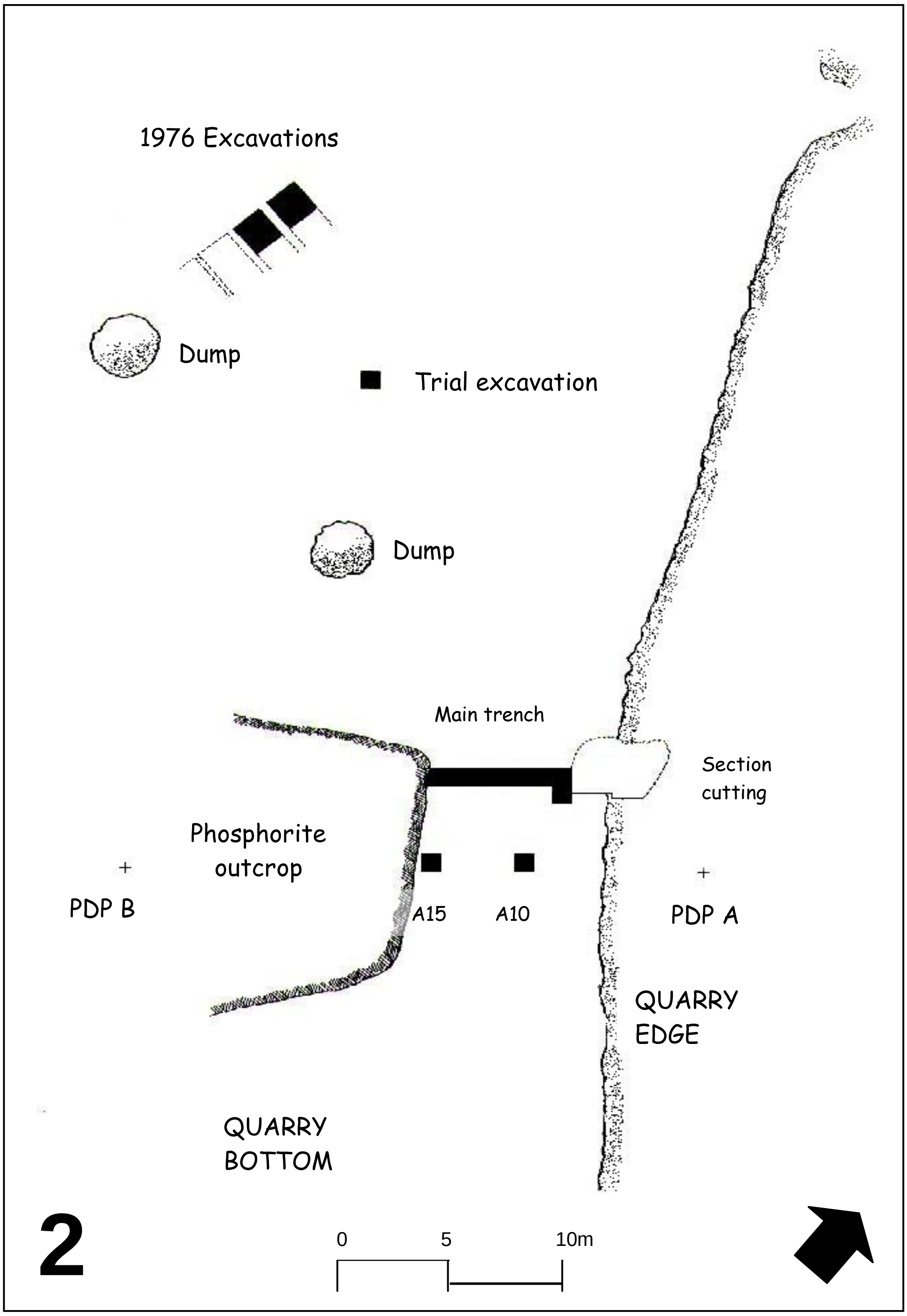
The area selected for the pilot excavation was close to the site of Hendey's 1976 excavations in "E" quarry. The site lies in the bottom of the quarry close to a large phosphorite rock outcrop. Fragmentary fossil material is abundant on the surface around the rock outcrop, in shallow basins on the outcrop as well as in the quarry sides. It is in this area that Hendey identified a Pliocene river channel which he suggested flowed in from the north east side of the quarry sweeping across and around the rock outcrop. An initial site inspection created an impression that very little of the channel deposit (referred to as lag deposit hereafter) had survived the mining operation in the quarry. An area of raised ground between the outcrop and quarry side that appears to have been inaccessible to the drag-line excavators was identified as having the potential to contain undisturbed deposits.

2.2 Background research

Although the findings from Langebaanweg have been widely published, a search through original field notes and the published material revealed very few details about the manner in which the 1976 excavations were conducted or the alignment of the grid system that was used. Furthermore, Dr Hendey is currently based in Durban and was not available to provide relevant details about the site. He suggested that further excavations should be based on a new grid system. A slide collection provided by Dr Hendey proved to be a valuable source of information for reconstructing events that took place on the site and played an important role in guiding the decisions that were made during the course of the pilot project.

2.3 Establishing the grid

Three permanent datum points were established on the site. Both of these consist of steel stakes cemented in position. The first of these (PDP A) is situated on top of the embankment above the excavation. The second of these (PDP B) was positioned on the phosphorite outcrop in the bottom of the quarry. A third contingency reference point (PDP C) was positioned to the south east of the site on the other side of the road. The base line from which all XY co-ordinates were measured extends from PDP A across to PDP B. The survey instrument (a Leica TC-500 electronic total station) was positioned on PDP A as this commands the best view of the base of the quarry. As the total station provided a facility for converting angle and distance readings to XY co-ordinates, all measurements on the site were based on this system. Figure 2 is a plan of the target area showing the phosphorite outcrop, the 1998 test excavations and those conducted by Hendey in 1976.



Site plan - 1998 excavation season

2.4 Excavation method

The first 4 days spent on site were used for digging exploratory trial holes to search for the best deposits. During this time the area originally excavated by Hendey in 1976 was re-examined, the area between the edge of the quarry and the phosphorite outcrop was tested and a trial hole was excavated into the QSM. Standard archaeological methods were used throughout. The grid system was based on use of $1m^2$ blocks for controlling horizontal provenance. The deposit was excavated according to the visible stratigraphy. The material from various blocks and stratigraphic units was kept separate throughout the sieving and curation process. A large proportion of the lag deposit consisted of fragmented fossil bone. Large diagnostic bones were left *in situ* and treated with a PVB acetone mix to ensure that they did not crumble after exposure.

A method had to be developed for the physical excavation of the PPM and lag deposit, which was highly consolidated and unyielding to both trowels and geological hammers. Some success was achieved through judicious use of a light electric jackhammer, however this proved to be potentially too destructive when used in the proximity of dense fossil bone accumulations. Best results were achieved by frequently wetting the deposit, which then softened into mud. A light industrial wet-dry vacuum cleaner set to blow mode proved to be extremely useful in areas where the bone was particularly dense and difficult to expose with conventional tools.

2.5 Sieving and storage

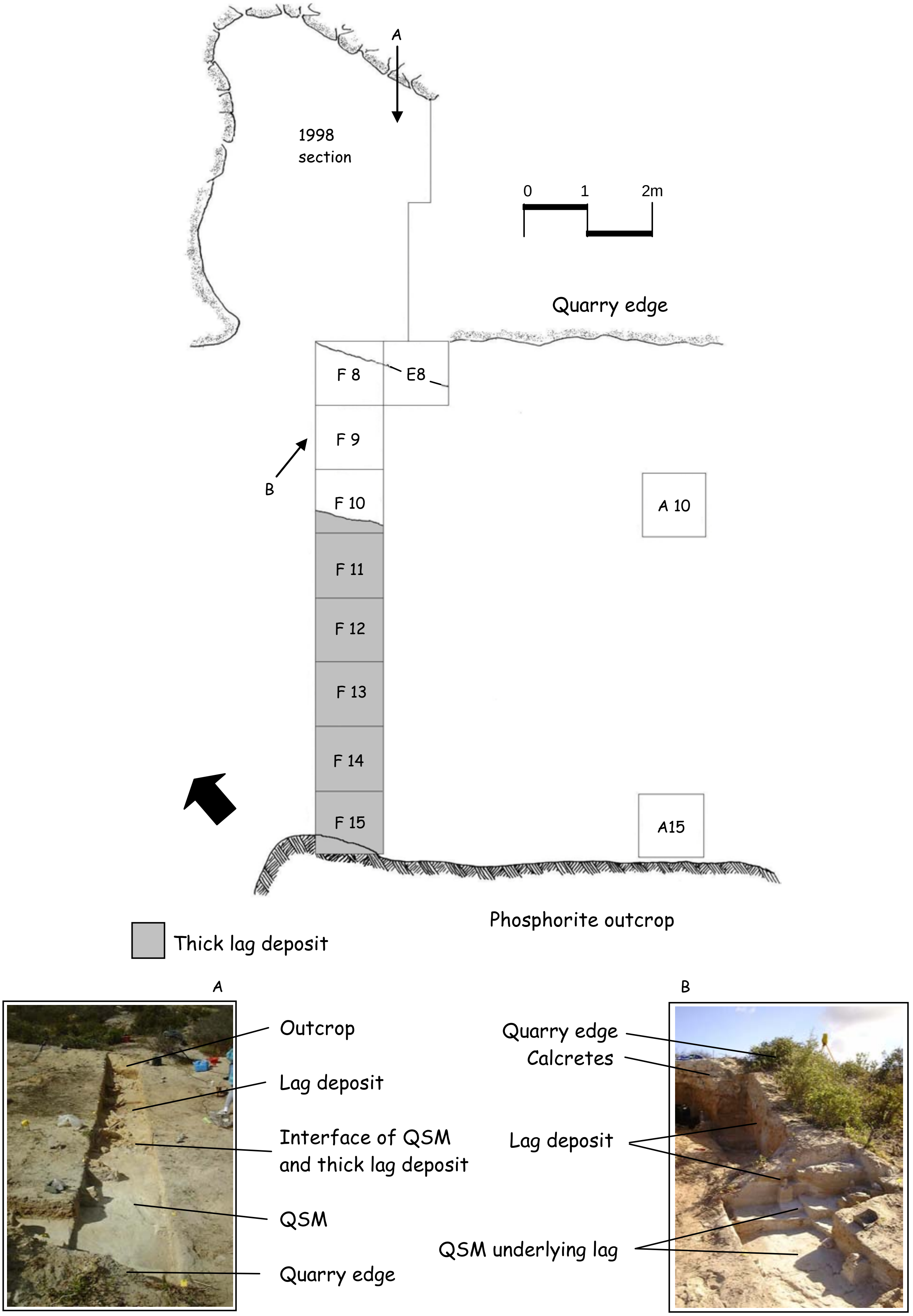
At first all the excavated deposit was passed through a 3mm dry sieve. However, this had to be discontinued once the wet excavation method was in use. The wet deposit was kept in labeled piles and eventually transported back to the mine office area for bulk wet sieving through a 1.5mm sieve. The resulting wet bone residue was spread on a large cement surface until it was thoroughly dry, after which it was collected and bagged for storage. Appendix A contains a list of bulk bags of sieved bone stored in the mine office laboratory.

3. FINDINGS

The trial excavations and relevant observations are described below. The locations of these are indicated on Figures 2&3.

3.1 Trial excavation A10

This was positioned on the highest part of the area between the outcrop and the quarry edge. The purpose of the excavation was to test whether the deposit in this area was undisturbed. Some fossil bone was located in the top consolidated surface layer. Underneath this was mostly sterile soft white sand of the QSM.



3 Detail of main excavation area

3.2 Trial excavation A15

This was positioned against the edge of the phosphorite rock outcrop. The deposit consisted of highly compacted red sediment that had to be removed with a jackhammer. Some fossil bone was found, however the sediment did not match the characteristics of the dense lag deposit described by Hendey (1976, 1982).

3.3 Trial excavation

A deep sounding was excavated away from the raised area to check for *in situ* deposits. Below a thin layer of surface material containing fragments of fossil bone, lay mostly sterile white quartzose sands.

3.4 1976 excavations

Since none of the trial excavations had produced any evidence of the lag deposit, a small section of the 1976 excavations were re-opened in order to examine the sections. This revealed that Hendey's excavation took the form of a number of 2m wide strips, each separated by a witness section of lag deposit about 250 mm thick. Unfortunately these had eroded down over the last 22 years leaving very little *in situ* material in place. Hendey excavated the lag deposit down to the QSM, at which point he appears to have stopped. Re-examination of the 1976 excavations showed that there was very little chance of finding good quality fossil material in the old excavation or the immediate area which had been mined down to the QSM.

3.5 Excavation E7- F15

Failure to locate the lag deposit motivated us to return to an area on the edge of the phosphorite outcrop (F15) where fragmented bone was visible in shallow sediments adhering to the edge of the stone. After removal of the surface layer, large quantities of bone were found including a number of diagnostic fragments. Further excavation in F15 soon produced 2 articulated vertebrae of an extinct short-necked giraffe (see Hendey 1976). At this point a decision was made to open squares F7-F14 forming a trench between the outcrop and the edge of the quarry. Many diagnostic bones were exposed in a hard matrix of riverine sediment and fragmented bone. Much of the bone was water rolled while the while many of diagnostic fragments (which were all part of the same stratigraphic unit) were better preserved. These had probably been parts of fairly fresh or semi-articulated carcasses, which had settled into older and more fragmented bone rich sediments.

Further excavation revealed a dense accumulation of bone that appears to have collected in what was once a large channel incised into the QSM. The full depth of the accumulation is not known as we were requested to leave large bones *in situ* for display, however, it can be stated with certainty that the frequency of diagnostic bone increases with depth. The existence of fossiliferous lag deposits on the surface of the outcrop indicates that this was also inundated in the past. A bank or raised area of the channel, which is clearly visible in the excavation, appears to have been very close to what is today the edge of the quarry. A section was cut into the side of the quarry to determine whether the lag deposit continued under the edge. This showed that although the lag deposit was thinner and wedges upwards, it contained well preserved bone, some of which was articulated. The implication of this is that there is material under the calcretes extending towards the side road back from the edge of the quarry. Fossil bone was also found in those areas where the excavation had cut into the older QSM on the edge of the channel. This occurred as isolated, often diagnostic bone fragments distributed within the sand body. Figure 4 is a schematic section drawing of the main excavation.

Preliminary observations indicate that the bones of microfauna, fish, medium and large bovids as well as carnivores were preserved in the lag deposit. Notable finds include the complete mandible of a *Sivatherium* (short neck giraffe) and teeth of *Agriotherium africanum* - an extinct bear (see Hendey 1977). Many of the larger diagnostic bones are from *sivatheres* indicating the possibility that a catastrophic event ended the lives a group of these animals, the carcasses of which were deposited in the river mouth during Pliocene times.

4. CONCLUSION

The results of the study are in agreement with Hendey's (1982) earlier findings. Nevertheless, many unanswered questions remain concerning the precise direction of river flow and the original extent of the deposits.

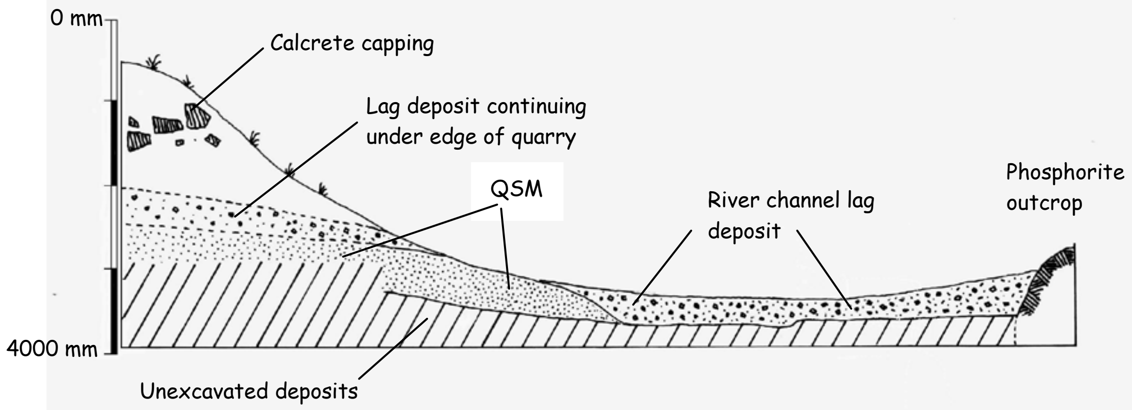
The concentration of bone that was discovered during the course of this project is probably the last remaining portion of the lag deposit left in "E" quarry although further material possibly exists under the calcretes where other portions of the river channel may lie. It is confirmed that remaining deposit between the phosphorite outcrop and the edge of the quarry as well as pockets of sediment on the outcrop itself contains fossil bones and deposits suitable for development into a site museum.

5. RECOMMENDATIONS

Having established that there is ample scope for development of a site museum, careful thought needs to be put into planning its future development. The launch event provoked a great deal of interest and it is important that this is followed up with prompt and visible action, which will result in the presentation of more finds to the public. At the same time careful consideration needs to be paid to the security of the site and protection of the material when construction activities begin. It is suggested that the pilot excavation be temporarily closed until such time that a suitably stable and secure environment has been created for displaying the finds. The following recommendations are a suggestion as to a way forward.

5.1 Protecting the existing excavation

Exposed bone will degenerate with regular exposure to the elements. Besides impacts caused by the natural environment, prior experience has shown that the greatest threat to exposed archaeological/palaeontological material is vandalism and illegal souvenir collection. Furthermore, unsupervised visitors to the site will trample sections and destroy bone. In order to solve both security and exposure problems it would be best to close the site to day



4 Section showing lag deposit between outcrop and quarry side visitors and backfill the trench with clean white sand until such time that a permanent structure is erected.

5.2 Future excavation

A professional team should be appointed to conduct an extensive excavation using the established baseline and the methods developed during the course of the pilot excavation to expose a large expanse of the fossil bearing deposits. Broadening of the existing trench towards the south east by 6m and towards the north-west by 3m should produce a spectacular array of *in situ* bone. Continuation of the excavation over the phosphorite outcrop will expose pockets of lag deposit and bone, which could be incorporated into the site museum. Similarly the excavation could also be extended into the existing side of the quarry revealing the edge of the pliocene channel. In selected areas the excavation could be deepened showing the full depth of the lag deposit and the underlying QSM. Figure 5 indicates the potential area that could usefully be exposed for display purposes. While staff are working on the site, small parties of visitors could be brought in under guidance to view the excavations in progress. A temporary viewing platform set up on the quarry edge above the site could also be considered. The excavation phase would also present an opportunity to keep the public informed on the progress of the project through regular press releases.

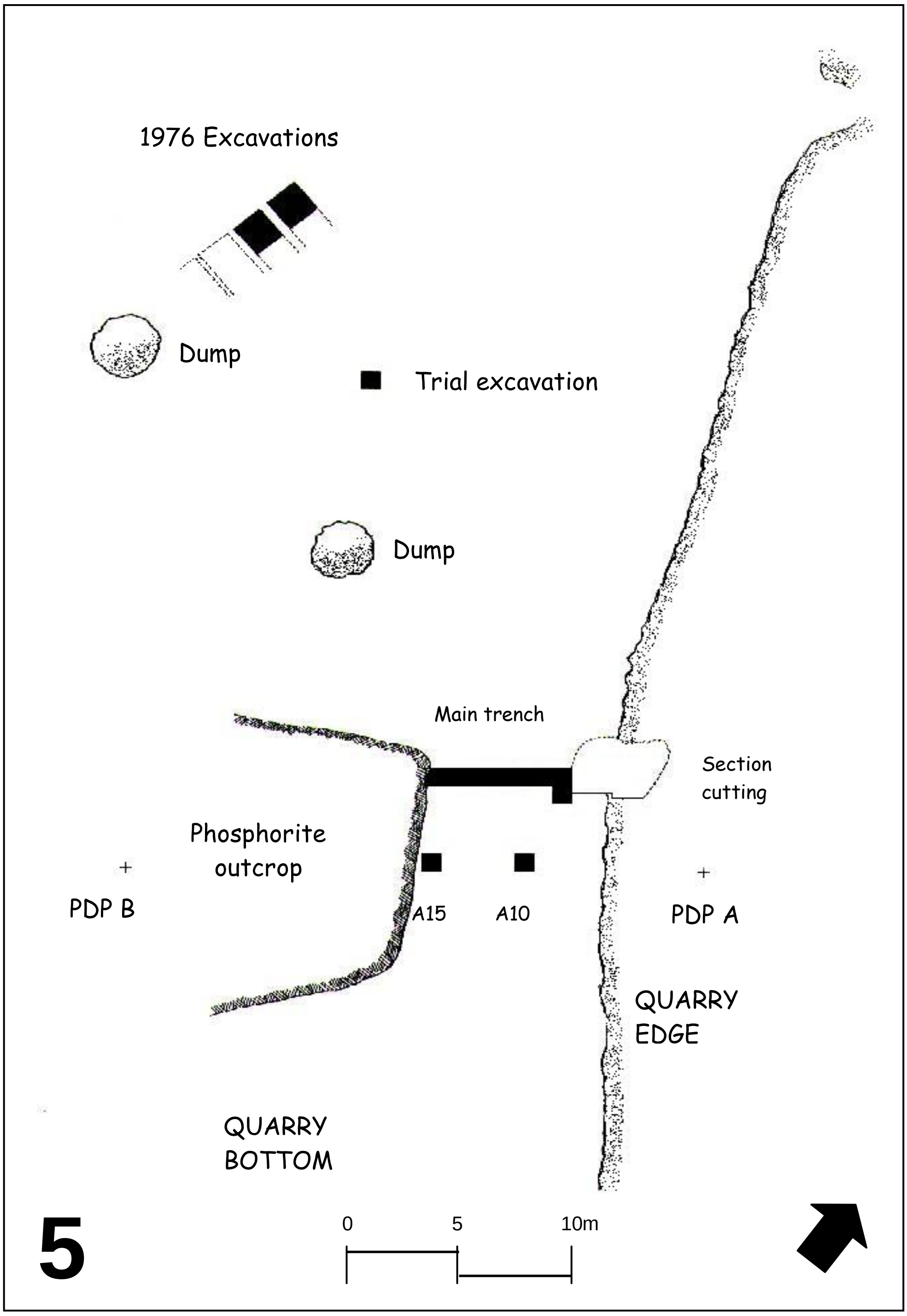
5.3 Establishing the site museum

On completing of the excavation, the project architects should be approached to examine the site to obtain specifications for design of the site museum. After this the entire site will need to be backfilled with clean sand to protect the finds, which would otherwise be badly impacted by contractors building the site museum.

Once the construction phase is complete, the backfill should be removed and museum technicians brought in to construct the display before the site is opened to the public.

5.4 Documenting the process

A photographic record should be kept showing the development of the site into a museum. This, together with photographs of the site taken by Hendey in the 1970s could form the basis of a display on the first discovery of the finds, the history of the research that took place and the eventual development of the fossil park.



Potential extent of future excavations for site museum

6. REFERENCES

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7. PROFESSIONAL TEAM

Principal investigators	Dave Halkett Tim Hart
Excavation	Dave Halkett Tim Hart Chopi Jerardino Mzumzima Mjikelizo Peter Nilssen Mzwandile Sasa Belinda Mutti

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APPENDIX A

Inventory of material from 1998 season in storage at Langebaanweg

DATE	SQUARE	UNIT	BAGS	SIEVE SIZE	COMMENT
18/09/98	E7	surface cleaning	1	1.5mm	small bag
18/09/98	E7	light brown	2	1.5mm	fine fraction
98	F7	light brown	2	1.5mm	fine fraction and large bone
98	F7	light brown in cutting	1	1.5mm	fine fraction
18/09/98	F7	surface cleaning	1	3mm	medium fraction
19/09/98	F8	surface deposit (cleanings)	1	1.5mm	fine fraction
19/09/98	F8	lag deposit	2	1.5mm	fine fraction
18/09/98	F9	surface cleaning	1	1.5mm	fine fraction
98	F9	lag deposit	1	pick up	large bone
98	F9	lag deposit	2	1.5mm	fine fraction
18/09/98	F10	surface cleaning	1	1.5mm	fine fraction
98	F10	lag deposit	7	1.5mm	fine fraction
98	F10	lag deposit	1	pick up	large bone
18/09/98	F11	lag deposit	1	3mm	medium fraction
98	F11	lag deposit	6	1.5mm	fine fraction
17/09/98	F11	surface cleaning	1	3mm	medium fraction
16/09/98	F12	surface cleaning	1	3mm	medium fraction
98	F12	lag deposit	9	1.5mm	fine fraction
98	F13	lag deposit	13	1.5mm	fine fraction
18/09/98	F13	surface cleaning	1	3mm	medium fraction
17/09/98	F14	lag deposit	3	3mm	medium fraction
98	F14	lag deposit	9	1.5mm	fine fraction
17/09/98	F14	surface cleaning	1	3mm	medium fraction
17/09/98	F15	lag deposit	3	3mm	medium fraction
17/09/98	F15	surface cleaning	1	3mm	medium fraction
16/09/98	76\2	cleanings above QSM	1	3mm	small bag
16/09/98	76\2	surface pickups in area of backfill	1	pick up	large bone
14/09/98	A10	mixed surface material	1	3mm	probably lag
15/09/98	E15	surface cleaning	1	3mm	probably lag
18/09/98		loose bone on surface	1	pick up	near north section
98	E/F	bone from section cutting	2	pick up	large bones
14/09/98	A15	surface cleaning	1	3mm	medium fraction
14/09/98	A10	surface	2.25	3mm	medium fraction
14/09/98	TEST A	yellow sand	1	3mm	small bag
14/09/98	TEST A	surface	0.25	3mm	mixed fraction