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COBERN STREET BURIAL GROUND: INVESTIGATING THE
IDENTITY AND LIFE HISTORIES OF THE UNDERCLASS OF
EIGHTEENTH CENTURY CAPE TOWN



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DISSERTATION

Submitted in fulfillment of the requirements for a Masters degree in Archaeology
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ABSTRACT

The Cobern Street site was shown to be a burial ground only in 1994, when a number of skeletons were disinterred prior to building operations. Attempts to locate documentary records of the burials have been unsuccessful, and we do not know who these people were. The lack of documentary records is unusual, and suggests that Cobern Street may have been the burial ground for lower-class citizens. From the history of the site, and the few items buried with the bodies, we can deduce that they are eighteenth century burials. As part of the investigation into the identity of these people five techniques of dietary tracing have been applied to 53 of the excavated skeletons, and are reported in this thesis. The methods comprise $^{13}\text{C}/^{12}\text{C}$ and $^{15}\text{N}/^{14}\text{N}$ measurements of bone collagen, $^{13}\text{C}/^{12}\text{C}$ of bone apatite, $^{87}\text{Sr}/^{86}\text{Sr}$ ratio measurements and bone density fractionation: a new technique that involves the separation and subsequent isotopic analysis of different fractions of bone, representing different periods of the individual's life. Analysis of different skeletal elements has allowed us to reconstruct the life histories of some of these people. Of particular interest are several skeletons with filed teeth. This practice is not known from the Cape, but is common further north in Africa. Isotopic analysis of teeth and long bones from the skeletons with decorated teeth show that these individuals were of tropical origin, from diverse areas, and are likely to be slaves brought to the Cape. Five individuals were buried on their right sides, and positioned at right angles to the rest of the burials. This style of burial has been interpreted as Muslim and these people may have come from the Indian Ocean world as immigrants or slaves. Some of the skeletons analysed appear to have spent, most if not all, their lives in the Cape colony. Differences between bone apatite and collagen $^{13}\text{C}/^{12}\text{C}$ ratios have proved difficult to interpret and the relationship is possibly more complicated than currently accepted in published literature. $^{87}\text{Sr}/^{86}\text{Sr}$ determinations, used in combination with the other isotopic indicators have helped to identify changes of diet and place of residence of some of these individuals. Bone density fractionation is a very new method. Its application in this study was hindered by the poor state of preservation of many of the Cobern Street bones, but it produced some promising results. The Cobern Street skeletons represent the eclectic mix that was the underclass of eighteenth century Cape Town.

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CHAPTER 1

INTRODUCTION

The Cobern Street burial ground is situated to west of the central business district and the harbour of modern Cape Town (Figure 1). It lay outside the formal burial grounds of the eighteenth and nineteenth centuries and was not marked as a cemetery on contemporary maps (Figures 2; see also figure 19). It has not been possible to trace the history of the ground in detail, but we know that terrace houses had been built on the site by 1862. The existence of the burials had presumably been forgotten, and they were not rediscovered until 1994 when construction on the site unearthed the remains of the dead. The rescue work, directed by Alan Morris, led to the excavation of sixty-three intact graves and various scatters of bone representing a total of 121 individuals. These skeletons have provided a unique opportunity for anatomists and archaeologists to study a large sample of individuals representing part of colonial Cape Town. The objectives have been to discover who these people were and to find out more about their lifestyles by analysing their demographic profile and observing the effects of disease and trauma on their bones. In this thesis a new dimension will be added to the information already assembled: diet. Through the analysis of their diets I will investigate, among other issues, the question of whether they originated in other parts of the world or spent all their lives in Cape Town.

The remainder of this thesis is divided into eight chapters. Chapter 2 will include a brief discussion on the discovery and excavation of the site. Scientists from the Department of Anatomy and Cell Biology have already completed a considerable volume of work on the skeletons recovered. This has included the aging and sexing of the skeletons and a study of all the observable pathologies. Apollonio (1998) classified the different burial styles at Cobern Street and described the numerous artefacts associated with these graves. We know from these studies that the material dates to the second half of the eighteenth and early nineteenth centuries. Cobern Street was probably in use as a burial ground from about 1755 to 1827, although some burials could have taken place before 1755.

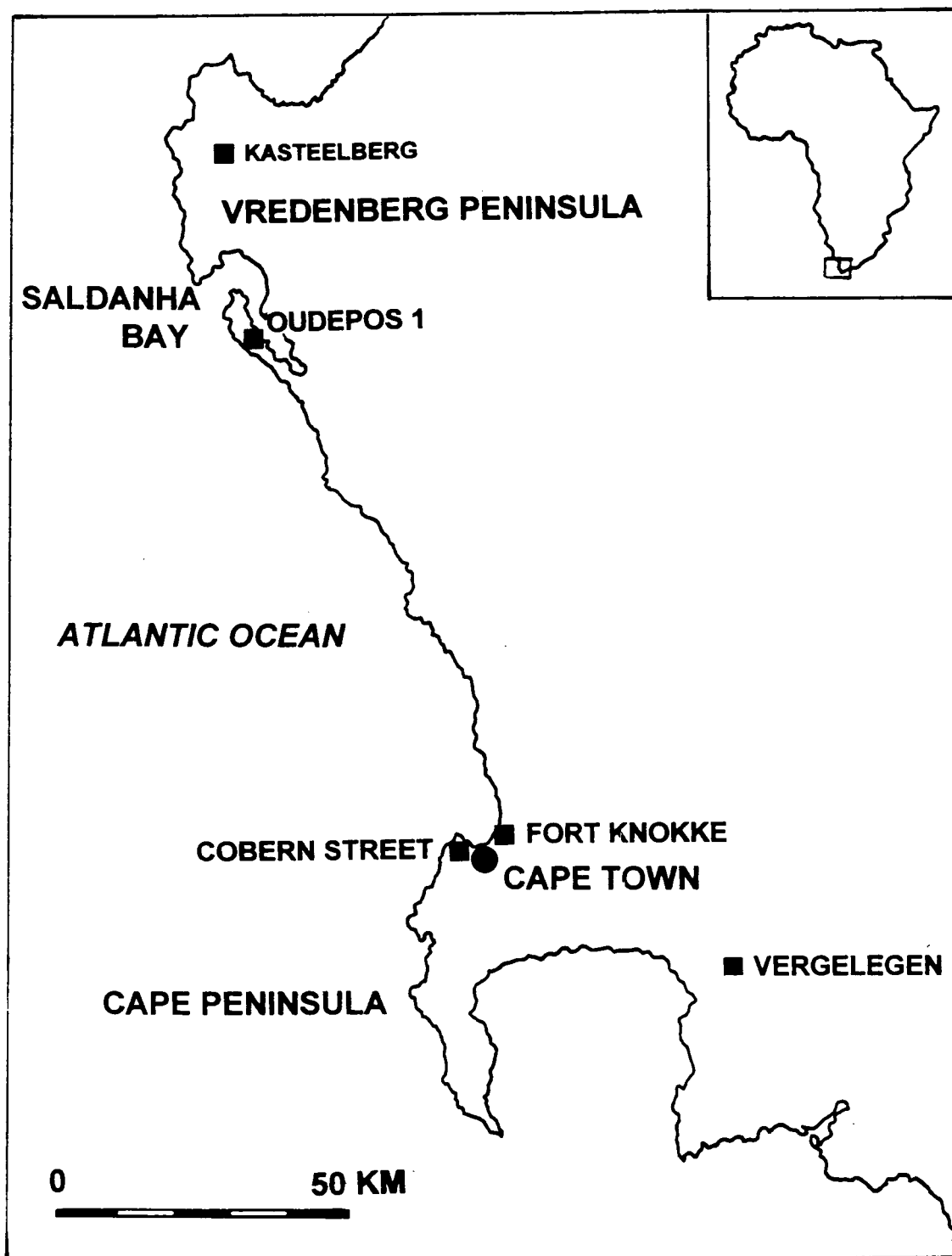


Figure 1: Map of the south-western Cape showing archaeological sites mentioned in the text

If we are to discover the identity of the people buried at Cobern Street it is important to consider who was living in Cape Town for the entire period from 1652 to around 1820. Focus will be placed on the underclass of 18th century Cape Town, as it has been suggested in Apollonio's work that they used the area around Somerset Road as their burial ground (Figures 19 and 21). In Chapter 3 the demography of Cape Town will be discussed. The geographical origins of the colonists will be studied in detail, especially the origin of the many slaves brought to the Cape.

Information on foods eaten in Cape Town from the seventeenth to the early nineteenth centuries will be summarised. As in any isotopic study, it is very important to have a thorough understanding of the dietary resources available at the Cape and also in the countries where the colonists originated. Historians have looked into health and diet at the Cape in considerable detail (Laidler & Gelfand 1971). Contemporary observers also referred to the food resources available in Cape Town. The people of Cape Town came from diverse cultures and countries with different climates, where different crops were grown. What did these people eat in their countries of origin? Once we have determined what a likely diet would have included it becomes possible to interpret the isotopic signatures. Previous archaeological studies of foodways in Cape Town have focused on faunal remains and ceramics (Graf 1996, Abrahams 1996). These studies are made more difficult by the fact that not all faunal and floral dietary items survive. Isotopic analysis provides a more complete means of reconstructing diet.

In Chapter 4 an attempt will be made to discover where people were buried in Cape Town, especially the underclass. Many of the death notices for members of the Dutch Reformed Church (DRC) mention where they were buried. However this and other church registers (e.g. that of the St. George's church) include few slaves or freed slaves. Mohammedan priests have no available death records (Judges 1977). The death notices throughout Cape Town's history are incomplete, especially those of slaves, because it cost the owners money to bury the dead. Chapter 4 will include as comprehensive as possible a study of the burial grounds of Cape Town, with special consideration of where slaves, poorer people and people of non-Christian faiths may have been buried.

Isotopic measurements of human skeletons are becoming a routine component of archaeological research. A number of techniques are often combined in order to obtain more detailed and reliable information. The most widely used methods are carbon and nitrogen isotope ratio measurements in bone collagen, carbon in bone apatite and analysis of strontium, a trace element. Work done so far will be reviewed in Chapter 5. Studies especially pertinent to this thesis include work done on Western Cape prehistoric skeletons, other colonial sites and work done at historical sites in and around Cape Town. The focus of this thesis is to develop life histories for the people buried at Cobern Street. A new technique (bone density fractionation) is currently being developed for studying changes in diet during life and it was applied to some of the Cobern Street skeletons with some success.

Questions to be addressed include:

- 1) What is the range of variation in diet among individuals buried at Cobern Street?
- 2) Is there a correlation between diet and burial style?
- 3) Did some of these individuals come to the Cape from elsewhere (i.e. were they immigrants, voluntary or otherwise)?
- 4) To compare the isotopic profiles of the Cobern Street skeletons with those of historic period skeletons from Woodstock Beach near to the old Fort Knokke and Vergelegen, thus expanding our database of isotopic results for historical skeletons from the Cape, especially skeletons likely to be the remains of slaves.

In addition, the isotopic analysis will help to identify first and second generation Cape Town residents.

Chapter 6 describes the analytical methods that will be employed in this study. Chapter 7 describes how the skeletons were sampled for isotopic analysis, and gives details of

burial type, pathological observations and artefacts associated with each burial. Chapter 8 summarises the results of the five isotopic analytical techniques employed. Chapter 9 presents a discussion and synthesis of the various avenues of evidence presented in this thesis. It highlights the most important discoveries and conclusions.

Dietary studies will confirm whether these people were slaves or immigrants or whether they had lived in the Cape all their lives. Artefacts and anatomical pathologies can be interpreted together with dietary history to form a more complete picture of life in 18th century Cape Town.

This project will draw on the work of a number of historians and archaeologists in order to set the scene for the analyses of the Cobern Street skeletons. Their work and that presented here will hopefully, bring us closer to an archaeology of slavery at the Cape. This project provides a unique opportunity to use archaeology to support or refute the documentary sources. Identifying the origin of these people buried at Cobern Street by looking at diet, burial style and other features (e.g. decorated teeth) will in turn help to interpret the grave goods found with some of these individuals. This study of a colonial slave society will hopefully have value, beyond South Africa, perhaps as a comparison with other sites where members of the underclass were buried, e.g. in Barbados and New York.

CHAPTER 2

PREVIOUS WORK DONE ON THE COBERN STREET BURIALS

This chapter consists of a brief summary of the considerable body of work that has been completed on the Cobern Street burials so far. The excavation, anatomical analysis, burial patterns and archaeological material will be outlined. This work has been done by a team of investigators led by Professor Alan Morris of the University of Cape Town's Department of Anatomy and Cell Biology.

EXCAVATION

The site was rediscovered when construction work in September 1994 in Cobern Street, Green Point (Figure 2, see also figures 19 & 21) revealed human skeletal remains. The property owner had obtained a permit from the city council to demolish the two existing houses on the site, and build a four-story business complex. The police were immediately informed. They investigated the remains and found that they were not recent and therefore not considered important and construction continued unabated. For three weeks bones were broken up and discarded illegally (Exhumations ordinance No.12 1980). This illegal removal was finally brought to the attention of anatomist Alan Morris who wrote to the National Monuments Council, requesting that construction be halted so that the skeletal remains could be properly removed (Morris 1997). After some delay permission was given for a rescue excavation to take place under the direction of Alan Morris.

The cemetery was excavated from 16 December to 23 December 1994 and again from 3 January to 18 January 1995. Alan Morris and the Archaeology Contracts Office at UCT undertook the exhumations with the assistance of John Gribble of the National Monuments Council and volunteers from the South African Archaeological Society. The standing structures were demolished. The building foundations dated to the nineteenth

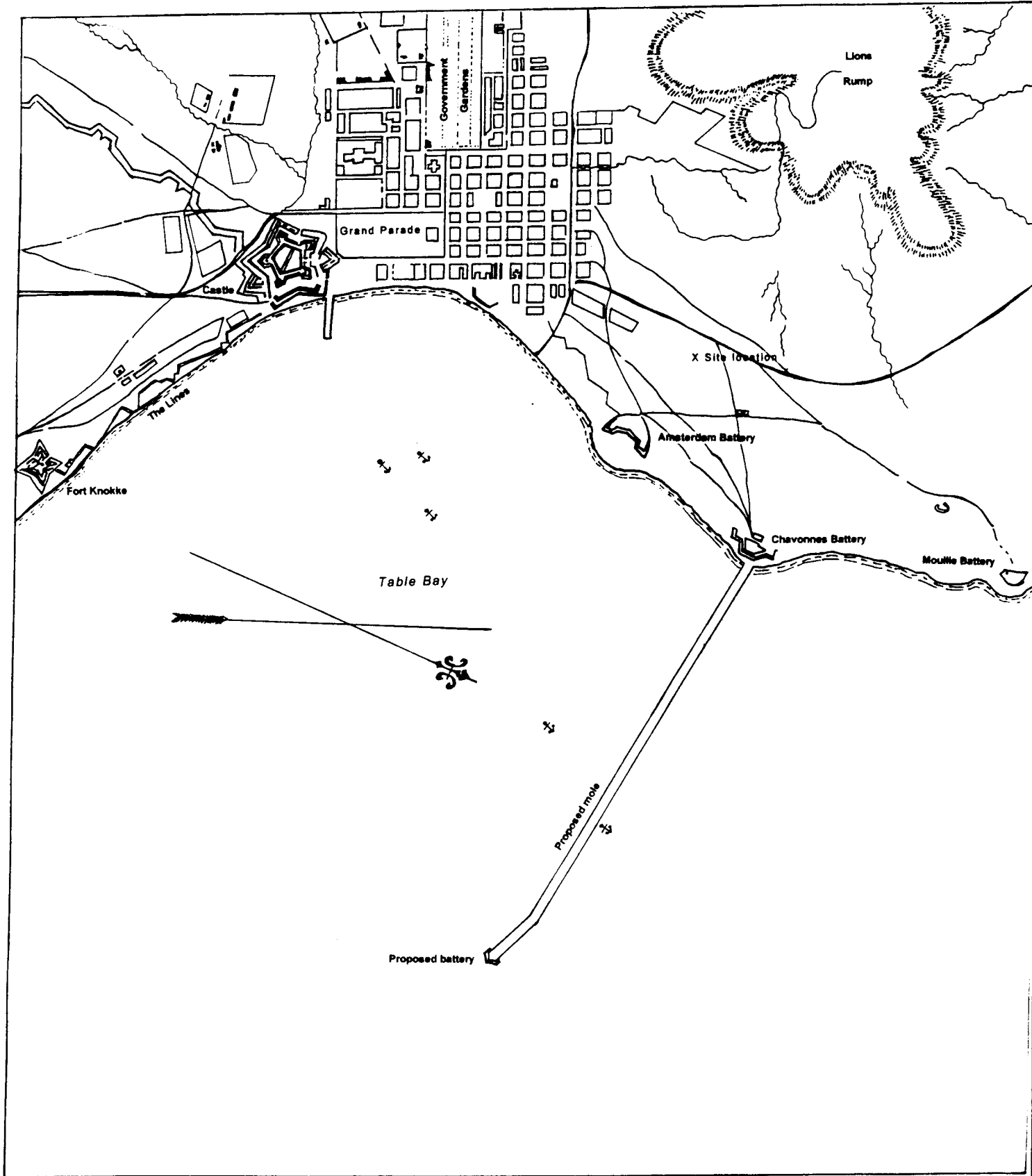


Figure 2: State of the Cape of Good Hope, 1822 (Bird 1823).

century and probably represent the first structures on the site (Halkett *et al.* 1995). (For a more detailed discussion of the site see Apollonio 1998). Excavations revealed 63 intact graves. Each grave was assigned a number between 10 and 65. Some graves included more than one individual and in these cases the skeletons were assigned letters (i.e. Burial 14A, 14B). In all, 121 individuals are represented in the sample (Constant & Louw 1997). Some individuals were present only as bone scatters, and a number of graves were disturbed by later burials. In this thesis the excavation numbers will be used to refer to individuals (Appendix 1).

DATES

Cobern Street is located in an area of Cape Town that, during colonial times, was used for cemeteries; however this particular piece of ground was not recorded as having been used for burials. Contemporary observers, for example Johannes Schumacher, illustrated grave markers outside the official burial grounds of the eighteenth century (Hallema 1951) (Figures 3 & 4). Gordon identified a *slaaven begraafplaats* [slave burial ground] to the north west of the Burgher Kerkhof and the Soldaten Kerkhof (Cape Archives (CA): AR TOPO 120F, AR TOPO 1585). This map is dated to circa 1790. It is not possible to trace the ownership of the Cobern Street site before 1827. In this year, it became the property of Mr G.H. Meyer and was prepared for development (Deeds Office (DO): Grant, Vol. 1 no. 79, 2.2.1827; Diagram 15/1827). It is unlikely that the site would have been used for burials once ground had been sold for development, so the burials are probably eighteenth-century. The site was probably in use as a burial ground by the 1760's and may have been used earlier when the official burial grounds became full (for a detailed discussion of the chronology see Chapter 4). Because it was not considered important enough to be marked on official plans as a graveyard, and because of the nature of the burials uncovered, Cobern Street has been interpreted as being a burial ground of the lower classes of Cape Town.

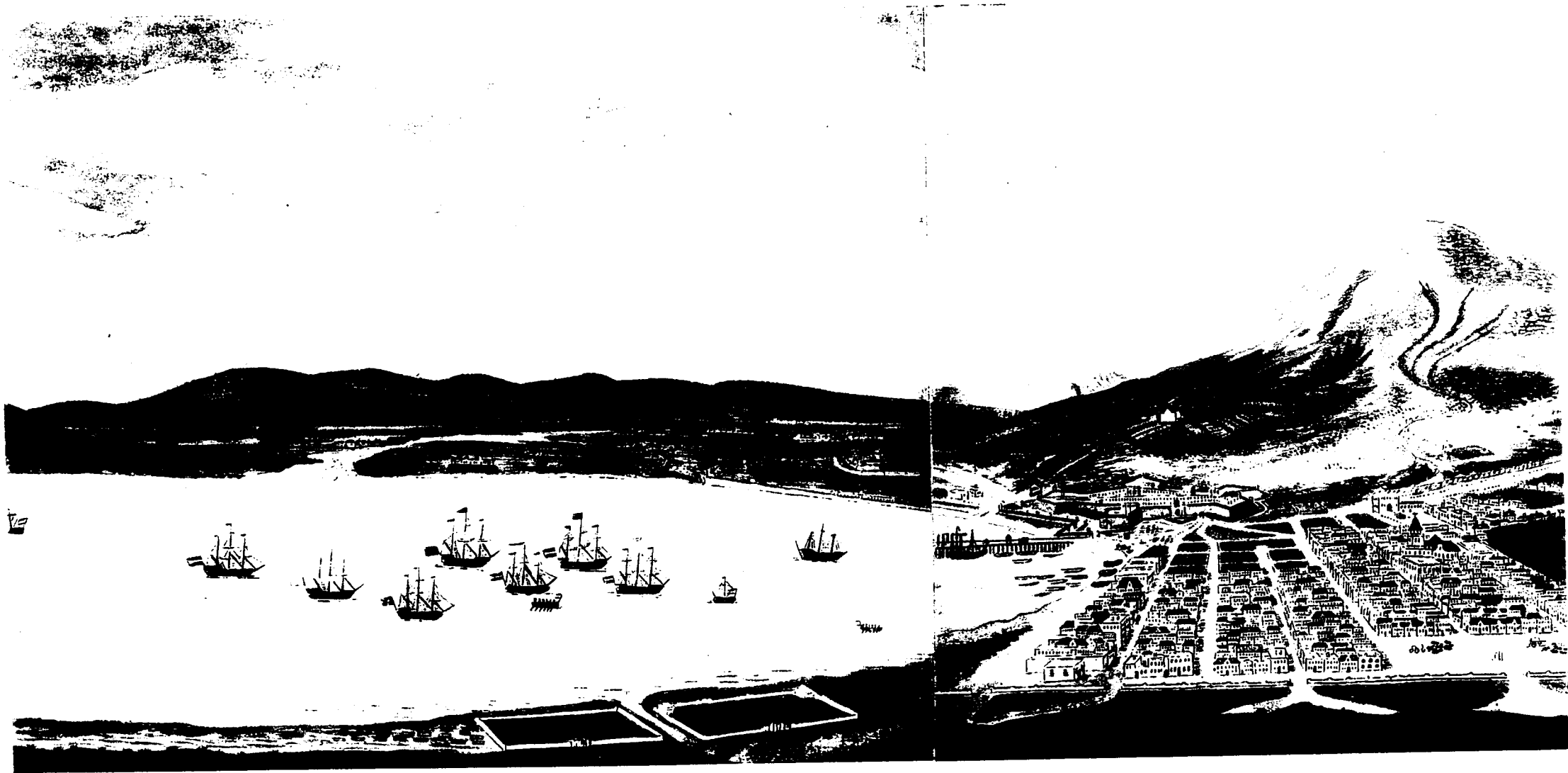


Figure 3: Schumacher's panorama from Signal Hill, 1776, showing the Colonial Burial grounds at left foreground (Hallema 1951)

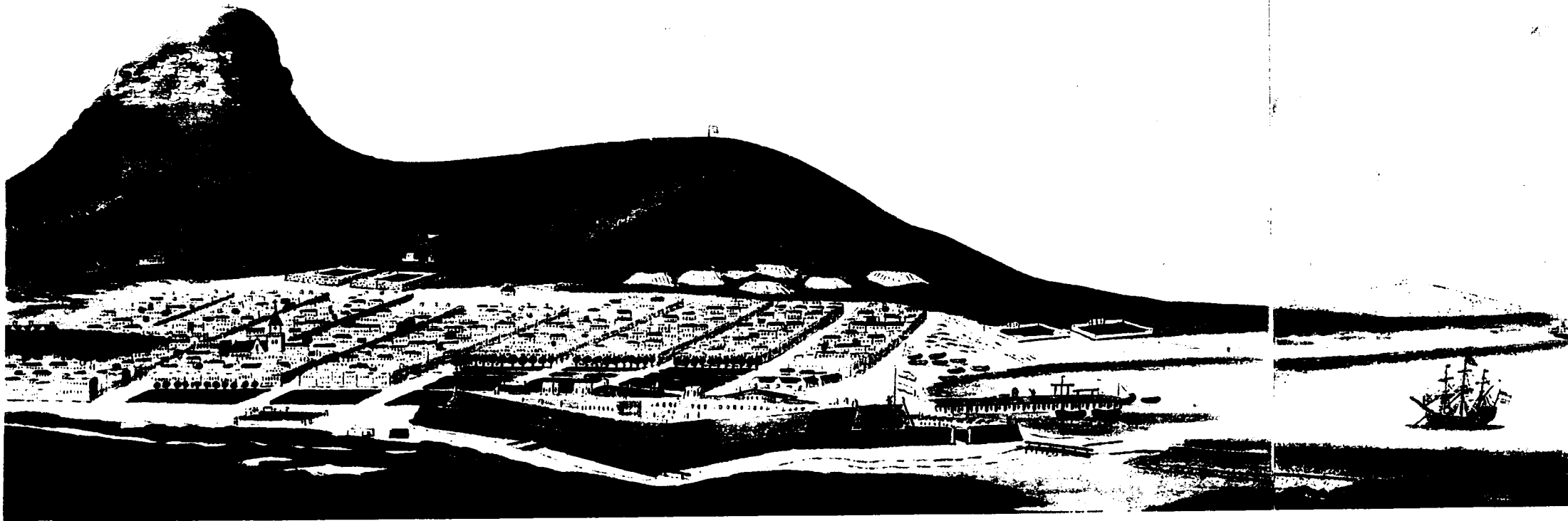


Figure 4: Schumacher's panorama from across Table Bay, 1776, showing the Colonial Burial grounds on the right (Hallema 1951)

ANALYSIS

The skeletal material is housed at the Department of Anatomy and Cell Biology at the University of Cape Town. A series of preliminary reports have been completed on the skeletal remains (Apollonio 1997; Constant & Louw 1997; Holtzhausen & Slater 1997; Ledger 1997; Morris 1997; Morris & Phillips 1997). These reports include information on the background of the site, age and sex of skeletons, paleopathological evaluation, dental health and practices as well as a biomechanical analysis of the long bones.

The cultural material was transferred to the Department of Archaeology at the University of Cape Town, where Antonia Malan did the initial analysis and archival study. Otto Graf, then a post graduate student in the Department of Archaeology, prepared a report on the tobacco pipes from the site. Mike Wilson of the South African Museum (SAM) prepared a report on the Khoikhoi pot found with one of two Later Stone Age (LSA) burials. Graham Avery of SAM identified non-human faunal material (Avery & Morris 1997; Graf 1995; Wilson 1995). Heather Apollonio has completed her Masters thesis examining the mortuary practices of the people buried at Cobern Street (1998).

Age and sex estimations

The methods used for sexing the adult skeletons included assigning scores and weightings to seven pelvic and fifteen cranial features. Age was determined by examining morphology of the pubic symphyses and rib ends, as well as the extent of cranial suture closure. Individuals were classified as either young (20-30 years old), middle-aged (35-50) or old adults (50+) (Figure 5). Juveniles were treated separately, and classified into age categories as follows: 1-5, 6-10, 11-15 and 16-20 years.

Aging and sexing was performed on all available skeletons, including scatters of bone. There were 88 adults and 33 subadults in the entire collection. Of 26 female adults, 9 were young, 16 were middle-aged, and 1 was uncategorised. There were 29 male adults of whom 9 were young, 16 were middle-aged, 1 was old and 3 were uncategorised. The remainder of the adult skeletons were too fragmentary for aging and sexing (Constant and

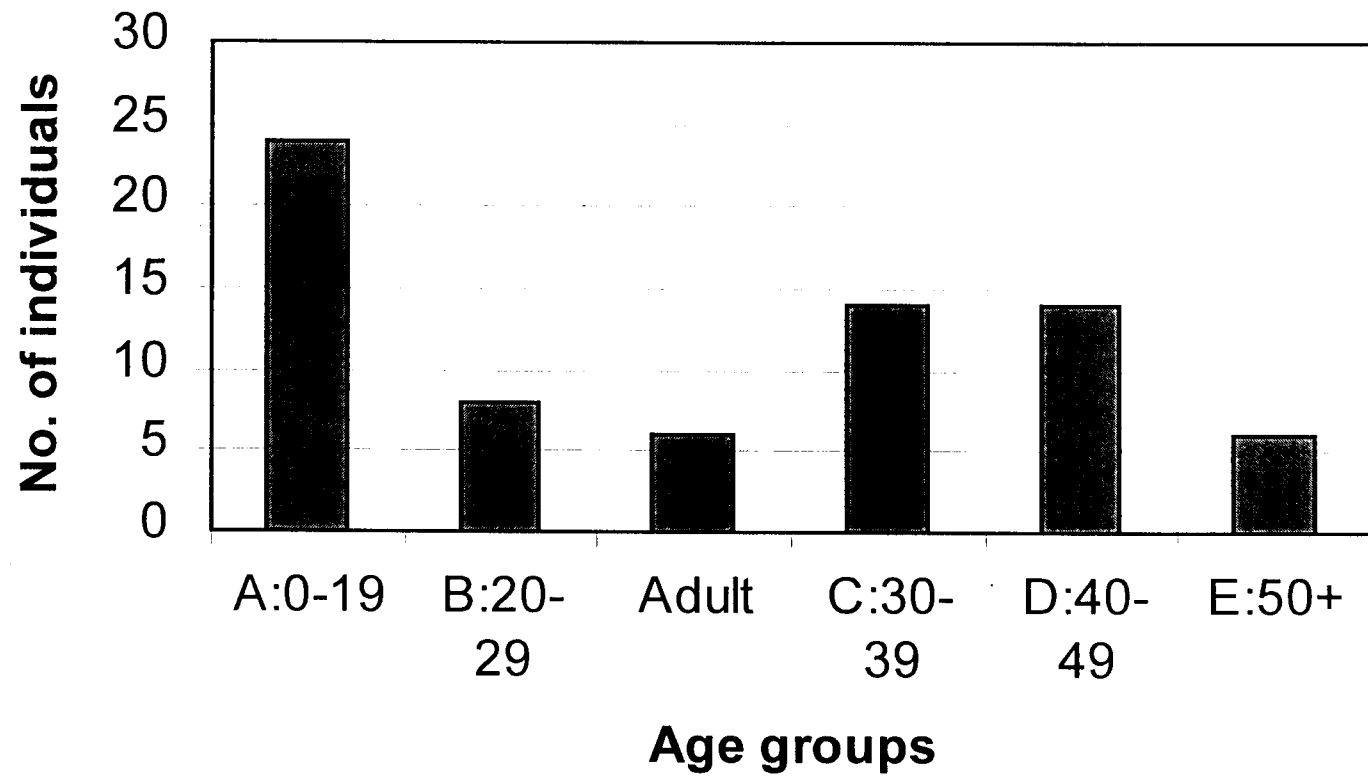


Figure 5: Demography of the people buried at Cobern Street

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BURIAL TYPES

Apollonio (1998) divided the human remains from Cobern Street into four distinct burial types, representing three styles of interment.

Burial type	Position	No. of graves	No of individuals	% of Graves	Total
A	Vertically flexed	2	4	3.2%	
B	Extended on back	45	48	71.4%	
C	Extended on right side	5	5	7.9%	
D	Bone scatters	9	13	14.3%	
?	unclassified	2	2	3.2%	
TOTAL		63	72	100%	

Table 1: Burial types (Apollonio 1998)

There are 121 individuals represented at Cobern Street. The total on Apollonio's table is 72. The individuals not included on this table fall into the Type D category.

Type A

Two graves have been classified as Type A. These belong to the Later Stone Age, and thus considerably pre-date most of the interments at Cobern Street. Later Stone Age burials are fairly frequently encountered along the Cape Coast (Morris 1992b). Each of the two Later Stone Age graves at Cobern Street contains two individuals, buried under a stone cairn: a heap of stone, which probably served both to mark and protect the grave. The cairn above Burial 37 was 110cm wide by 120cm high. The cairn of Burial 42 was roughly the same size. Marine shells were mixed in with the stones. Artefacts associated with the burials include: stone tools, ochre, pottery and a tortoise carapace bowl. They have been radiocarbon dated, but the dates are somewhat confusing. In each grave, one

skeleton lies above the other, and thus was presumably interred later. In one cairn (Burial 37) the topmost burial (37A) has a date of AD 896 (Table 2) whereas the lower burial (37B) has a date of AD 1252. Burial 37A is fully articulated and shows no sign of disturbance and it is unlikely that it is the older of the two. In an attempt to resolve this problem, the skeletons were re-dated, however the new date for Burial 37A (AD 779) is similar to the original one. Burial 42A has a date of AD 1015, unfortunately the bone from Burial 42B did not contain enough collagen for analysis. Apollonio (1998) has concluded that these burials are unrelated to the historic period graves at the site. The tops of the cairns would have been hidden beneath the land surface, before any of the historic period interments took place.

Analysis #	Burial	¹⁴ C Age (years BP)	δ ¹³ C	Calibrated date (AD)	% Suitable carbon
Pta-6862	37A	1180±50	-14.2 ‰	AD 874(896)980	2.0% from 64.1g
	37A*	1290±60	-14.2 ‰	AD 689(779)874	2.0% from (N/A)
Pta-6866	37B	840±80	-15.8 ‰	AD 1182(1252)1286	1.2% from 51.8g
Pta-6869	42A	1060±70	-15.9 ‰	AD 980(1015)1041	1.0% from 78.8g

Table 2: Results of radiocarbon analysis. Calibrated for the Southern Hemisphere with the Pretoria programme (Talma & Vogel 1993). The one-sigma range is given, with the most probable date between brackets. * Repeat

Type B

Type B is the predominant burial pattern: the body interred in a supine position with the arms folded over the pelvis or at the sides of the body. 79.5% of the Type B burials show some evidence of being interred in a coffin. 56% of individuals at the site were buried in coffins. Apollonio (1998) has suggested that some of the coffin material may have been overlooked during excavation or was not visible. Copper pins and pieces of cloth were found associated with nine of the burials: probably the remains of burial shrouds.



Figure 6: Type C burials: Burials 32 (left) and 57 (right)

Type C

Type C were deep lying side burials (Table 4). There were five Type C burials in total, three of which were niche burials (Table 3). Niche burials include alcoves or recesses cut into the wall of the grave shaft, for the head and feet (Figure 6). These burials are deeper than the Type B burials and minimally disturbed. The bodies were interred lying on their right sides "...and the axial orientation is pointing north or north-west, in line with Signal Hill and at right angles to a majority of the Type B burials..." (Apollonio 1998:60). No burial items or evidence of coffins or burial shrouds were found with the Type C burials.

Burial No.	UCT Anatomy No.	Age	Sex	Niche
32	526	50-60	Male	
57	555	20-30	Female	Yes
59	557	40	Male	
64	562	35-40	Male	Yes
65	563	22-25	Female	Yes

Table 3: Age and sex distribution of Type C burials (Apollonio 1998)

Type D

Type D consists of scatters of bone. Many of these were disturbed burials, where older burials had been moved to make room for more recent interments. Some Type D burials represented semi-articulated individuals who were reclassified as scatters when there was not enough contextual information to identify the burial style. In some cases loose bones were piled on top of the coffin of the newer burial. A possible explanation is that this site may have been used for hasty and frequent burials during one of the smallpox epidemics dating to 1713, 1755, 1812-13, 1840 and 1862 (Apollonio 1998). A number of these disturbed burials may also be the result of construction activities when the site was leveled in the second quarter of the nineteenth century (mentioned earlier).

Others

Three graves contained multiple individuals (Burials 14, 20 and 27). Apollonio (1998) noted that two burials could not be classified because they have features of more than one type. Burial 20 has been assigned to the Type B group but with a question mark. Burial

20 contains two adults and a child (Cover). There is evidence of a coffin and this is the reason why this burial has been assigned to the Type B category. The bodies are positioned on their sides, resembling the Type C style. They may, however, have been buried on their sides so that both of them could fit into one coffin. Burial 14 was a coffin burial that contained two individuals. Burial 14A was an adult woman (evidence of a shroud) and 14B was an infant. Burial 27 was a male buried in a coffin. The burial shaft contained human bone, which indicated disturbances of multiple earlier burials.

SPATIAL LAYOUT

Apollonio (1998) investigated the spatial layout of the site and plotted the positions of the graves on a series of overlays based on depth above or below a datum. The shallowest graves occur at forty centimeters above datum, and the deepest were one hundred and three centimeters below datum. It was hoped that this approach might yield information on the chronology of the burials-were the deepest burials also the oldest? Unfortunately it was not possible to infer a general chronology based on burial depth. However it may be of some significance to note the burials that occur at the deepest levels.

Depth of burial	Burial No.	Type	Features
130cm	37	A	Later Stone Age
120cm	60	B	Decorated teeth
100cm	61	B	Artefacts: date '1764'
	64	C	Niche
80cm	50	B	Decorated teeth
	51	B	Earthenware pendant
	52	B	Pipe: date 1690/1725 to 1847 Decorated teeth, Buttons
	56	B	
	59	C	
	65	C	Niche

Table 4: List of burials at deepest levels below datum

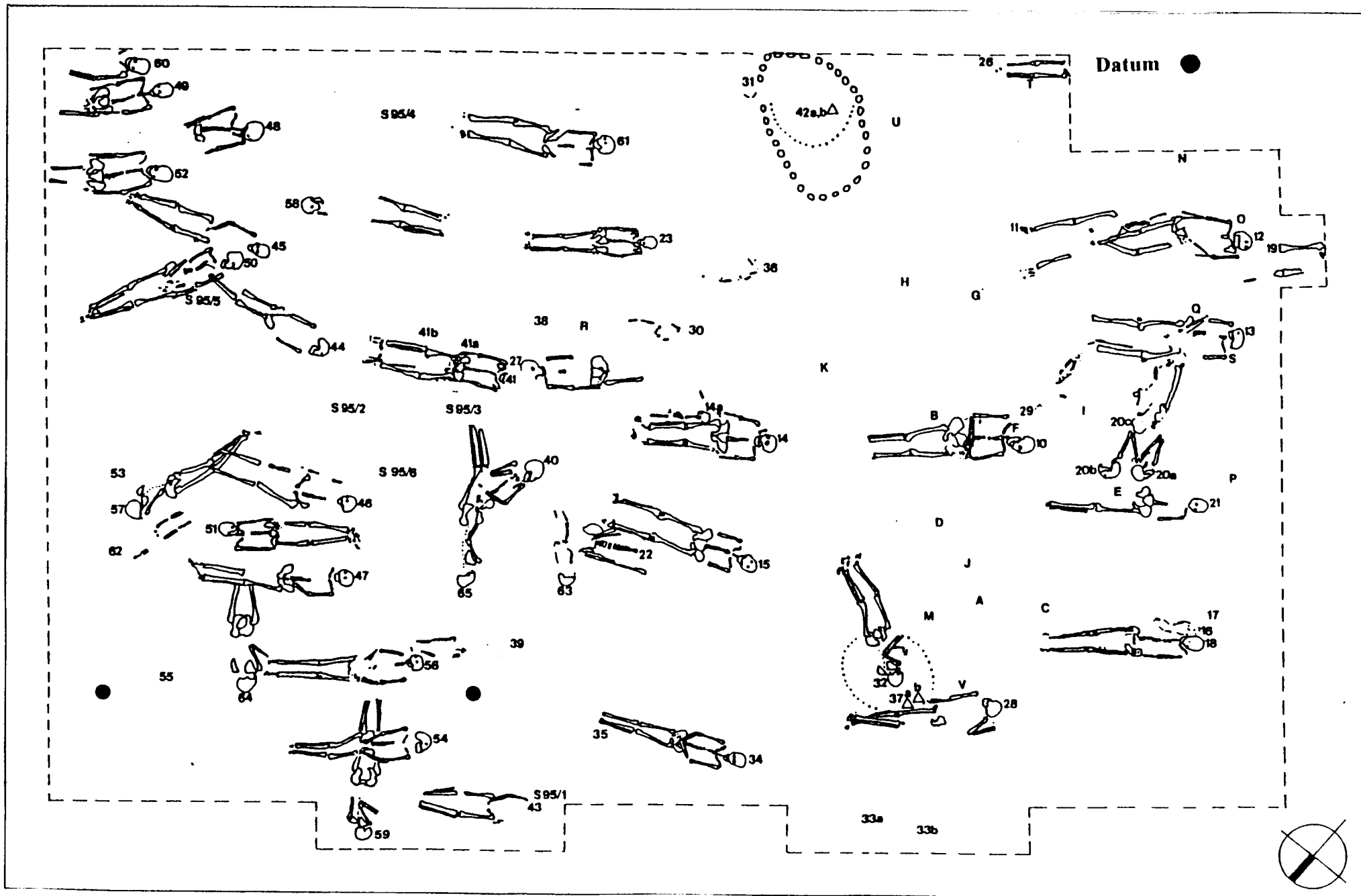


Figure 7: Spatial layout of the skeletons from Cobern Street

CHAPTER 2

PREVIOUS WORK DONE ON THE COBERN STREET BURIALS

This chapter consists of a brief summary of the considerable body of work that has been completed on the Cobern Street burials so far. The excavation, anatomical analysis, burial patterns and archaeological material will be outlined. This work has been done by a team of investigators led by Professor Alan Morris of the University of Cape Town's Department of Anatomy and Cell Biology.

EXCAVATION

The site was rediscovered when construction work in September 1994 in Cobern Street, Green Point (Figure 2, see also figures 19 & 21) revealed human skeletal remains. The property owner had obtained a permit from the city council to demolish the two existing houses on the site, and build a four-story business complex. The police were immediately informed. They investigated the remains and found that they were not recent and therefore not considered important and construction continued unabated. For three weeks bones were broken up and discarded illegally (Exhumations ordinance No.12 1980). This illegal removal was finally brought to the attention of anatomist Alan Morris who wrote to the National Monuments Council, requesting that construction be halted so that the skeletal remains could be properly removed (Morris 1997). After some delay permission was given for a rescue excavation to take place under the direction of Alan Morris.

The cemetery was excavated from 16 December to 23 December 1994 and again from 3 January to 18 January 1995. Alan Morris and the Archaeology Contracts Office at UCT undertook the exhumations with the assistance of John Gribble of the National Monuments Council and volunteers from the South African Archaeological Society. The standing structures were demolished. The building foundations dated to the nineteenth

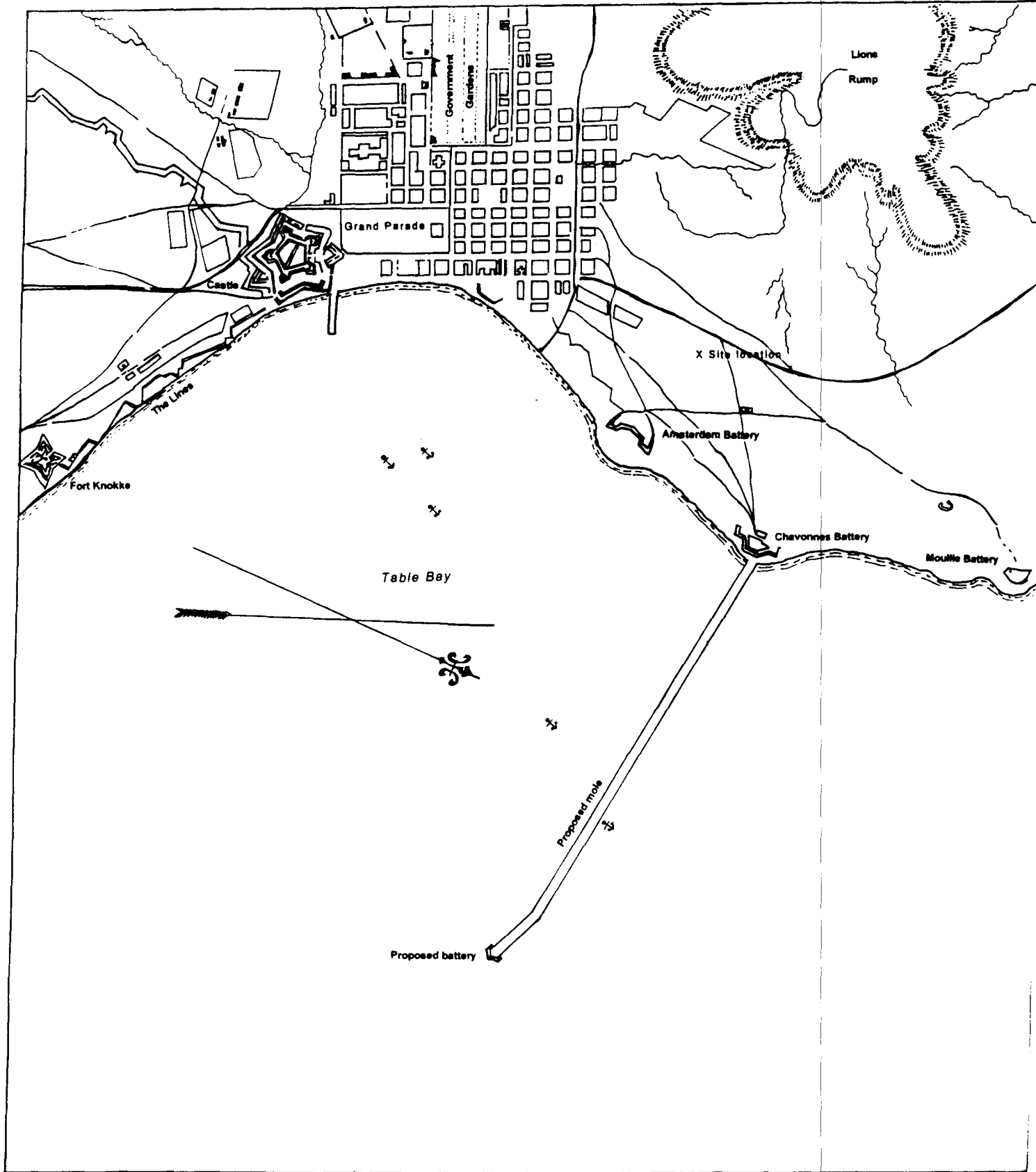


Figure 2: State of the Cape of Good Hope, 1822 (Bird 1823).

century and probably represent the first structures on the site (Halkett *et al.* 1995). (For a more detailed discussion of the site see Apollonio 1998). Excavations revealed 63 intact graves. Each grave was assigned a number between 10 and 65. Some graves included more than one individual and in these cases the skeletons were assigned letters (i.e. Burial 14A, 14B). In all, 121 individuals are represented in the sample (Constant & Louw 1997). Some individuals were present only as bone scatters, and a number of graves were disturbed by later burials. In this thesis the excavation numbers will be used to refer to individuals (Appendix 1).

DATES

Cobern Street is located in an area of Cape Town that, during colonial times, was used for cemeteries; however this particular piece of ground was not recorded as having been used for burials. Contemporary observers, for example Johannes Schumacher, illustrated grave markers outside the official burial grounds of the eighteenth century (Hallema 1951) (Figures 3 & 4). Gordon identified a *slaaven begraafplaats* [slave burial ground] to the north west of the Burgher Kerkhof and the Soldaten Kerkhof (Cape Archives (CA): AR TOPO 120F, AR TOPO 1585). This map is dated to circa 1790. It is not possible to trace the ownership of the Cobern Street site before 1827. In this year, it became the property of Mr G.H. Meyer and was prepared for development (Deeds Office (DO): Grant, Vol. 1 no. 79, 2.2.1827; Diagram 15/1827). It is unlikely that the site would have been used for burials once ground had been sold for development, so the burials are probably eighteenth-century. The site was probably in use as a burial ground by the 1760's and may have been used earlier when the official burial grounds became full (for a detailed discussion of the chronology see Chapter 4). Because it was not considered important enough to be marked on official plans as a graveyard, and because of the nature of the burials uncovered, Cobern Street has been interpreted as being a burial ground of the lower classes of Cape Town.

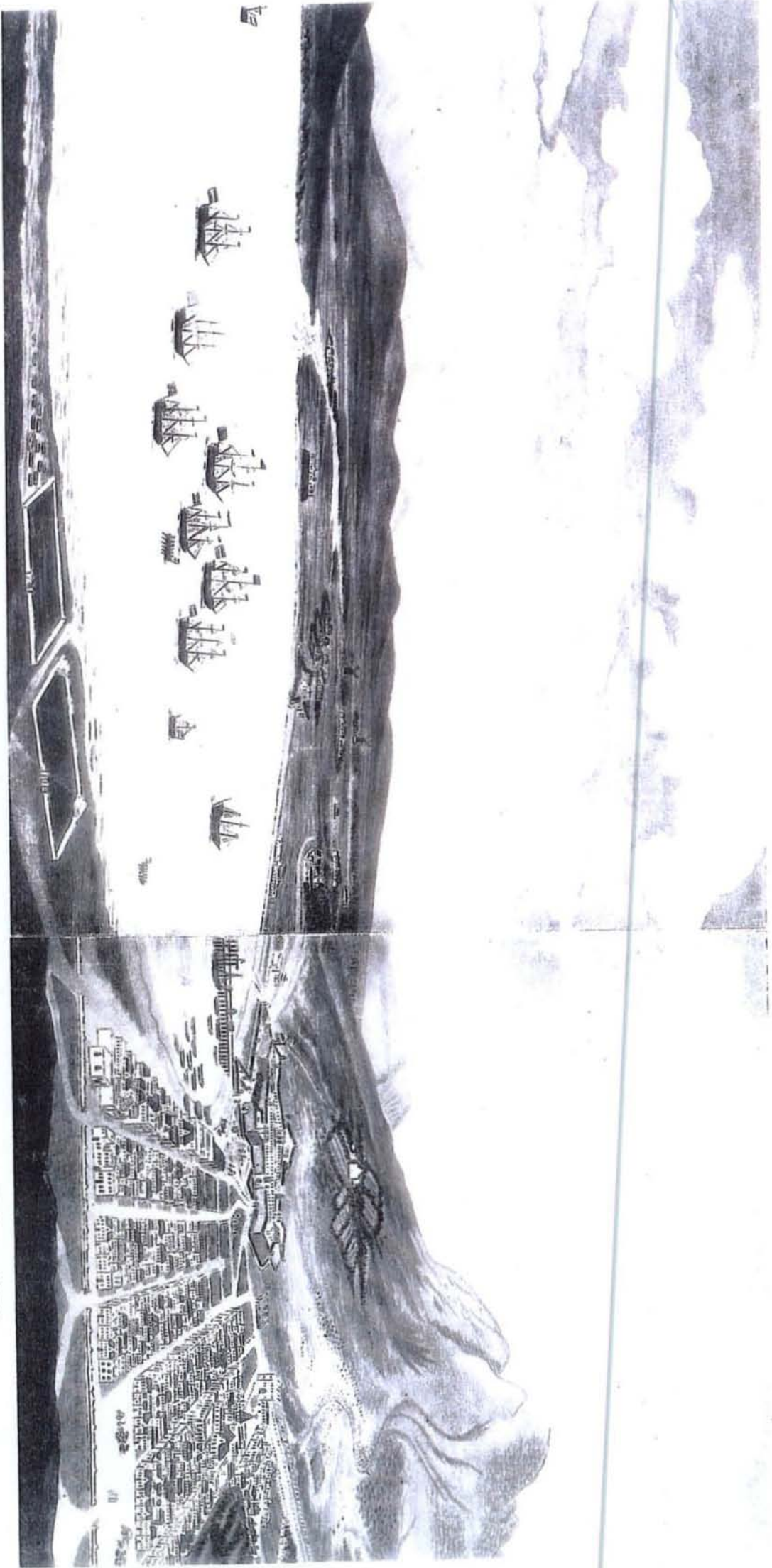


Figure 3: Schummacher's panorama from Signal Hill, 1776, showing the Colonial Burial grounds at left foreground (Hallema 1951)

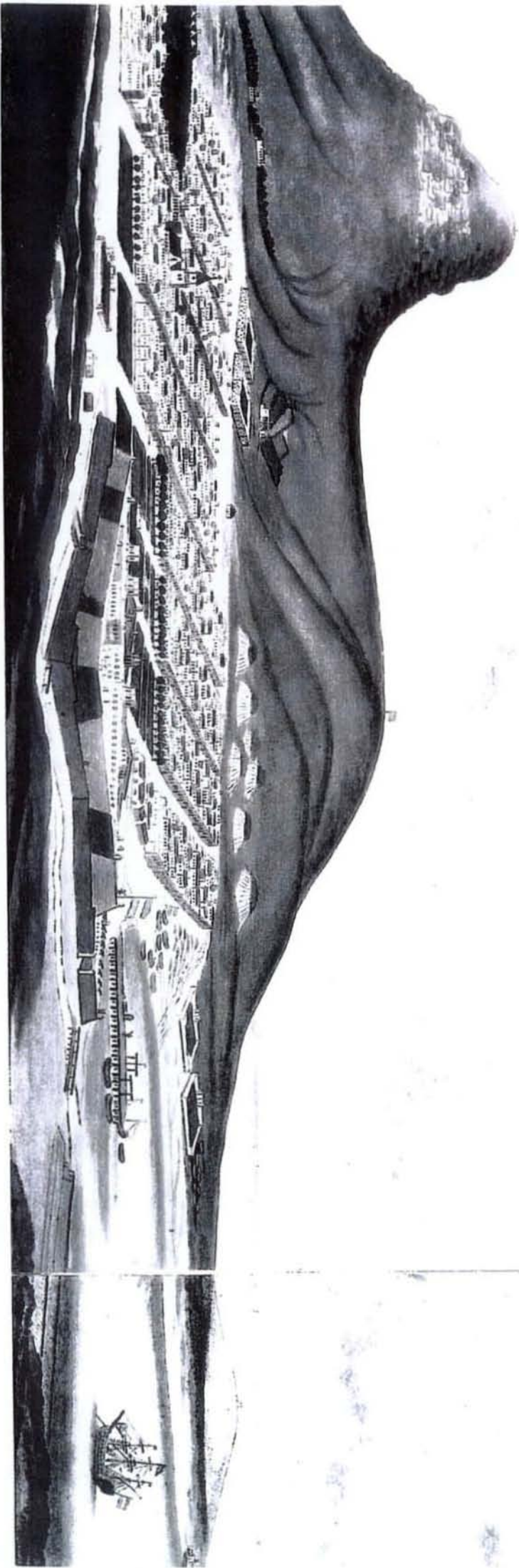


Figure 4: Schumacher's panorama from across Table Bay, 1776, showing the Colonial Burial grounds on the right (Hallema 1951)

ANALYSIS

The skeletal material is housed at the Department of Anatomy and Cell Biology at the University of Cape Town. A series of preliminary reports have been completed on the skeletal remains (Apollonio 1997; Constant & Louw 1997; Holtzhausen & Slater 1997; Ledger 1997; Morris 1997; Morris & Phillips 1997). These reports include information on the background of the site, age and sex of skeletons, paleopathological evaluation, dental health and practices as well as a biomechanical analysis of the long bones.

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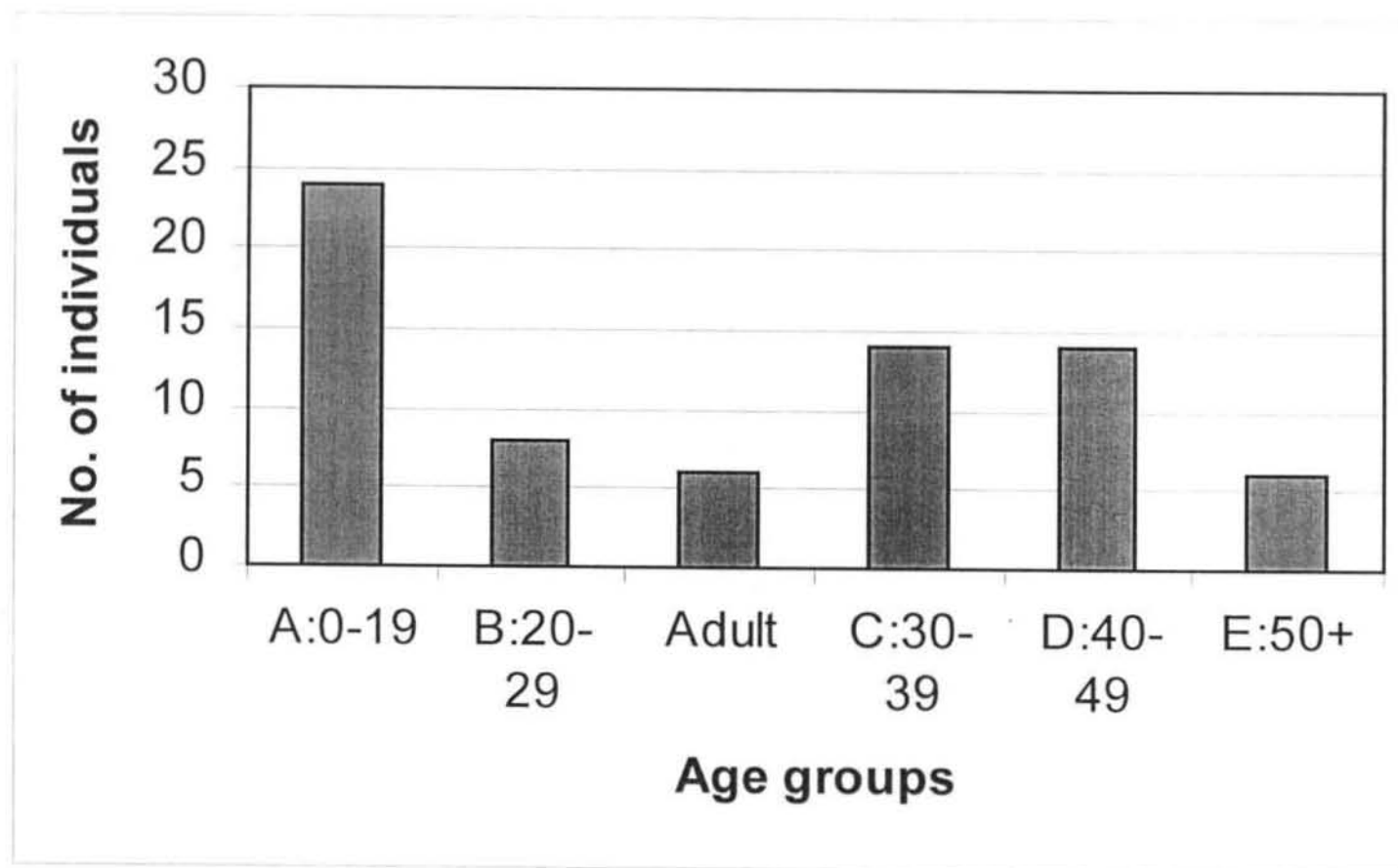


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Table 3: Age and sex distribution of Type C burials (Apollonio 1998)

Type D

Type D consists of scatters of bone. Many of these were disturbed burials, where older burials had been moved to make room for more recent interments. Some Type D burials represented semi-articulated individuals who were reclassified as scatters when there was not enough contextual information to identify the burial style. In some cases loose bones were piled on top of the coffin of the newer burial. A possible explanation is that this site may have been used for hasty and frequent burials during one of the smallpox epidemics dating to 1713, 1755, 1812-13, 1840 and 1862 (Apollonio 1998). A number of these disturbed burials may also be the result of construction activities when the site was leveled in the second quarter of the nineteenth century (mentioned earlier).

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Depth of burial	Burial No.	Type	Features
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120cm	60	B	Decorated teeth
100cm	61	B	Artefacts: date '1764'
	64	C	Niche
80cm	50	B	Decorated teeth
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	56	B	
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Table 4: List of burials at deepest levels below datum

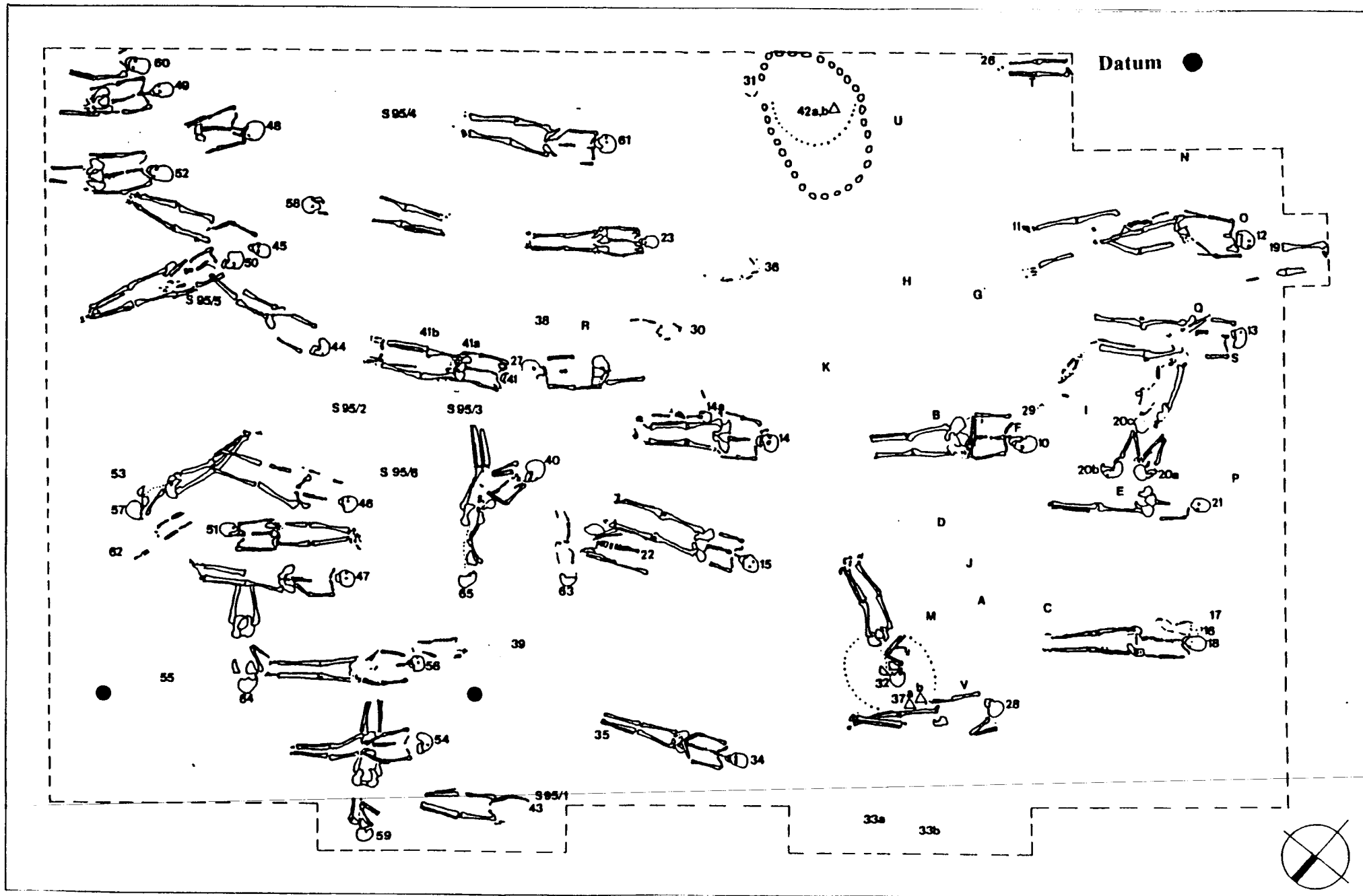


Figure 7: Spatial layout of the skeletons from Cobern Street

Apollonio's plots also showed that Type B burials were scattered evenly across the site. Type C burials were clustered in a group: four lay in the northwest quadrant of the site, and the fifth in the southwest quadrant (numbers given in Table 3, positions in Figure 7).

DENTAL DECORATIONS

Intentional dental alterations in the form of deliberate modification of teeth or unusual patterns of abrasion as the result of the use of teeth as tools are a valuable source of information when reconstructing past human behaviour (Handler *et al.* 1982a, 1982b; Handler 1994, 1997). Dental decorations undertaken for reasons of personal ornamentation and/or group identification are present at Cobern Street, and are of importance if we are to discover the identity of those buried. Many Central Africans practiced decoration until this century, when it began to go out of fashion (Van Reenen 1986). The African ethnographic literature has been surveyed for clues to the geographical distribution of the various patterns observed (Cox 1995). Decoration was also practiced in North America, South America, Mesoamerica, India, South East Asia, Philippines, Japan, Malay Archipelago and New Guinea (Milner and Larsen 1991). Many of these areas are not relevant to this study, for example the Americas.

Only one article has been obtained on decoration found in India (Kennedy *et al.* 1981). It describes a pattern found on a prehistoric individual; the burial dates to around 8000 BP. Incised marks occur on the maxillary central incisors and the right lateral incisor. This type of decoration, which does not involve alteration of the occlusal edges of the incisors, has been classified as the line or groove pattern (Romero 1970), and has also been recorded in the Americas. According to Kennedy *et al.* (1981) dental decoration is still present in modern groups in India, and this involves notching, cutting or chipping the occlusal surface of the incisors or drilling of holes for stone inlays. According to Wales (1964) "...the Siamese stain their teeth with betel without, however, filing and destroying the enamel of the front teeth, like the Indian islanders..."

Apollonio (1998) has identified six burials with decorated teeth (Burials 20A, 20B, 40, 49, 50 and 60). Two other burials also have loose decorated teeth associated with them. Burial 27A is classified as a scatter and includes 6 individuals. Many loose teeth were found with this scatter and two have been decorated. It is impossible to associate these teeth with a particular individual. Burial 52 comprises a discrete burial. The skeleton is disarticulated and the teeth are loose and some are missing. However four of the incisors have been decorated.

Apollonio (1998) has divided the decorations into three patterns. Pattern I was found on Burials 20A, 20B and 40. These have had their maxillary incisors chipped to form an inverted 'V' shape. On closer examination, however, the manner of chipping varies. Burial 20A's maxillary central incisors were chipped mesially at the midline to form a shallow inverted 'V' shaped gap. The maxillary lateral incisors also had small chips removed on the distal surfaces (Figure 8). Burial 20B has a similar pattern but the chips are deeper and the result is an inverted 'V' shaped gap and a 'V' shaped point where the created apex of the central and lateral incisors meet. The teeth have been chipped too deeply and this has resulted in the formation of an abscess. There are few examples of intentionally modified teeth from archaeological contexts with the subsequent formation of abscesses (Milner & Larsen 1991; Stewart & Groome 1968). Burial 40 also has an inverted V-shaped notch between the maxillary central incisors. The lateral incisors have been left untouched. The mandibular central incisors are missing. It is possible that these teeth have been ablated (Stewart & Groome 1968). It is, however, difficult to demonstrate archaeologically (Morris 1989). The empty sockets show no signs of remodelling, but Burial 40 was 12 years old at death and the dental modifications may have been performed shortly before death. In that case, the sockets would not have resorbed. Thus Burials 20A and 20B show a similar pattern but Burial 40 should be placed in its own category, Pattern IA (Figure 9). In the case of Burial 40 it is difficult to know whether the mandibular central incisors were ablated. If this were the case, this pattern would be sufficiently different to Pattern I to warrant its own classification.

Pattern II was the inverse of Pattern I. One individual (Burial 50) shows this pattern. The maxillary central incisors were chipped distally, and the maxillary lateral incisors were chipped mesially (Figure 9).

Pattern III involves the chipping of the maxillary central and lateral incisors to points. The mandibular incisors were left untouched. This pattern occurs on Burials 49, 60 and on the loose teeth associated with Burial 27A and Burial 52 (Figure 10).

Various ethnographic accounts and reports relating to tooth decoration refer to Pattern I. Van Reenen (1986) describes tooth decoration practices amongst the people of Namibia. The Kavangas produce the same inverted V-shaped notch. Further north, in Angola, the Ovimbundu chip notches to form an inverted V-shape (Childs 1949). Some groups in East Africa produce a similar pattern (Waller 1880; Hambly 1930). This pattern has also been recorded in Cape Town, on the skeletons of shipwrecked slaves recovered from what used to be Woodstock beach before the land was reclaimed (Cox 1995). These slaves were on their way from Mozambique to Brazil when they were wrecked at the Cape, when the captain stopped for much needed supplies (Cox 1995) (Figure 11).

Pattern Ia has also been recorded in Namibia (Van Reenen 1986). The Anyika of Malawi have an inverted V-shape chipped between their maxillary central incisors and the mandibular central incisors removed (Waller 1880). Pattern II is unique and no reference to it has been found in the ethnographic accounts or at other sites. Pattern III has been observed in various groups across Africa. The peoples of the Congo Basin filed their maxillary central and lateral incisors to points (Singer 1953). Various groups from the hinterland of Mozambique also chipped their teeth to points; the Maconde, Yao and Macua (Werner 1906; Hambly 1930). Two of the shipwrecked slaves from Woodstock Beach also had this pattern (Cox 1995) (Figure 11).



Figure 11: Dental decoration on skulls from Woodstock Beach, near the old Fort Knokke: SAM AP-4774 (South African Museum accession number) (above) & SAM AP- 4872 (below)



Unintentional Modification

Pipewear

Pipe-smokers' wear has been observed on seven of the individuals from Cobern Street. Pipewear is caused by clay (abrasive substance) pipe-stems being held in a constant position for a long period between the teeth. The wear can occur unilaterally or bilaterally, typically on the lateral incisors and canines (Corrucini *et al.* 1982; Morris 1988; Cox 1995). Burial 3 (male), 10 (female), 13 (male), 25 (male), 49 (male), 54 (male) and 56 (male) all have pipewear. Burial 49 has a combination of pointed maxillary incisors and bilateral pipewear.

Task-related wear

Burials 12, 32, 45, 46, 64 and 65 all have dental alterations. It is not clear whether these are task-related, tooth fractures or contact with an abrasive substance. Burials 12, 32, 64 and 54 all have wear on the labial surfaces of all four maxillary incisors. Burials 45 and 46 have wear on the lingual surfaces of all the maxillary teeth, possibly the result of holding a hard object in the mouth for many hours.

ARTEFACTS

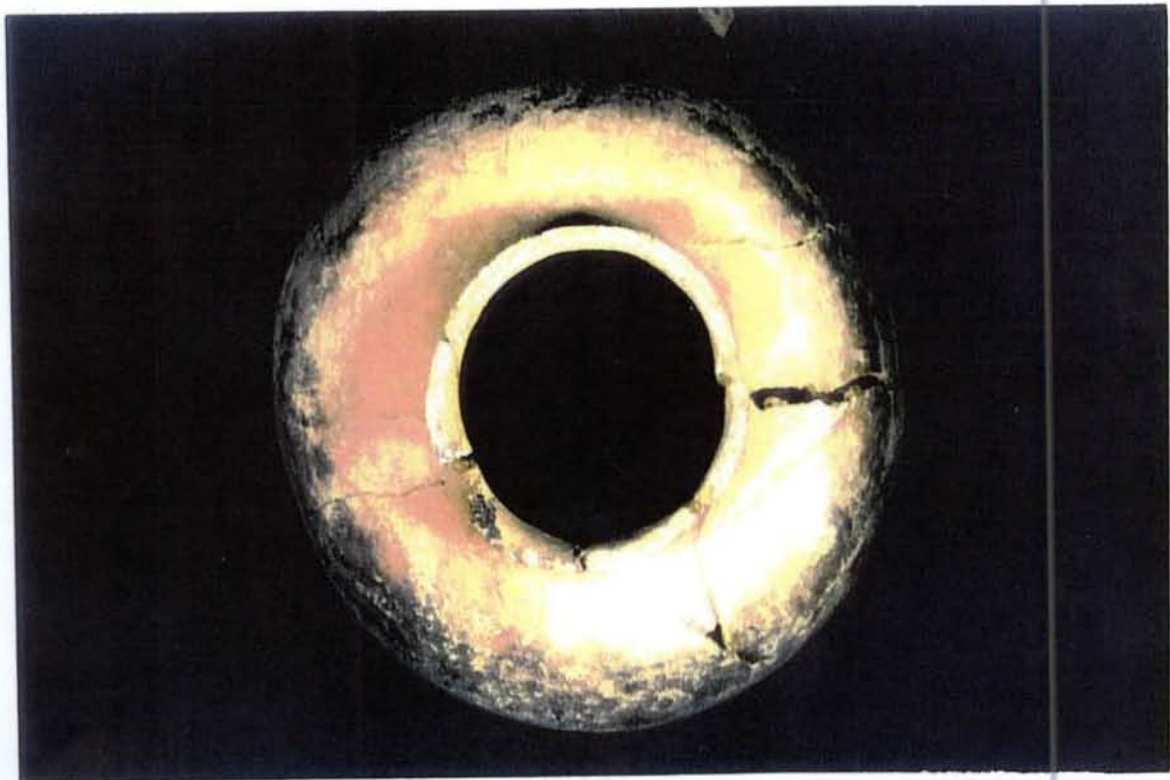
Apollonio (1998) has grouped the artefacts associated with the burials into six categories. The first, objects associated with the Type A burials, are LSA artefacts. The second category consisted of coffin hardware, the third of items of clothing, the fourth of items associated with the interment process, the fifth of personal items and adornments. Artefacts that are intrusive and were not intentionally associated with specific burials were placed in category six. A detailed description of all the artefacts is not necessary here but can be obtained from Apollonio (1998). The discussion below is limited to those aspects relevant to the discussion, at the end of this thesis, about the identity of the people buried in Cobern Street.

Later Stone Age

Both Type A burials contained grave goods. A pot was found below individual 37B. This pot has all the attributes of a typical Khoikhoi pot: it has an ovoid vertical shape and



Figure 12: Khoikhoi pot associated with Burial 37: side and top views. Vessel is 29cm tall.



an elliptical horizontal shape (Wilson 1995). It has two bosses, probably used as thumb grips. The neck is concave and flares out toward the rim (Figure 12). A grindstone and a utilised stone (ground) were recovered from the cairn over Burial 42.

Coffin Hardware

Coffin hardware included nails, handles, backplates, hinges and a keyhole plate as well as fragments of wood. Many of the coffin burials were badly disturbed and the coffin style was not noted. However some examples have been well described in the field notes. Burial 13's coffin had legs and well preserved sides. The coffins containing Burials 18, 21 and 23 had handles. The coffin of Burial 50 was painted white on the outside. That of Burial 52 had green staining over large areas of the wood, implying either that there was copper staining, or that the coffin had been painted green on the inside. The coffin of Burial 60 had large quantities of iron on it, in L-shaped brackets (Figure 13). The last three individuals have decorated teeth (discussed above).

Buttons were found with Burials 3, 11, 12, 15, 27, 41, 51, 52 and 61 (Figure 14). Copper shroud pins and pieces of fabric appear in nine graves: Burials 13, 18, 27, 31, 36, 39, 48, 49 and 58.

Personal Items

This category included glass beads, razor blades, flints, knives and tobacco pipes (Figure 15). Burial 18 was buried with the longest complete pipe stem (51½ cm) excavated in Cape Town. The letters on the heel of the pipe date it to between 1727 and 1791 (Graf 1995). Other pipe bowl shapes and styles are typical of the second half of the eighteenth century (Graf 1995) (Figure 16).



Figure 13: Coffin hardware





Cobern Street
Burial No.52



Cobern Street
Burial No.52

Figure 14: Buttons. Left and right hand photos show back and front views.



Cobern Street
Burial No.52



Cobern Street
Burial No.52

Burial	Age	Sex	Type	Artefacts
14A	45-55	female	B	Snapped cane and rounded beads
14B	Infant	?	B	Pipe stem
18	40-50	female	B	Tobacco pipe (1727-1791)
21	25-35	Female	B	Cane tube beads
27	40-50	Male	B	Razor blade, glass beads
36	Foetus		B	Brass thimble
41	35-50	Male	B	Iron razor blade; tobacco pipe (1727-1843); tobacco plug; tinderbox; flints; striker; link chain; wire circlet with fabric; metal disc
49	40	Male	B	Tobacco pipe (1748-1770), tinderbox, striker; flint
51	35-40	Male	B	Earthenware shard pendant
52	25-35	Female	B	Tobacco pipe bowl (1725-1847); flint; iron penknife
54	30-35	Male	B	Tobacco pipe stem; bone handled knife
61	20?	Female	B	Silver snuff box; silver needle case

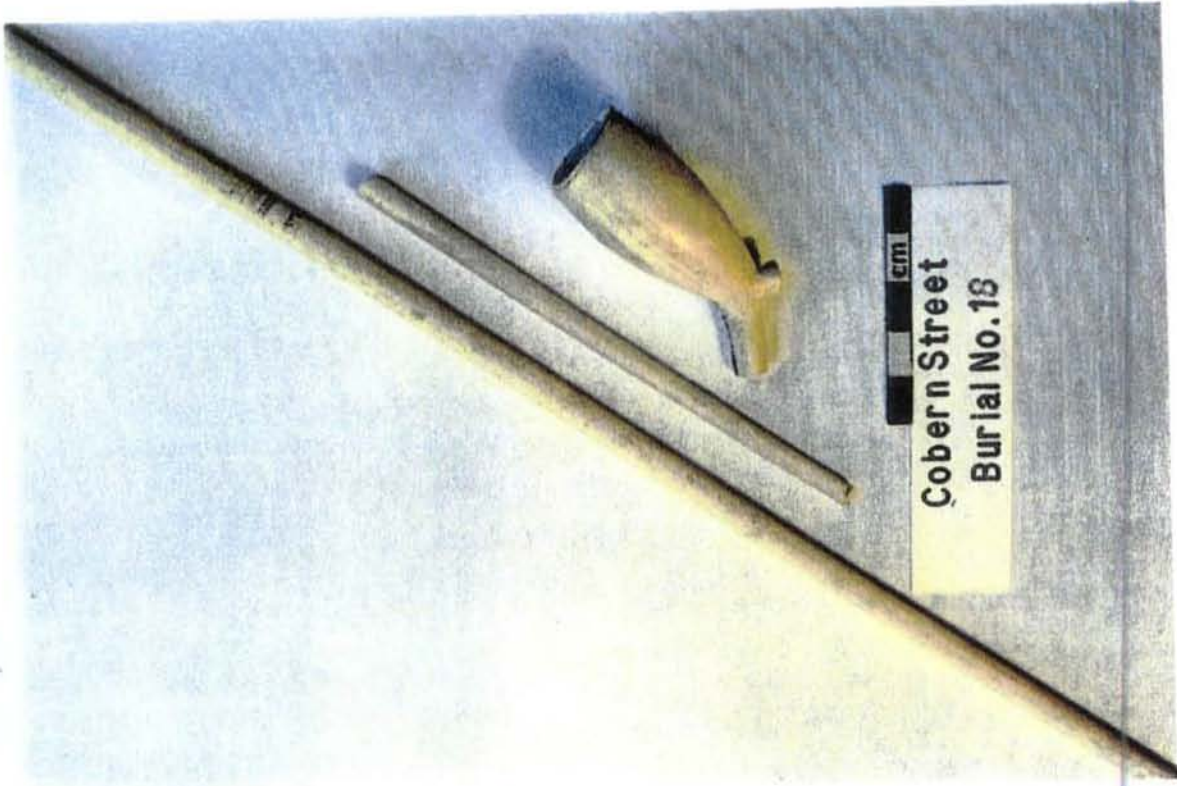
Table 5: Personal items (Apollonio 1998)

There are several ‘miscellaneous inclusions’ in this category. Burial 61 was buried with a silver needle case and a snuffbox (Figure 17). The lid of the needle case was etched with letters that were unfortunately illegible. However the snuffbox had “MHK 1764” engraved on it (Figure 17).

Burial 3 was interred with an iron shackle around his left ankle. This person died in bondage and for some reason, perhaps an oversight on the part of his gravediggers, was buried still wearing his shackle.



Figure 15: Items associated with Burial 49- pipe, tinder-box and flint. The tinder-box is shown before (above) and after (below) cleaning



Cobern Street
Burial No. 13



Cobern Street
Burial No. 14A

Figure 16: Clay tobacco pipes

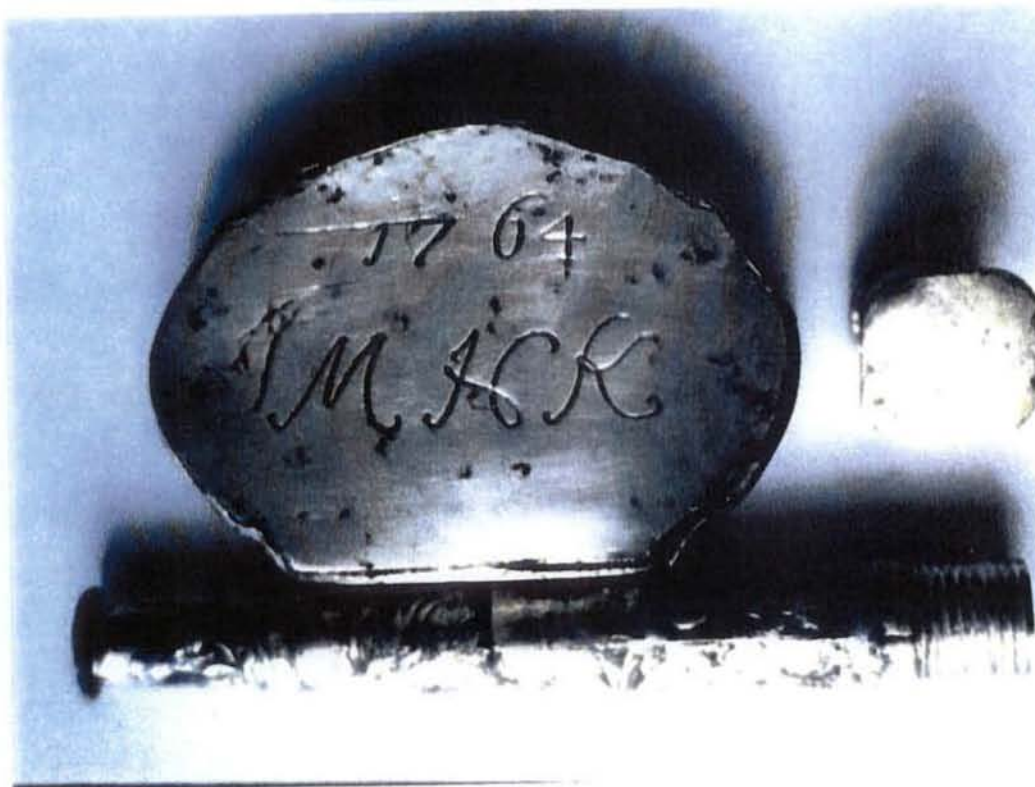


Figure 17: Top: silver snuff box and needle case associated with Burial 61. Middle: Lid of needlecase. Bottom: Inner side of the lid of snuffbox, with engraving.

SUMMARY OF PREVIOUS WORK

Burial types

The haphazard nature of many of the burials and the presence of numerous scatters of bone have been interpreted as the result of hasty interments by burghers burying their own slaves. The official gravediggers of the time were probably not involved with the interments (certainly, there are no records of their involvement-Chapter 4) and private individuals may have been less concerned about the depth of the burial or whether they were disturbing an earlier grave. Type A burials are similar to other Cape Coastal Later Stone Age graves. Type B burials are fairly uniform and are typical of most cemetery sites. It seems that burials in coffins were standard practice, even for those of the poorer classes: 79,5 % of the burials were in coffins. Even the slaves were buried in coffins, with the exception of Burial 40 who was only 12 years old at death. Type C style graves are more unusual. One possibility is that these were the burials of missionised Khoisan people who were using the extended European style of burial, but adding niche features, like those recorded at several graveyards at missions in the Northern and Western Cape. Niche burials have been recorded at an old graveyard in Vredendal, on the Cape West Coast, where the bodies lay extended on their backs (February 1996). A similar pattern has been recorded by Morris (1992a) in the north-western Cape. However the Type C burials may also be Muslim burials, the interpretation favoured by Apollonio (1998). Muslims made up one third of Cape Town's population between 1750-1830 (Da Costa 1985). Traditional Islamic burial practices have the body interred facing Mecca, on its right side, and placed in a niche cut into the left hand side of the grave. The bodies in Type C graves are at right angles to the rest of the burials, facing toward Signal Hill, an important locality for Cape Muslims. According to Apollonio (1998) the graves of the Chinese people brought to the Cape were constructed in a style similar to that of the Muslims, but without the niche.

Artefacts

Personal items

A few of the graves contained large quantities of grave goods. These are generally assumed to be associated with, or used by the deceased while alive (Apollonio 1998). They may be included in a grave because of a special regard for, or status of the individual whether positive or negative. Grave goods may represent a social position

aspired to, but not achieved, for example the silver snuff box with Burial 61. Or they could be treasured items: gifts or maybe items acquired through theft. Sentiment among those performing the burial plays a key role in whether items are included in a grave. Thus it could be that the individuals with grave goods were laid to rest by family and friends rather than masters, hospital officials or the colonial authorities. If some of these people were smallpox victims, hurried burial could have led to their being buried with the items in their pockets, or in their clothing.

WHO WAS BURIED AT COBERN STREET

The lack of documentation regarding burials at Cobern Street provides certain clues as to who was interred there. The haphazard nature of the graves supports the supposition that Cobern Street was an informal burial ground, used by people who did not have access to the official burial grounds. The following groups may have used Cobern Street, "...slaves, free-blacks, convicts, heretics, and transient soldiers or sailors passing through the colony. These could include people of Asian, East African, Khoisan, or mixed origins (i.e. those of not only pure European ancestry)...smallpox victims..." (Apollonio 1998:83). "...The result is a cultural mixture of people, closely representative of the eighteenth century Cape Town community..." (Apollonio 1998:93). These burials were outside the official walled cemeteries, and Apollonio concludes that "...Status is ordered in death as it was in life...with the undesirables kept away from their betters..."(1998:86). The individuals with decorated teeth have been interpreted as slaves, probably from East Africa. Over the entire period of slavery 26% of slaves came from East Africa. Most were brought to the Cape between 1777 and 1801 (Shell 1994).

A number of the questions Apollonio set out to answer have not yet been answered. One of the objectives of her study was to attempt to understand more about Cape slaves through their burial practices and any grave goods. This was a challenging objective because so little comparative material is available. A second question posed, but unanswered up to this point, is who interred the bodies at Cobern Street; family, peers, or 'the system'?

CONCLUSION

Most of the analysis presented above is the work of others except for the section on dental modifications. Apollonio's three patterns of decoration have been expanded to four and two other examples of modified loose teeth have been added. The discussion of pipewear and task related wear is my own. A report is being completed on dental morphology, caries and intentional and unintentional modifications (Morris per comm.). Work is also in progress on cranial measurements (Morris 1999).

The different grave styles are evidence of the burial of different groups of people at Cobern Street. In this thesis the analysis of isotopic ratios of the skeletons will be performed to see whether there are any detectable dietary differences between these groups. This approach may help to ascertain whether the different burial styles represent people from homogenous groups, or are the remains of people of diverse origins. Similarly, it is intended to investigate the diversity (or otherwise) of origin of the individuals with decorated teeth, who were probably slaves. The coffins and grave goods associated with these individuals are of great importance. It is hoped that their significance will become clearer in light of the additional documentary evidence and dietary reconstructions that will be included here. The following chapters will attempt to detail more specifically who was buried at Cobern Street as well as who was responsible for their interments.

CHAPTER 3

THE UNDERCLASS OF EIGHTEENTH CENTURY CAPE TOWN: IDENTITY AND DIET

Cape Town's population during the eighteenth century included an eclectic mix of people from different continents. The urban center was an international port and refreshment station, a military outpost and penal colony. The focus of this chapter is on the slaves and poorer people of Cape Town, since these are the people buried in Cobern Street. Here, I will draw on historical sources to investigate the origins and ethnic identity of these groups. Historical records, including census data, divided the inhabitants of Cape Town into different groups based on their vocations. The demographic profile of the residents of Cape Town included the following divisions: Khoi, Dutch East India company employees, free burghers, slaves, free blacks and *bandieten* (criminals sentenced to hard labour).

A thorough understanding of the dietary resources available in Cape Town is fundamental to our interpretation of the isotopic results. The second half of this chapter will look at contemporary observations and historical accounts of what people were eating in Cape Town and in the countries of their origins.

IDENTITY

KHOIKHOI

The Table Bay area was home to the indigenous Khoikhoi, pastoralists who may have moved into South Africa from Botswana (Elphick & Shell 1989). An alternative view is that it may simply be the domestic stock which moved, as hunter-gatherers already living in South Africa acquired sheep and cattle from their neighbours to the north. There is an ongoing debate on the nature of this southern migration and the relationship between pastoralists and the hunter-gatherers (San) who had occupied the land for millennia. These issues are not of concern in this thesis (Schrire 1987; Schrire & Deacon 1989; Smith 1987, 1992; Sadr 1997). Hunter-gatherers occupied Table Bay before the

pastoralist way of life arrived between 1000 and 2000 years ago. There is evidence at archaeological sites on the Vredenberg Peninsula (120 kms) of San and Khoikhoi living contemporaneously (Figure 1). Historic accounts also refer to seeing both groups near to Table Bay (Smith 1992). The first European colonists recognised three indigenous groups in the vicinity of Table Bay: the Goringhaiqua, Gorachouqua and the Goringhaicona. The first two were pastoralists, but the third, the Goringhaicona or *Strandlopers*, were described as having lost their livestock and subsisted primarily on marine resources.

The Khoikhoi who inhabited the Southwestern Cape had access to excellent pasture and plenty of rain. As the frontiers of the colony expanded, friction between the Khoikhoi and the Europeans was inevitable. During the first twenty years of the colony the Khoikhoi regularly supplied quantities of livestock in exchange for iron, copper and tobacco (Elphick 1985). In later years the number of cattle owned by the Khoi diminished and they resisted trade, so that the nature of exchange became more coercive. In time the Khoikhoi were forced into the role of labourers and servants. Marriage and concubinage occurred with slaves, free blacks, and to a lesser extent Europeans (Elphick and Shell 1989).

COMPANY EMPLOYEES

Cape Town was a Dutch colony from 1652 until 1795. The town's primary function was to serve as a refreshment station for ships needing supplies as they rounded the tip of Africa on their way to or from Asia. Between 1720 and 1780, an average of between 9700 and 11600 people per year embarked on ships of the Dutch East India Company (VOC) (Van Duin & Ross 1987). Almost all (except those who died on board) would have come into Cape Town and spent several weeks recuperating. There were also large numbers of vessels from other countries. After 1770 the number of foreign vessels (mostly English and French) increased, so that they outnumbered the Dutch (Van Duin & Ross 1987). Crew mortality rates aboard Dutch East Indiamen increased through the eighteenth century, and were at their worst from 1760-95. Without the Cape refreshment station, figures would no doubt have been much worse (Boxer 1965).

A census performed in 1731 shows that Company officials formed the largest number of Cape Town inhabitants (Table 6). The elite of the Company employees were Dutch. Many VOC employees were recruited in Europe and entered a five year renewable contract. Unskilled soldiers and general employees were drawn from the lowest ranks of European society. Men from Amsterdam, Antwerp, Hamburg, Stockholm and Gottingen were working alongside each other in the timber yards at the Cape. Other recruits included men from Scotland, England, France, Denmark, Switzerland and Russia (Worden *et al.* 1998).

As the eighteenth century wore on and the economic conditions in Europe improved, fewer recruits volunteered for VOC service and new employees were obtained from the unemployed proletariat of the Dutch towns. The low-ranking employees in Cape Town had little hope of promotion or pay increases. Soldiers were forbidden to marry and only the most successful could apply for burgher status. An ordinary soldier could move up the ranks by 'taking up the pen' and becoming a merchant. Personal and family ties played an important role (Schutte 1989). The garrison formed 70% of the Company's establishment in the eighteenth century. They formed part of the underclass and developed a low reputation, often neglecting their duties (Worden *et al.* 1998).

		ADULTS		
	TOTAL	MALE	FEMALE	CHILDREN
VOC employees	959	959		
Free burghers	585	151	127	307
Free blacks	200	51	60	89
VOC slaves	566	±250	±250	66
Private slaves	767	424	187	156
Bandieten	80	78	2	0
Khoi	?	?	?	?
TOTAL	3157	1913	626	618

Table 6: Census 1731 (Worden *et al.* 1998)

FREE BURGHERS

The first deeds of free burgher status were issued to nine men in 1657 (Schutte 1989). In the census of 1731 there were 185 identifiable free burgher households, and by the end of the Dutch period in 1795 there were some 15000. Free burghers were essentially VOC employees who were released from their contracts to become farmers. The number of free burgher households in Cape Town remained small. The free burghers in Cape Town became inn-keepers or tradesmen (tailors, bakers, turners etc.). These burghers were mostly of Dutch origin but some came from other areas in Europe. The increase in the free burgher population was rapid but at the same time the mortality rate was high. An English visitor commented that "...Their lives in general do not exceed fifty years, and vast numbers die between forty and fifty, so that an old man or woman is really a wonder..."(CA A681, Letter 13).

SLAVES

The Cape colony from its foundation had been largely dependent on slave labour. The households of the officials and the burghers acquired significant numbers of slaves. The company itself needed slaves for its vegetable and fruit gardens and to load and unload its ships. Workshops in town needed artisans (Ross 1980). In 1731, slaves formed 42% of the recorded population and this percentage was to increase during the course of the eighteenth century. The majority of the Cape slaves worked on the wheat and wine farms, outside the urban center. (This project focuses on the city itself, so the experiences of these slaves are not relevant here). A large number of slaves, however, spent their lives in town, some owned by the company and others by private individuals. The slaves owned by the company were housed in the Company slave lodge (Figure 19) which was completed in 1679 (Bozarth 1987). Slaves constituted more than half the total population in the colony by the 1770's (Shell 1994). Where did they come from?

Origins

Many South Africans still celebrate their Dutch, French, German or British ancestors. There are many slave descendents who have lost the memory of their ancestors. Shell (1994: 41) attributes this loss of memory to "...our ignorance of two complex processes:

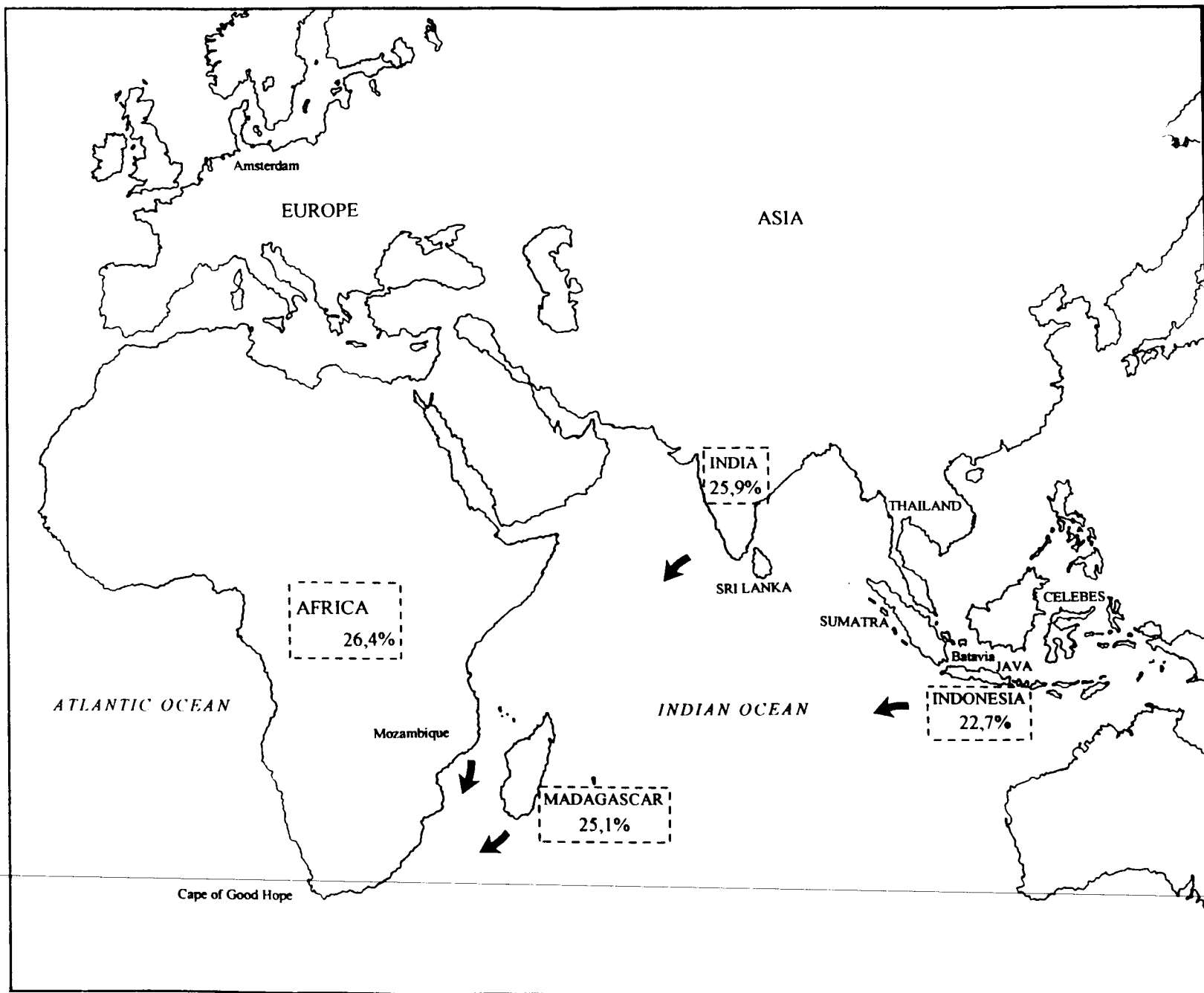


Figure 18: Origins of Cape slaves (Boxer 1979; Shell 1994)

the oceanic slave trade and creolisation...” The oceanic slave trade that supplied the Cape had complex changes and patterns that need to be followed carefully to understand who ended up at the Cape. The majority of the slaves at the Cape, unlike those in the US, Brazil and the Caribbean, were from the Far East and not from Africa. Between 1658, when the first slaves were brought to the Cape, and 1806 (when slave trading was abolished in the British empire) the origin of slaves varied depending on accessibility, which was determined by the policies of the ruling country (Shell 1994). The place of origin of the majority of slaves and ‘free blacks’ can be traced from the descriptive appendages applied to their first names. Thus for example a slave from Bengal would be called by his first name plus the appendage ‘van Bengale’ in Dutch, or in English ‘of Bengal’. These records were not always accurate, partly due to officials who did not always care where the slave came from- whether it was Bengal or Ceylon (Bradlow & Cairns 1978).

Between 1652 and 1808, approximately 63 000 slaves were imported to the Cape. They came from four main areas: 26.4% from Africa; 25.1% from Madagascar and the Mascarene Islands; 25.9% from India and 22.7% from Indonesia (Figure 18) (Shell 1994). In addition, a large number of slaves were born into slavery.

Africa

The first slaves brought to the Cape were from West Africa, Angola and New Guinea (Boeseken 1977). In the early years of slavery at the Cape, numbers did not grow substantially because many died or ran away. From 1720-1730 a number of slaves were brought to the Cape from ‘Rio de la Goa’ on the south coast of Portuguese Mozambique, which had been temporarily abandoned by the Portuguese and taken over by the Dutch (Shell n.d.). The Dutch also withdrew when their casualty rate at this post became too high for it to be worthwhile. Slaves were still brought to the Cape from Mozambique in increasing numbers from 1770 (Shell 1994). The ‘Mozbiekers’ (as slaves from Mozambique became known) gained a reputation for being reliable agricultural labourers. In the late eighteenth and early nineteenth centuries (especially after 1795 when the British first took the Cape) Mozambique became the single most important

source of slave labour (Shell 1994). The Dutch no longer brought slaves from the east. The suppression of the slave trade began in 1807 with the Slave Act, which prohibited any slave trade in British colonies. After 1808 slaves captured at sea by the British navy became known as 'Prize Negroes', many of whom were liberated at the Cape. These slaves were not freed unconditionally, but were apprenticed for periods of fourteen years. Saunders (1984,1985) has suggested that their conditions as apprentices were little different to those they lived under as slaves.

Alpers (1975) identified three societies most affected by the slave trade in East Central Africa during the nineteenth century: the Makua-Lomwe, the Yao and the Maravi. The other group, which played an integral part in the slave trade, was the Swahili (Hafkin 1973).

Madagascar

Slaves from Madagascar were brought to the Cape during the whole period of slavery. Many of the slaves were in fact of African origin. Arab slavers bought Malagasy slaves on the north-west coast of Madagascar and disembarked Makoa and other African slaves on the south-west coast (Heseltine 1971). African slaves were imported throughout the period of slavery until it was finally abolished in Madagascar in 1896 (Campbell 1988). The Malagasy also enslaved each other as a result of inter-group wars. Arab and local Merina traders sold these slaves to the French who had plantations on the Mascarenes. The people of Madagascar are of mixed origins, a unique cultural mix of African and Asian populations. They spoke Malagasy (an Indonesian language). The VOC sponsored voyages from the Cape to Madagascar, and between 1652 and 1795 it has been estimated 33-38 journeys were made and between 3000-3500 slaves were brought back to the Cape (this count excludes those who died on the way) (Armstrong & Worden 1989). These figures are for VOC ships only and do not include French, Portuguese and British slavers. The mortality rate of these Malagasy slaves was especially high both on the voyage and after they landed (Boeseken 1977). From 1663 to 1715 Madagascar was a prime source of slaves, initially women and children, but by the 18th century men were also imported (Shell 1994). Van Riebeeck and his successor Zacharias Wagenaer felt that Malagasy

slaves were not reliable and that they sickened and died easily. The slaves from the East were considered superior but expensive (Boeseken 1977).

A slump in import occurred between 1716 and 1739 when Rio de la Goa on the Mozambique coast replaced Madagascar as a source. The period from 1740-1785 saw trade resuming but not as intensively as in the first period (Worden 1996). Although VOC trade ended in 1806, when the British occupied the Cape for the second time, other foreign traders supplied slaves from Madagascar to the Cape.

The Malagasys formed a quarter of the total slave population during the 17th century but by the 18th this proportion declined as more slaves were born in the Cape. The children of Malagasy parents were identified as being 'van de Kaap'.

There is evidence that the Muslim religion was practiced in parts of Madagascar from the 12th century (Mack 1986). Many Malagasy, however, continued to follow their traditional religion in which the process of burial, the transition between human and becoming an ancestor is an important focus of Malagasy ideas. The funeral involves a long procession. The corpse is covered in white cloth and placed in a plain wooden coffin. The body is buried with its head to the east and feet to the west (Feeley-Harnik 1991).

Slaves from the Indian Ocean World

After 1731 slaves from the eastern possessions of the Dutch East India Company had come to outnumber all other imported slaves at the Cape. Slaves were drawn from Bengal, China, India, Sri Lanka and the islands of Indonesia (Shell 1994). Many slaves from the East were brought by Dutch officials who were returning to Holland and wanted to sell their slaves on the way back (Bruijn *et al.* 1987). This trade was illegal and the slaves were therefore not recorded in the Company documents (Bruijn *et al.* 1987). These slaves were often skilled artisans or trained domestics and they were treated well on the journey and fetched a good price.

India

A large number of slaves came from Bengal, a large populous area. Others came from the East Coast of Coromandel. These slaves were often described as simply being 'from the coast' e.g. 'Rosalie of the coast'. Slaves were also brought from Malabar on the West Coast, an area favoured by Dutch slavers (Bradlow & Cairns 1978). In the first few decades of the eighteenth century 80% of the slaves brought to the Cape came from the Indian subcontinent. This figure declined during the century, as shipping traffic with Sri Lanka and India decreased (Shell 1994). By the end of the century 15 % of slaves at the Cape were from India.

The first two senior religious officials of the Muslims at the Cape were Frans of Bengal and Achmat of Bengal, both of whom played a very important role in the development of Islam at the Cape. Achmat was probably an immigrant, and Frans was a slave (Bradlow & Cairns 1978).

Ceylon

The island of Ceylon (Sri Lanka) provided a fair number of slaves. The availability of these slaves fluctuated according to the shipping patterns of the eighteenth century Indian Ocean described above. These Ceylonese (Sinhalese) were Buddhist rather than Muslim but spoke Malay and so they could fit in relatively easily with other slaves from the East (Bradlow & Cairns 1978).

Indonesia

The Dutch dominated Indonesia during the 17th, 18th and 19th centuries and used this area as a slave-trading base. This area includes the Great Sunda complex of islands, Sumatra, Java, Celebes and a large part of Borneo and the Lesser Sundas including Bali and Western Timor. A number of slaves came from Bali, where Hinduism and Buddhism were practiced (Bradlow & Cairns 1978). The majority of Indonesian slaves came from Sulawesi (Celebes), especially those of Bugis origin (Worden *et al.* 1998). Others came from Bali, Buton and Timor. Restrictions were placed on the number of slaves from Macassar and Bali that were brought to Batavia (the VOC's Indian Ocean capital)

because these people were considered proud and prone to revolt; however these regulations were often ignored (Boxer 1965).

Other Areas

Small numbers of slaves came from the Philippines, Japan, Malacca in Malaysia, from Indo-China and maybe even New Guinea. In the latter part of the slavery period there are records of some slaves being brought from Mauritius, the West Indies and Rio de Janeiro (Bradlow & Cairns 1978).

These slaves and eastern immigrants became known as 'Malays'. This is something of a misnomer considering that they did not all come from Malaysia and Indonesia; indeed, a larger proportion came from India. In the Dutch records they are referred to as 'Javaanen', 'Bataviaansche' or 'Oosterse Slawen' (Bradlow & Cairns 1978). Although the term 'Malays' is not in the official records, it seems that it was in use before British rule. Anders Spaarman, for example, in 1772 used the various Swedish words for 'Malay'. The most likely explanation is that the name Malay was used for linguistic reasons. The trading language for a vast area of the East stretching from Madagascar to China was called Malay or Malayo. 'Krom or Baster Portugees' was also spoken at the Cape, not only by slaves but also by officials (Franken 1953). Even eastern immigrants who came to the Cape as free individuals were known by their places of origin.

Before 1895 no civil registration of birth of persons of any race was required under Dutch or British rule. Birth dates can only be approximated from baptism records. Non-Europeans and Malays were not baptised, so tracing the genealogies of Cape Muslim families is particularly difficult (Bradlow & Cairns 1978). In these cases, oral histories have to be used. Death records of whites have been preserved since 1759, although many would have escaped registration. Between 1652 and 1795 the deaths of only company slaves were supposed to have been recorded. The rest of the population of the Cape was ignored, the exceptions being violent death, and those who had committed crimes. Deaths can also be traced if the person had a will, or had left an estate taxable by the authorities.

CREOLISATION: CAPE-BORN SLAVES

The largest number of slaves was Cape born. Shell (1994) suggests that the moment of creolisation when more than 50 % of all slaves were born locally occurred around 1770. There was a surge of slave imports from around 1790 when the French garrisons (allies against the British) were stationed at the Cape. French slaving practice selected for younger and often female slaves. These female slaves reached maturity in the 1800's. The number of Cape born slaves increased, so that in about 1816 they formed the majority of slaves (Bradlow & Cairns 1978). These slaves were the results of relations between colonists and slaves, or two slaves. Slave couples were not allowed to marry according to the law at the time.

FREE BLACKS

Another group that formed part of Cape Town's eclectic mix were the 'vrijzwaren' or free blacks. "...The free blacks were a subgroup of the burghers...[they] originated from the slave population, from a handful of political exiles, and from several hundred Chinese convicts..."(Shell 1994:xxxii). The number of first generation free blacks at the end of the seventeenth century was a mere 40, and by the end of the eighteenth it remained less than 400 (Worden *et al.* 1998). The descendants of these people cannot always be identified in the records, and many merged into the free population of Cape Town. The geographical origins of this group vary little over time with approximately equal numbers coming from South Asia, Indonesia and at the Cape. Of a list of 827 free blacks extracted from Records of the Council of Policy between 1804-1806 the majority (62.15%) were born at the Cape. 20 % of those who were foreign born were from Indonesia, almost 10 % from India and 3 % from Ceylon. (CA: RDG 106). There seem to be only a few free black Malagasys. Worden (1996) quotes the following figures: in 1725: only 6 out of 94; in 1773: 3 out of 218. In 1820 only 2 free blacks are identified as Malagasy. It is however possible that many of the slaves 'van de Kaap' could have been of Malagasy origin (Worden 1996). By 1770 there were 345 free blacks in Cape Town (Elphick & Shell 1989)

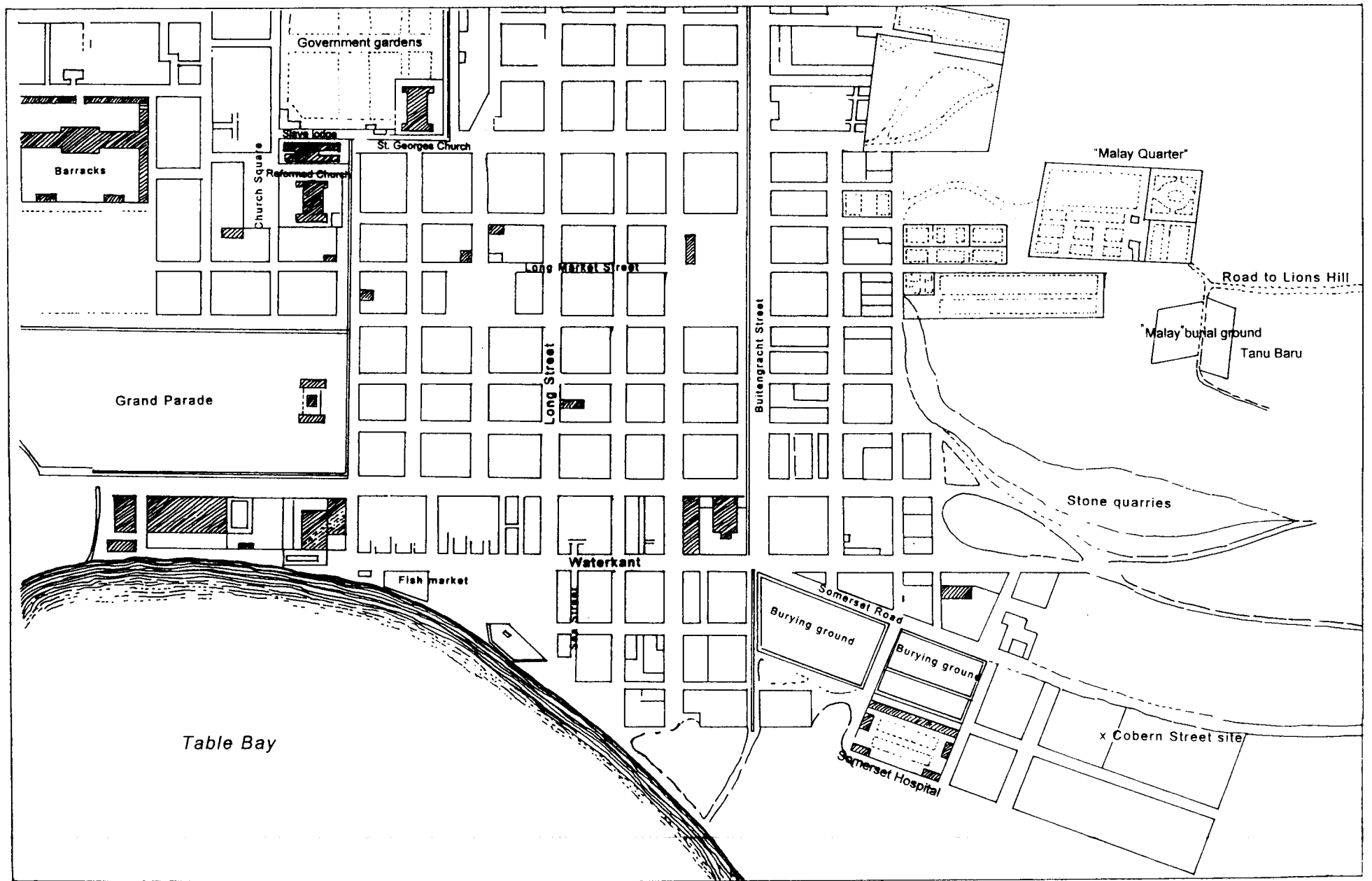


Figure 19: Cape Town in 1825 showing localities mentioned in the text. (The Castle lies to the left of the Grand Parade. Woodstock Beach is a continuation of the shoreline shown here, to the left of this area)

Between 1715-1791 there were 1000 manumissions. The majority were female, Cape born slaves living in Cape Town. The majority of free blacks were said to have lived by fishing. "...Free black fishing families formed the first identifiable occupational labouring community in Cape Town, which dominated the foreshore area up to the twentieth century..." (Worden *et al.* 1998:64). Many of the free black properties were in the Zee (Sea) Street area, at the lower end of town (Figure 19). At the beginning of the eighteenth century free blacks had certain rights and held a similar position to the poorer free burghers; they were "...entitled to the services of the church...they could carry weapons..." (Elphick & Shell 1989:215). However by the end of the eighteenth century many of these privileges had been revoked and free blacks were compelled to carry passes (Rafudeen 1995).

BANDIETEN

The *bandieten* were criminals who were sentenced to hard labour. Many were kept on Robben Island but some were housed at the Company slave lodge. The majority were local company employees with short criminal sentences, while some were from other parts of the VOC empire. A number of *bandieten* were Asian (Worden *et al.* 1998). 200 to 300 convicts were landed by the VOC during the eighteenth century (Elphick and Shell 1978). They became free once their sentences had expired and formed part of the free black community.

The tables below do not represent the entire Cape slave population, as many slaves were brought in illegally and not recorded. Even those who were legally brought in were not necessarily noted in official records.

Origin	Number	Percentage
Africa-Madagascar	397	30.63
Ceylon	20	1.54
India	653	50.38
Indonesia	189	14.58
Malaya	4	0.32
Indo-China	1	0.08
Japan	1	0.08
Cape of Good Hope	10	0.77
Unidentified	21	1.62
Total	1296	100.00

Table 7: Origin of slaves: 1658-1700 (Bradlow & Cairns 1978)

Origin	Number	Percentage	%of non-Cape born
Africa	17	1.93	3.45
Ceylon	36	4.09	7.3
India	184	20.89	37.32
Indonesia	245	27.81	49.7
Malaysia	4	0.45	0.81
Philippines	3	0.34	0.61
Siam	1	0.11	0.20
Unidentified	3	0.34	0.81
Cape of Good Hope	388	44.04	
	881	100.00	493=100%

Table 8: The origins of slaves identified from a list of slave names from Leibbrandts Precis of the Cape Archives. Requesten A-O 1715-1806, include only those owners of slaves and slaves who are requesting manumissions and does not represent all slaves.

The most interesting aspect of Table 8 is the large number of Cape born slaves. 65% of the Indian slaves came from Bengal, 13,5% from the East Coast and 16% from the West Coast.

Slave Identity

Did slaves at the Cape develop a slave identity, despite their different languages, appearances and origins? Robert Semple (1805), a contemporary observer, noted that "...At the Cape (the slaves) are collected into one. There are no longer merely Malays or Malabars, or natives of the coast of Mozambique, they are slaves..." The nature of slavery is such that cultural dislocation is inevitable. Shell (1994) has suggested that activities at the Slave Lodge indicate that some aspects of a "slave culture" were present. In 1713 a play about a Cape slave woman being ravished was performed by firelight at the Lodge. The first religious meetings (Muslim) took place at the Lodge in the 1740's (Du Plessis & Luckhoff 1983). There is little subsequent mention of cultural affiliation, as the origins of the slaves varied through time. Even in Cape households there was a mix of cultures. This made communication difficult; however the advantage for the owner was security in diversity. A cultural mix in individual households made slave ethnic solidarity unfeasible (Shell 1994). Occasional rebellions were usually the actions of an individual imported slave who acted alone. This rebellious action was known at the Cape as 'running amok', when a slave ran around town destroying whatever property and persons were in his or her path. Between 1735 and 1736 three fires were started by slave arsonists (Worden *et al.* 1998).

Slaves resisted their owners in several ways, ranging from running away to physical attack, arson to day to day disobedience, tardiness and pilfering. Hall (1989) argues that examples of resistance are often not recorded in historical accounts because the slave owners did not want to admit openly that their control was not as complete as they would have liked.

A slave code was introduced in 1754 in an attempt to protect the free population of Cape Town (CA: S.O.7/35). Slaves were obliged to carry 'passes' signed by their masters. They had to carry lanterns at night to prevent them lurking in dark corners. Slaves were not allowed to carry weapons, were prohibited from whistling, singing and smoking in the streets. A curfew was set for 9 p.m. - an hour earlier than the other inhabitants of Cape Town. Table Mountain was temporarily declared out of bounds in 1760. Slaves were forbidden to hawk goods apart from edibles. A percentage of the proceeds from goods sold was paid to the master and in some cases when the money was not returned punishment was dealt out (Worden *et al.* 1998).

In 1799 correspondence between the governor and Mr. Van Ryneveld (the fiscal) alludes to an attempt by the authorities to ban slaves from carrying fire-striking implements. Mr. Van Ryneveld suggested that slaves should not carry these implements because they could start fires, especially during the dry season. The matter was postponed until the beginning of the following dry season. Striking implements may have been some of the few objects that slaves had in their possession (CA: B.O.153).

CONCLUSION

Part of the difficulty of calculating population figures for Cape Town during the eighteenth century is that many of the numbers include the whole colony. The estimated population of burghers, free blacks and slaves in 1775 is 4500. This figure excludes government employees, visiting sailors and Company slaves (Penn 1986). The British took a census in 1806. Of the total 16428 people, 6435 were regarded as free and 9367 were slaves. Over 800 of the free people were ex-slaves. It is safe to say that slaves and their descendents outnumbered the free people of Cape Town in the early nineteenth century and probably throughout the eighteenth century (Penn 1986).

DIET

“ It is an obvious truth, all too often forgotten, that food is not only inseparable from the history of the human race, but basic to it. Without food there would be no human race, and no history...” (Tannahill 1988)

In order to interpret the isotopic signatures of the skeletons at Cobern Street, a survey of what the people of Cape Town were eating is necessary. Some of the Cobern Street individuals could have spent all their lives in Cape Town. Cape Town was an international port, so it is possible that some people buried here died on board ship or shortly after arriving at the Cape. What resources were available on board ship for passengers and crew, and for slaves in transit? Some of the inhabitants of Cape Town came from Europe, elsewhere in Africa or Madagascar, India and Indonesia. What plant foods were they eating in these countries? Did they have access to protein in the form of meat or animal products? Did seafood form part of their diets? Would the food in their home countries have been different to the food they had access to in Cape Town?

KHOIKHOI

Archaeological evidence

The prehistoric San and Khoi people of the Southwestern Cape had access to many different wild foods. From historical and archaeological evidence, we know that wild plant foods were important, especially the corms of members of the iris family (eg. *Watsonia*). Fruits and berries, tortoises, dassies and small antelope were also very important (Parkington 1977; Parkington & Hall 1987). At the coast, people ate large quantities of limpets and mussels. Young seals and birds were hunted (Parkington 1977; Sealy 1986), and occasional washed-up whales provided large quantities of food. Wild honey was also highly prized.

The Khoi followed a pastoralist existence, herding sheep and cattle. Meat and/or milk formed an important part of their diets, though they continued to gather wild plant foods, and to hunt. The only plant cultivated by the pastoralists at the Cape was *dagga* (cannabis) (Elphick 1985).

FOOD IN 17TH AND 18TH CENTURY CAPE TOWN

Historical records and contemporary accounts

The Cape was a halfway point for ships en route to or from Asia. The Company gardens were created to supply fresh food to passing ships and fruit trees, vegetables and grain crops were planted. The garden included sweet potatoes, pineapples, pumpkin, cucumber and radishes, as well as lemon and orange trees. It had already been recognised that citrus fruit prevented and cured scurvy. Edible wild plants had to be eaten at first while the garden was being established. These included sorrel, Cape wild mustard leaves, wild asparagus and wild almonds, although the first soldier to eat this latter plant died (Coetzee 1977). It was later discovered that if one soaked or roasted wild almonds the poisonous prussic acid was removed. The cultivation of grain at the Cape was slow at first because storms destroyed crops. Van Riebeeck introduced wheat, rye, barley, oats and buckwheat. Rice cultivation was attempted, but with little success and passing ships had to bring supplies of this staple food of slaves and prisoners. Fresh meat was also on the list of much needed supplies and sheep, hares and pigs were bred on Robben Island. Fresh fish, including snoek, was also caught (Coetzee 1977).

The first 'corn' mill to be erected at the Cape was a horse-mill brought to the Cape in 1657 from Holland. It seems this mill was used for barley (Walton 1974). Thus "corn", in early Cape records, seems to have been used as a synonym for "grain", and can refer to wheat, barley or rye. It is unclear whether it is sometimes used to refer to maize.

Wouter Cornelissen Mostert was one of the VOC's first official millers. He ground wheat, rye and hops for the company at a watermill in Cape Town. The company's mill is shown on a map dating to 1660 (Walton 1974).

The first maize was brought to the Cape on the ship *Hesselt* and planted at Rondebosch in 1658. It was not popular as a food for a '...long while...' (Laidler & Gelfand 1971). It was probably not an important food at the Cape during the period of interest here - the eighteenth and early nineteenth centuries.

Food production at the Cape prospered and by 1679, when Simon van der Stel became governor, he wrote to the Council of the VOC to say that the colonists lacked nothing. The cellars at the Cape were stocked with liquor, the lofts stocked with sufficient wheat and there was no shortage of fresh meat and fish (Coetzee 1977).

Diet varied at the Cape, as it still does according to status. Patients in the hospital were fed bread. The convicts at Robben Island made use of the fish that was freely available. Members of the garrison ate mutton, vegetables and beef (Laidler & Gelfand 1971).

SLAVES

Food was not, however, plentiful at the Cape throughout its history (Laidler & Gelfand, 1971). During the early days of the colony the slaves at the lodge each received three quarters of a pound of rice a day. They complained that this was not enough and in 1672 fresh meat was brought to the lodge once a week. A resolution of the Council of Policy in 1687 states that they had "...decided to give them [slaves] their daily rations the heads, the feet, the intestines and other scraps of butchered cattle..." Diseased and bad meat was also given to the slaves (Bozarth 1987).

During the 1750's the slaves at the slave lodge received bread for their infants, but sold it to soldiers and sailors so this practice was stopped. During the 1750's there was a severe shortage of wheat and the Council of Policy forbade the sale of wheat to ships (Laidler & Gelfand 1971). As the century went on attempts were made to improve the diets of the slaves at the Lodge and they were given mutton on a more regular basis. Each slave received 8 pounds of bread a week, three quarters of a pound of meat (mostly offal) as well as peas, beans and 'meal'.

The account of Barrow of 1806 suggests that bad or insufficient food was a major cause of slave mortality, especially in Cape Town. In the rural areas slaves received more food and could also catch wild animals such as tortoises. There are records (cited above) of what slaves who lived at the Company slave lodge were fed, but not much is known about privately owned slaves (Bozarth 1987). Contemporary observers such as Robert

Semple (1805) wrote that ‘...He [slave] is fed with what comes from his [master’s] table, mingling with it however a greater proportion of rice...’

The diets of slaves probably consisted mainly of rice, bread, some fish and meat and to a lesser extent ‘good extras’ such as peas, beans, wine, vinegar, sugar, salt, pepper and herbs (Bozarth 1987). In the early settlement period some game would have been part of the colonists and their slaves’ diets as, well as birds, including penguins. It seems from most accounts that the diets of company workers were only moderately superior to those of the slaves (Bozarth 1987).

Contemporary observers noted the chewing of ‘areka’. The fruit resembled a nutmeg but was more elongated. Pieces of areka, betel leaves and shell lime were munched until the mixture was reduced to a pulp of reddish colour that would be spat out. It was observed that these slaves had excellent teeth although they were discoloured a yellowish shade. (Mentzel 1925:131). Taylor (1983) also refers to a similar substance ‘betel’.

Fish

According to Bozarth (1987), fish formed an important part of slaves’ diets (Figure 20). It was reasonably cheap and available in abundance in the water along the Cape Coast. The fish were caught in nets; some were eaten fresh but most were preserved in brine vats or salted and dried. According to Coetzee (1977) the Cape Malays were born fishermen. Whether this is the case or not fish became part of their diets at the Cape. By 1683 an estimated 100 000 pounds of fish had been consumed (Bozarth 1987). In 1717 a Plakaat was issued prohibiting free burghers from fishing because there was a shortage of fish. Subsequently, meat (which was more expensive) was consumed to a greater extent. Barrow (1806) lists the different fish caught in the bay: ‘...Roman is considered as the best fish in the colony, but is never caught except in False- Bay...white Steenbraffems [sic] (Steenbras), Cabeljau (Kabeljou), Hottentot’s fish, Silver fish, Stompneus and also Harder, a species not unlike the common herring, is considered as good as fish...’

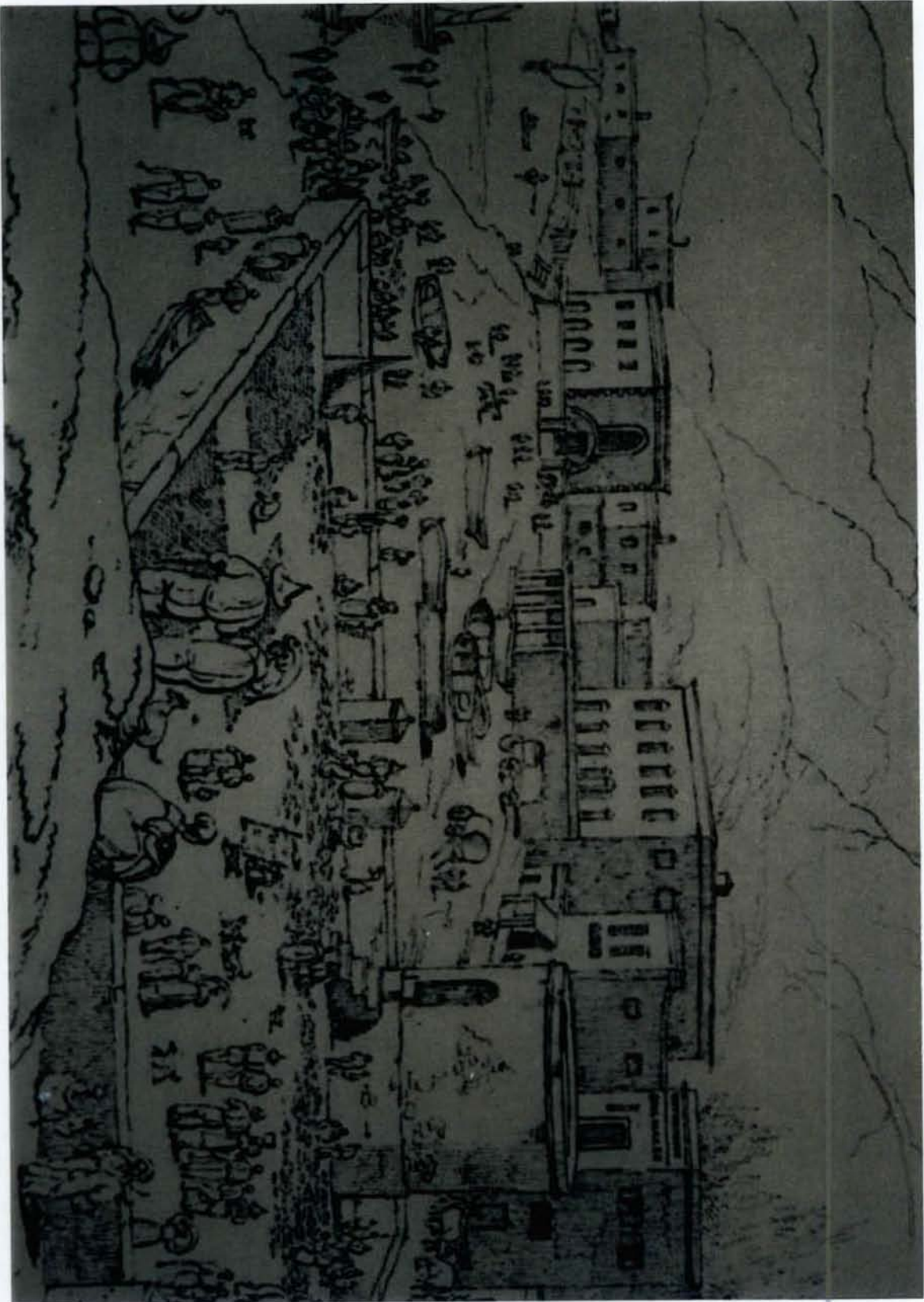


Figure 20: The fish market in 1832, drawn by D'Oyly (CA A3131)

Europeans

Cape Burghers ate bread mutton, some fish- galjoen, rooiman, steenbras and klipfish,. Pickled pork (obtainable from the Company store) or smoked or salted food was a treat. Butter and milk were expensive (Laidler & Gelfand 1971).

The upper class had more choice: Madam Neethling had a table available for her boarders laid with peaches, apricots, raisins, pears, cheese, butter, wine, pipes and tobacco. Treats included stewed Venus ears (*Haliotis*), octopus soup, dried fish and well hung hams. Every item of food was salted (Laidler & Gelfand 1971). In 1797 the wheat harvest failed due to drought and again the government prohibited the sale of biscuit, flour and corn (wheat).

The nineteenth century began with a severe food shortage at the Cape. This was due in part to the prolonged stay of the French fleet and garrisons from 1781-4. Supplies from rural areas poured into town and at the same time more ships arrived. An economic boom ensued but it did not last long, prices soared and profits slumped (Worden *et al.* 1998). There was not only a shortage of wheat but also a serious shortage of cattle, sheep and pigs. Price wars were waged between the farmers and the government. It became obvious that there was a need for the regulation of food supplies (Laidler & Gelfand 1971).

In 1801 bread had to be rationed (Worden *et al.* 1998). The Cape consumed large quantities of rice during the wheat shortage. The government dispatched four vessels to South America and India. 2380 tons of rice were purchased which, it was estimated, would last 15 months (Laidler & Gelfand 1971). White bread was used only for the sick- for the rest barley was mixed with wheat and rice and eaten in place of bread. Even the brewing of beer ceased during this time. Although there was a shortage in Cape Town the farmers managed better. The townspeople suffered the most, especially the poor, an indication that, due to the increase in population, demand had outgrown supply in the area around town, where the farmers had failed to react to the increasing market offered to them (Van Duin & Ross 1987).

In 1805 the first regulation for rations of rice for the 'real poor' were set out. This was the first example of official care. In 1814, with the ongoing shortage of food, prices were fixed for bread.

New foods were also imported: English roast beef, boiled beef, milk, soup, essence of vegetables, pickled tripe, herrings, fish sauces, mushrooms and English vinegar (Laidler & Gelfand 1971).

Food preparation

The problem of preservation was paramount in the minds of the early colonists. It was thought that produce went off once it was exposed to air, so every attempt was made to prevent this from happening. One method was to fry meat and coat it in fat- this 'corned' meat was a popular technique of preservation (Laidler & Gelfand 1971).

Beef was salted and smoked to preserve it. The influence of Eastern cooking on food at the Cape is still seen today. Men from the Indian Ocean world were expert carpenters, tailors and craftsmen and the women were excellent cooks. They brought with them the spices of the East and the first Cape curries were developed. A variety of spices are served in one dish or a hot curry is combined with a cool sambal (side dish).

FOOD ON BOARD SHIP

In 1674 Dutch sailors were generally sickly. The death rate was high, mostly due to the fact that food was kept for nine months. They ate rice and salt beef and pork that was very old and 'stinking' (Boxer 1988).

Food on board slave ships bound for the Cape consisted of 1 bag [does not specify the size of the bag] of food per day for each slave of which $\frac{3}{4}$ consisted of groats (the grain of oats derived from the husks) and $\frac{1}{4}$ beans. This combination was cooked into a broth. For 400 slaves an estimated 20 pounds of pork per day was issued. Hard bread was also issued and the broth was spiced with pepper. Tobacco was also brought on board for the slaves: "30 gross of short pipes to be weekly distributed". Millet was added to ships provisions if it was cheap and obtainable (Bozarth 1987). (Millet is a C₄ food, but oats and beans are C₃-see Chapter 5).

ARCHAEOLOGICAL EVIDENCE

The survey of the available literature has been used to introduce the basic cuisine of seventeenth and eighteenth century Cape Town. These accounts represent one source of information; another is the archaeological evidence. Three sites in Cape Town have been chosen. There are other historical archaeological sites on the outskirts that will not be discussed below because in this study our primary concern is the diet of people in Cape Town itself.

The Grand Parade

The area known today as the Grand Parade was the site of the original fort built by the Dutch colonists in 1652. This fort was in use until 1674 when the stone Castle (discussed below) replaced it. The artefacts excavated date from the late seventeenth to the mid-eighteenth century (Abrahams 1996).

The faunal assemblage from this site includes a mixture of wild and domesticated animals. Small ungulates, some shellfish, tortoise and wild fowl are also represented. The remains of a seal were found. Seals were culled for their meat, skin, fur and oil. Domesticated animals include rabbits, pig, fowl, cattle and sheep. The sheep were the most abundant, which confirms accounts of their greater importance at the Cape table (Penn 1986). The skull elements of sheep are well represented. It has been noted in this and other studies that slaves often received these cuts of meat (Abrahams 1996, Hall 1989, Graf 1996). There is, however no specific evidence that the remains on the Parade are a result of slave lifeways, indeed this seems unlikely. It is more likely that the entire animal was eaten to prevent waste.

Castle

In 1666, 14 years after the Dutch arrived at the Cape, work on the five bastioned stone Castle began. The construction force included the Cape garrison and the Company slaves. Some slaves were housed within the walls of the castle before and after the construction of the slave lodge (Hall 1989). They would have lived in the 'low status' areas of the

Castle. Hall (1989) believes he has identified one such area between the silo walls of the grain store at the back of the 'kat' (a transverse wall that provided an inner sanctuary within the castle). This has been excavated, and the scatter of material found most probably represent the remains of everyday objects used and collected by slaves. There was no porcelain, unlike other areas of the castle. Cuts of meat were very different. Cranial fragments dominated the collection, indicating that these people ate offal. The bones and scales of the 'haarder' fish were found around the fireplaces. Fish bones have not been found to such an extent in higher status living areas. These remains do seem to indicate the presence of non-elite members of the Cape community, whether these were slaves or soldiers or other workmen.

Sea Street excavation

Sea Street is located in the lower half of Cape Town (Figure 19). In historical times (before the reclamation of land in the twentieth century) this street led down to Table Bay. The archaeological excavation at Sea Street recovered material from a dump site dating to between c.1780 and c.1830. Graf (1996) examined the sheep remains, which dominate the assemblage. Other animals include cattle and pig. Fish was also an important part of the daily diet at Sea Street: "...white stumpnose, steenbras, harder and kabeljou were all eaten, but snoek invariably accounted for about 95% of the fish fauna..."(Hall 1991:52). It is clear from the contemporary sources that Graf (1996) included in his study that fruit and vegetables formed an important part of the dinner table during the eighteenth century. These items are, however, missing from the archaeological record. Ex-slaves, free blacks and European immigrants lived in the Sea Street area, and the excavated material has been interpreted as being the refuse of these poorer people (Graf 1996).

DIET IN PLACES OF ORIGIN

Europe

Europeans at the Cape could have come from a number of different countries (discussed above). The majority, however, especially during the eighteenth century were from Holland and its neighbouring countries. In 1820, 90 % of the free white population was

still of Dutch or German origin (Worden *et al.* 1987). Their food at home included crops such as wheat, barley and rye, together with meat, fish and dairy products. A study of the crew of a Dutch whaling ship, from poorer regions of the country, shows that they were eating bread, cheese, salted or smoked meat and fish, groats, peas and beer (Schoeninger 1989). Other northern Europeans ate similar food.

Africa

West

In the heavily forested parts of West Africa crops such as yams, fonio and fruit (especially bananas) are farmed. Millet and sorghum are farmed in the savannah clearings. Maize and cassava (manioc) were brought to this coast from the Americas. In West Africa cattle rearing is restricted to the north because of the tsetse fly (Udo 1978). West African dwarf goats, as well as sheep and domesticated fowl were farmed in the humid zone vegetation on the coast (Blench 1993).

East

The staple crops of East Africa are sorghum, millet and maize. Cattle-keeping is important, and small stock and poultry also contribute to the food base. Hunting and fishing provided part of the diet depending on what was available.

Madagascar

Rice was and is the staple crop of Madagascar. The conquering motto of King Andrianampoinimerina, who ruled much of Madagascar from 1787-1810 was: "...The sea forms the perimeter of my rice paddy..." (Evers 1995: 160). There are five major ecological areas in the island and therefore each region is successful at producing particular crops. A wide variety of fruit is produced: bananas, lychees and breadfruit are common. Groundnuts and dried beans are used as cash crops (Bloch 1971). Most farmers have cattle but these are most abundant in the west and northwest (Heseltine 1971). The Malagasy, like the Chinese, often place all their dishes on the table at once. Rice forms the basis of most meals, together with a stew of meat or grilled fish or chicken or duck.

INDIAN OCEAN WORLD

The bulk of the Asian population lived on a diet of cereals and vegetables. Rice and bread were staples for both rich and poor. Dry rice, millet, and maize (after its introduction in the sixteenth century) were the most common crops in the clearings with periods of rest every few seasons (Chaudhuri 1990). Sorghum and millet (primarily monsoon-fed summer-crops) banana and sugar cane are also important foods.

Among ten to fifteen major cereals grown, wheat and rice held the premier positions. These two cereals used the two basic systems of crop production: 'wet' and 'dry' farming. 'Dry' crops include wheat, barley and millet, whereas rice requires 'wet' farming. Rice is a highly successful crop: ratio of seed planted to that harvested could be as high as 1:100. Chaudhuri (1990) says the rice fields of Asia are like food factories.

In many parts of Asia, food for the poor consisted of porridge made from millets, barley and rice. In India it is called "khichri", in China "keng" and in Indonesia, with some meat or fat added, "tharid" (Chaudhuri 1990).

South Asia-India and Sri Lanka

Apart from rice, the most important food grain, staple crops included wheat and barley. In dry areas millet and sorghum were also farmed (Farmer 1983). Cattle were used for milk only. Sugarcane was grown to a large extent but formed only a small part of the local diets (Rotberg & Rabb 1983). Fish formed an important part of the diets of Sri Lankans and Bangladeshi.

Indonesia

Rice was also the staple food throughout Indonesia. The Portuguese had control of the Indies from 1511 to 1668. They introduced new crops such as maize, potatoes, cocoa and tobacco (Sievers 1974). Sugar was developed into an export crop. Cassava, sweet potatoes and soybeans also became important crops during the eighteenth century.

Life and death

For the more elite Cape Town residents, breakfast was at eight, lunch at one, and supper at nine. Meat was eaten at each meal broiled, boiled and roasted. It was very greasy. Tea and coffee were served at every meal. Many overindulged and obesity was common, accepted and considered desirable. Overindulgence in food was coupled with drink and many colonists were alcoholics. The lifespans of Cape colonists rarely exceeded fifty years and vast numbers died between 40 and 50 (CA A681, Letter 13).

Conditions for slaves were much harsher. Bird (1823) commented on mortality rates of slaves at the beginning of the 19th century: “female slaves...greatly reduced to death...before they reached 18...” He also noted that a slave couple had 12 children, of whom only two survived. The Mozambican porters “seldom live beyond thirty years...” Judges (1977) estimated that during the early nineteenth century the death rate between 1-5 years was high, the rate between 5-14 was lower and the average age at death for the poor was between 25-30.

Heese (1986) lists, from the archival record, deaths between 1720-1725. He concludes that if a child managed to survive past two it would be likely to live beyond 12. He also plotted death rates over the months of the year. Most of the slaves died in winter (July) with very few dying in the summer months. There is also a graph showing deaths of slaves for the years 1720-1782. A comparison between the two graphs indicates interesting differences between Cape-born slaves and newly imported slaves. More imported slaves died than those who were born locally. He also draws attention to a number of slaves brought to the Cape from Zanzibar in 1777. It seems they all died; they were susceptible to European diseases and cold weather at the Cape aggravated their ailments.

CONCLUSION: IDENTITY AND DIET

Company employees and Free Burghers were mostly from Holland and Germany with some from surrounding areas. The slaves came from four main regions, roughly ¼ each from Africa, Madagascar, India and Indonesia. By 1770 there were more local-born

slaves than imports. Slaves, lived under a strict code of regulations and rules. Their original cultural identities were inevitably lost, and there are only a few fragments of evidence for the development of a shared slave identity.

Many new members of Cape society, free or unfree, ate food at the Cape that they had not eaten in their countries of origin. Fish became part of the diets of most of the poorer people of Cape Town. Europeans had to make a change from diets based on wheat, rye and barley to include rice. Slaves from Africa no longer ate sorghum, millet and maize. People from Madagascar and the East may have felt more at home with a diet based on rice but the off-cuts of sheep and fish were probably new to them.

It remains to be seen just how accurate dietary reconstructions are when they are based on historical accounts. Historians have discussed mortality rates and some death records are housed at the archives. The next step in this study is to attempt to discover where the people of Cape Town were buried.

CHAPTER 4

THE BURIAL GROUNDS OF CAPE TOWN

This chapter reports on attempts, undertaken for this thesis, to find out as much as possible about the burial grounds of Cape Town. The history of the formal walled burial grounds is outlined, from the first known interments to the nineteenth century when “all” the bodies from the Somerset Road area were exhumed and moved to the newly established Maitland cemetery. Eighteenth and early nineteenth century contemporary observers refer to areas where slaves were buried, although often with frustrating vagueness. This is perhaps because the question has not been of importance until now. The Cobern Street skeletons were buried outside the recognised burial grounds. Thus the question of where people were buried- who was interred in a formal graveyard and who was not- is relevant to our understanding of these people.

Sources

Research at the National Archives in Cape Town (CA) included a search through various sources including the Slave Office (SO) records and Batavian Records (BR) for references to deaths, burials and cemeteries. The Dutch Reformed Church (DRC) archives proved to be a valuable source. The records discuss the history of their burial grounds in some detail. There is also the occasional reference to slaves, especially rules about their baptism. A few slaves are included in the ‘Death Records’ but no mention is made of where they were buried. Unfortunately the records for the periods between 1695-1718 and 1724-1748 are missing. A number of the references below are from the alphabetical register, a subject list which refers the researcher to original documents.

Religions of Cape Town

Before beginning the following chronology it is important to know something about the religions of early Cape Town. A cemetery or burying ground is ‘consecrated’; in other words it has been set apart for holy use. The Cape under the Dutch formed part of the Indian Empire and was governed in terms of the Statutes of India which stressed that no

other form of worship but that of the Dutch Reformed Church would be tolerated (Davids 1992). Because the Dutch Reformed Church and its version of Christianity was the only recognised form of religion, this church was allowed access to land in Cape Town that could be used to bury members of their congregation. Muslim slaves and free blacks fell under this law. Even the Catholics at the Cape were married and baptised in the Dutch Reformed Church. In 1664 the Council of Policy, which formulated resolutions for the governing of the Cape, instructed that slave children could be baptised as long as their owners provided them with a Christian education. Company slaves were baptised before they were manumitted. During VOC rule, “Islam was to be tolerated, not encouraged, and every effort was to be made to convert these Easterners to Christianity” (Davids 1992:81). The Dorp Street Madrasah was established in 1793 (Davids 1992). The dates for the recognition of other religions and the subsequent granting of land for cemeteries will be outlined below.

BURIALS AT THE CAPE FROM THE 17TH TO THE 19TH CENTURIES

The information on burial places and burial styles was obtained from the documents mentioned above. The focus here is on references to burials of poorer people and slaves.

The first burials in Cape Town after the colony was established in 1652 were in “...die kerkhof in die Kasteel...” [the graveyard in the Castle]; then the company established a burial ground in a ‘new’ place (Hopkins 1965:48). This was close to the original fort on the site of the present Central Post Office. These burials were scantily covered and jackals and hyenas scavenged at night (Laidler & Gelfand 1971).

Years later a church and graveyard were established and the first burial in this official burial ground took place on 15 December 1677. The church was completed in 1703 and officials were buried in the original church. Ordinary soldiers and sailors, as well as slaves were accommodated elsewhere (Hopkins 1965). They were buried in the eastern part of the plot underneath what is now Church Square (Figure 19). A wall was supposed to be built around the ground to protect the graves against animals and flooding (Hopkins 1965). At the beginning of 1699 the wall still hadn’t been built and the graveyard was in

poor condition. During the course of this year a wall was built, part of which is still visible in the wall of the old High Court in Buro Street (Hopkins 1965:125).

In the course of work done for this thesis, the earliest reference located which mentions who was burying the dead was dated to 15 October 1708. Jacob Paaschen was appointed the gravedigger for the Dutch Reformed Church (DRC; Kerkraadsnotule:1).

Also in the 'Alfabietise Registers op Kerkraadsnotule' we find the following note: "Swaarten: Op den 2 den September 1709 word besloten dat Swarten die niet gedoopt zyn, niet op het kerkhof zellen magen begrawen worden" [Blacks: on the 2 September 1709 it was decided that blacks who are not baptised, are not allowed to be buried in the church cemetery] (DRC, G1 3/1:169). The original document is not available to follow up on where so-called 'black people' were buried.

Before 1710, corpses from the Company hospital were buried in blankets. Interments took place in the dunes outside town, near the shore of Table Bay. Six soldiers usually carried the bodies to the graveside. In 1710, hospital officials employed a journeyman carpenter to make coffins when wood was available, or to sew the corpse up in canvas when it was not. During periods of high mortality it was necessary to revert to blankets (Laidler & Gelfand 1971).

There are various contradictory accounts of how slaves were buried. In the early days of the colony, company slaves were buried in gunnysacking material or blankets. After 1710 coffins were ordered for dead slaves from the lodge (Bozarth 1987). The slaves who died in the hospital continued to be buried in gunnysacking until at least 1778. A list of expenditure for the hospital in this year includes the following item: "100 packages of gunnies to be used for dead slaves" (Bozarth 1987).

The first small pox ("pokke" in Afrikaans and "kinderpokken" in Dutch) epidemic was in 1713 (De Kock 1950). It started in March and by July all the wooden planks in the store had been used, so that it became necessary to bury the dead without coffins. 200 slaves

and a quarter of the Europeans died. There were so many graves to be dug that the official gravedigger complained that freemen had usurped his job and were not doing it very well (Laidler & Gelfand 1971).

Laidler (1926:68) comments that "... for dogs and slaves the hours of darkness were hours of freedom. When they died, both received scant respect; for the former the gracht [canal, ditch], for the latter a graveyard outside of town...". In 1715 a gravedigger complained that the owners of slaves were burying their slaves and doing such a bad job that after a while the body became exposed (Laidler 1926).

In the town of Stellenbosch, 50 km outside Cape Town, church council requested the Council of Policy in 1717 "...to bury slaves next to but outside the new graveyard...". (CA: Leibbrandt's Manuscript, 16:970a, 26 April 1717).

It was not uncommon for women to dig graves. In 1717 Joan Ellewee was the gravedigger for the Stellenbosch church. De Kock (1950:145) reported that "...these gravediggers more often than not, were widows. A woman thus bereaved was sometimes permitted on compassionate grounds to work for remuneration, especially if she had numerous children to support...."

In the DRC notes of 1721 the gravedigger was given instructions that a report was to be submitted to the Diaken [church council] every time someone was buried, as well as a written report every month (G1 3/1:43).

By 1730 reports started to appear regarding the mistreatment of slaves. It was declared that because masters were flogging slaves to death, in future no persons should bury their deceased slave without a permit (CA: SO 17/1, 10 July). On the 10 July 1731 in the Plakkaatboek (CA 2:149-150) there is a note that, "...vermoorde slaven hier of daar onder de aarde weg to stommelen..."[murdered slaves are cluttered here and there under the earth]... And so in the Slave Code of 1740, point 15 "...No persons shall bury his

deceased slaves on his land without the previous knowledge of the Officers of Justice...”(SO 7/35)

Mentzel (1921:128), a mid-eighteenth century observer, discussed funerals briefly in his accounts. He noted that the Church charged 50 Cape Gulden for a burial plot in the churchyard. There was another cemetery for those who couldn't pay, which was situated “...on the west side (of town) facing the Bay and near to the big battery [Amsterdam], near this cemetery are also found the vaults of the Chinese...slaves were also buried in the same locality close to the wheel and gibbet [gallows]...”

In 1755 the second smallpox epidemic struck. There are long lists at the DRC archives of the dead, with lists of the amounts paid to the church for burial (G1 1/3: 181, 198).

“...The dead were speedily buried in their clothes in which they died, if possible within 24 hours, but slaves absolutely within that period...” (Laidler & Gelfand 1971:56). Corpses were buried above corpses not yet decomposed, reducing the depth of burial and causing a terrible stench (Laidler & Gelfand 1971). Nicolaas Leij (Ley) was the gravedigger for the Dutch Reformed Church. On 1 September 1755, he gave the church a list of 194 “Christians”, and 65 “Free blacks” and “bastard Hottentots”- presumably people whom he had buried (G1 1/3:181). It has been estimated that as many as 2072 people died between May and October of that year. Many of the dead were not buried in the walled burial ground. Bodies were found lying in the streets and mass graves had to be dug.

The Dutch Reformed Church burial ground filled up and the governor, Ryk Tulbagh, granted new land. On the 2nd July the following notice was given “...a certain piece of ground to be used as a common burial place (“een algemeen kerkhof”) or cemetery for the inhabitants of Cape Town...”(Alphabetical Register on Kerkraadsnotule: 77). This burial ground became known as the “Buiten Kerkhof” or Outer Churchyard. L.Leibregt became the gravedigger for this ground in 1764 (Kerkraadsnotule: 42).

Despite regulations regarding the burial of slaves, more complaints appear in the Kaapse Plakkaatboek (CA:42) on the 27 December 1793 and again on the 11 January 1794. They read as follows (from the original text) "...dit is ondervonden dat eenige lieden zich niet ontzien hunne overleedene lyfeigenen (slaves) zelfs ter aarde te doen bestellen, zonder voorkennis van die doodgraaveresse..." [it has been found that persons without guidance are burying their slaves themselves without giving notice to the gravediggers].

The First British Occupation of the Cape in 1795 brought about the end of VOC rule, and ushered in new policies and the beginnings of religious freedom. Other forms of Christianity, besides the DRC, were allowed. Other religions and cultures were granted land to bury their dead. The change was a gradual one and the problem of overcrowded graveyards, created by the VOC, was solved only in the late nineteenth century.

In 1796 professional men and others founded a burial society in Cape Town. It seems that it was difficult for the lower strata of European society to save sufficient money to ensure a decent Christian burial (Laidler & Gelfand 1971). The minutes and founding of this society are supposed to be housed at the Cape Archives but they could not be located.

Sir George Yonge granted additional ground for the enlargement of the Dutch Reformed cemetery on 6 April 1801. In the following year, discussions began about a possible slave burial ground. A map is mentioned, but was not found in association with these letters. The request to the governor is as follows "...kerk meester geproduseerd een kaart door den Landmeester Geformeerd wegens een stuk lands, geprojecteerd ter begraving van gedoopte slaaven en vryegegeeven...,waarop beslooten is t'navolgende Request aan 't Gouvernement af te vaardigen..." [the church elder has produced a map for the surveyor regarding a piece of ground, proposed for burial of baptised slaves and freed slaves..., whereby a decision was made to put forward this request to the government] (DRC,G1 1/8:349,18 January 1802). The ground proposed was situated "behind" the Burgher Kerkhof. It seems that slaves were buried in the "Buiten Kerkhof"[outside cemetery] because there was nowhere else, but the documents imply that they were going to be exhumed and reburied elsewhere (G1 1/8:4).

CITY LANDS OFF SOMERSET ROAD GRANTED FOR CEMETERIES NOW DISUSED (1904)

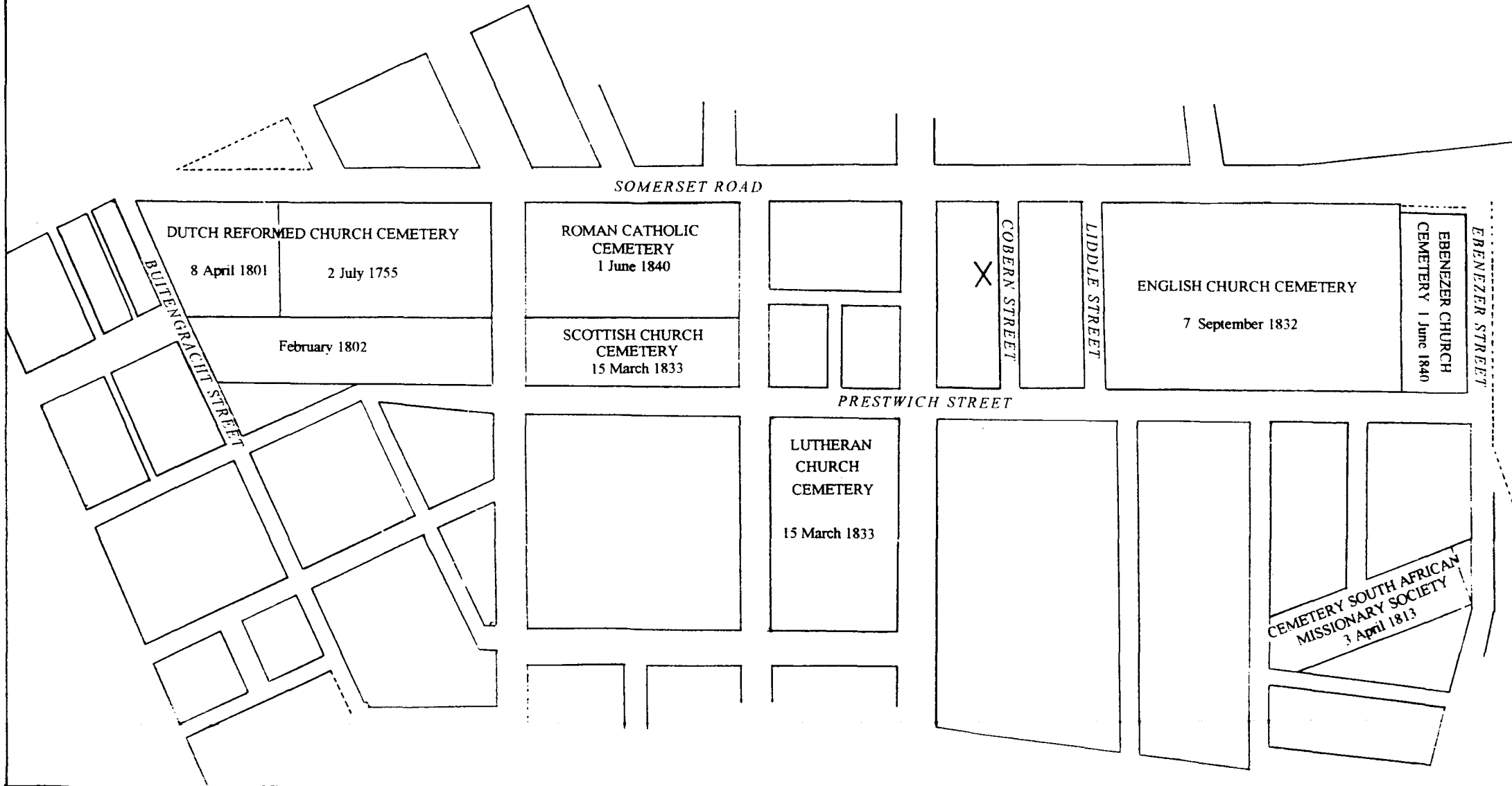


Figure 21: Cemeteries off Somerset Road (1904), with dates of establishment (Select Committee Reports 1904)

Under the terms of the Peace of Amiens, the Cape was handed back to the Dutch in 1803. The VOC had been dissolved in 1798 so the Cape was handed over to the Batavian Government. Batavian rule lasted for three years.

In the records from the period of Batavian rule, there is a letter from a military general to the authorities, dated 23 November 1803, complaining that the overflow of bodies from the slave burial ground was a hindrance to his military maneuvers: "...Door den Gouveneur & Generaal en chef voorts aangemezt zynde dat de van dag tot dag toeneemende uitbreiding der begraafplaatzen van Javaanen & Slaaven, aan gene zyde der gewoone Kerkhoven, thans reeds zeen hinderlyk is aan de 'Exertie der Troupes' en in t'vervolg, voor al in cas van attaque, een weezintlyk obstacul zal worden [word illegible] en regulieze manoeuvres, en andere noodzaakelyke militaire operatien, is beslooten den Raad den Gemeente by Extract deezess, te noodigen....begraafplaats zen andere meer geschikte plaats in die environs der Kaapstad voor handen is..."

[...to the Governor and the Chief General for their remarks that from day to day the increasing spread of the burial ground of the Javanese and slaves, on the other side of the ordinary cemetery (extension of DRC cemetery) is already a hindrance to the exercise of the troupes and it follows, especially in the case of attack, will become one offensive obstacle {word illegible} regular maneuvers and other necessary military operations, it has been decided by the Council that it is necessary to grant a burial ground in a more appropriate place in the surrounding areas of Cape Town] (CA, BR 19:2430).

The death notices throughout Cape Town's history are incomplete, especially for slaves, because it cost the owners money to bury the dead. There are some church burial registers, for example St. Georges (Anglican) and Dutch Reformed Church, but these include few slaves (Judges 1977). Some certificates were found, however, during research for this thesis, amongst a pile of miscellaneous documents in the Slave Records (SO 7/35). They date from 1803, 1804 and 1809. The notes are brief and do not state where or how the person was buried. " Doodgraveniste Nicolas Leij laat begraven: ...Vier Baarsche slaven van t-schip Minerva... 16 March 1804..." [Gravedigger Nicolas

Leij buried four Baarsche slaves from the ship Minerva] or one slave buried “...in die tuijn van [in the garden of].....[owner-illegible]”

There are also death notices for slaves who died on board the American ship Friendship. This ship had 220 slaves aboard and was on its way from Mozambique to Rio de la Plata in 1803. The ship had to stop at the Cape because some slaves had died, and many were sick. The captain (David Crocker) wanted to land the survivors and sell them. It was agreed that the surviving slaves could be landed and should go through customs. The death notices list 18 slaves from the ship Friendship and give their sexes and ages. The youngest was 6 and the oldest 40.

After the First British Occupation in 1795 General Craig agreed to allow the Muslims at the Cape to erect a mosque. In 1805 the “Javaansche Begraaftplaats” was officially granted to Frans of Bengal by the Raad der Gemeente. This burial ground is known as Tanu Baru, and it is located on the slopes of Signal Hill at the top of Longmarket Street and above the “Malay Quarter” of Cape Town (Figure 19). The earliest burials here date to 1772 (Davids 1985). (This burial ground is not the same one referred to above in the complaint by military officials.)

A British army officer visiting the Cape wrote “...the burial of a Malay is conducted with respect and decorum...the Mozambique and Madagascar slaves conduct these matters with indifference, and an entire neglect of all decency and form: they throw the corpse on a bier, and very unconcernedly commit it to the grave” (Anon 1806: 248). Burial practices in Mozambique are not well documented. However in Madagascar funerals are very important rituals because of these peoples’ beliefs in the power of the ancestors (see Chapter 3).

In a letter in the DRC archives dating to 6 April 1807 there is a proposal for the production of coffins for ‘needy people’ who are part of the congregation (DRC: G1 1/8).

The South African Missionary Society was established in 1799. A chapel was built in that same year and still stands in Long Street today. The surveyor's map (Figure 21) indicates that the burial ground for the Missionary Society was established in 1813. However, from the minutes of this society it seems that a graveyard for slaves was suggested only in 1818 (V1 Records of Zuid Afrikaans Genoodschap), when a Mr Stronk addressed a meeting of the Society. He asked that the Society request a piece of ground for the proper burial of slaves who were members of the congregation. He argued that bodies of "heathen" had turned up when the foundations of the New Hospital [Old Somerset Hospital-see Figure 19] were being excavated. It seems that bodies of slaves were turning up unexpectedly.

According to Langham-Carter (1973:18) "...the great majority of non-Europeans were buried elsewhere, their cemeteries all lying even further out of Cape Town to the north west. There was the Mozambique ground which was originally for slave burials but was also used for a few free persons who were neither Christians or Muslims. It lay near the corner of Ebenezer Road and between the Chavonnes and Mouille Batteries (Figure 2). Further out still was a graveyard for Coloureds on Portswood Road, which had been opened in 1819..." This latter cemetery may be the one suggested by the Missionary Society (Figure 22). This article is not well referenced, with no maps to show the exact locations of the cemeteries mentioned.

The haphazard nature of burials in Cape Town continued into the nineteenth century. In July 1819, the following notice appeared in the Cape Town Gazette: "...In consequence of complaints lodged before the President and Members of the Burgher Senate that dead bodies are buried outside the walls of the general burial places, to the great nuisance of the public...the burial of such dead bodies is hereby seriously forbidden...there is now a place fixed between the Moulie [sic] and Chavonne Battery for the interment of slaves and those (other than Moslems) that are not of Christian Persuasion..."(Murray 1964:22). According to Murray (1964) this site was in the same location as the prison which was later built in Portswood Road (Figure 22).

The English community was allotted their own burial ground in 1827, fronting Somerset Road and lying northwest of the military burial ground. This was usually called the English ground or St. Georges burial ground (Figure 21).

On 26 March 1829, William Assaw petitioned the Governor of the Cape for a suitable burial ground for the Chinese (his countrymen). This was granted on the 26 November 1830, located "...on the slopes of Signal Hill, bordered by Dawes Street, just off Longmarket Street..." (Yap & Man 1996:12).

In 1833 the Lutherans were granted one and two-thirds of an acre beyond the old Somerset Hospital for burying their dead. In 1834 the Scottish church was granted a one-acre burial ground to the east of the military burial ground, close to the Somerset Hospital (Figure 21).

James Backhouse, a Quaker missionary, commented on the Cape Town burial grounds and was shocked at their condition: "...we visited the burial grounds which lie contiguously to each other, on a sandy flat toward the light-house, and on the adjacent ascent of the Lion Hill unfenced, on the open wastes. It may be regarded as a testimony to the want of consideration of man for the feelings of his fellow man, while holding him in bondage. Those cemeteries belonging to different Christian congregations are enclosed by walls, and those of the Malays or Mohammedans and Chinese are fenced in, but one in which slaves have been interred, lies, to the disgrace of the Professors of Christianity, in Cape Town unfenced in the open waste. Adjoining the burial place of the slaves, useless horses are shot. The bones of these lie whitening the ground and their carcasses afford food for numerous dogs..." (1834:81).

In 1840 the Ebenezer church was also granted land (Report of the Select Committee 1904). Criminals executed at Gallows Hill were buried on the eastern slope of the hill northwest of Ebenezer Road.

There are a number of other references to places where slaves and poor people were buried. For example, "...The slaves resting place was just beyond the Chavonnes Battery, an area now included in the docks ...(where old horses were shot)..." (Laidler 1926:168).

Van Heyningen (1989:175) refers to a piece of ground called "the White sands" i.e.the burial ground behind Gallows Hill "...a piece of wasteland on which pauper burials took place with no registration or control..."

A signalman stationed on Signal Hill between 1867-1869 made a list of the interments that he witnessed (Langham-Carter 1973). He counted no less than 1843:

Malay	546
Dutch Reformed	379
Breakwater and Mozambique	204
Vogelsang and Ebenezer	293
English	131
Jewish	92
Roman Catholic	73
Lutheran	50
Scottish	49
Military	26

Table 9: List of interments 1867-1869

Investigations into the closure of the Somerset Road cemeteries began in 1875. 15 January 1886 was declared the last day of legal burials, although Laidler (1926:169) says "... when the ground was closed to burial in the eighth decade [of the nineteenth century], surreptitious interments took place at night... the procession quietly scaled the wall, passed the coffin over...." From 1886 onwards, the majority of legal burials took place in the newly opened Maitland Cemetery. The "Malay" community objected because of their customs that require them to carry the dead to the cemetery on men's shoulders; the new plot was too far away for this to be done conveniently (Davids 1984).

CONCLUSION

The policies of the Dutch East India Company from 1652 to 1795, giving exclusive rights to burial to the Dutch Reformed Church, caused unsanitary conditions on the doorstep of the city. Members of other religions or those who were unable to pay the burial fee were obliged to bury their dead wherever they could. After the British Occupation in 1795, other religious and burial rites were recognised. It took time for the new graveyards to be established, however, and the problem of uncontrolled burials seems to have been at its worst at the beginning of the nineteenth century when the population was on the increase and new burial grounds had not yet been allocated.

Slaves were probably not buried with European colonists. Free Blacks may have been buried in the Dutch Reformed Church cemetery. Slaves were buried at the convenience of their owners, sometimes on private land, but often in the region of Somerset Road.

One of the questions that remained unanswered in the work done by Apollonio (1998) was who interred the bodies at Cobern Street; family, peers, or 'the system'?

It is beyond the scope of my project to go into this question in great detail. As a historical study it would help archaeologists and historians understand the origins of the discrimination in death that caused the individuals in this study to be buried outside the bounds of the official burial grounds. In many cases owners buried their slaves to avoid paying burial fees to the official gravediggers. There are accounts of slave and Muslim funerals and in these cases traditional burial practices would have been followed. Slaves buried by the official gravediggers [often women] would have been buried in coffins [depending on the availability of wood]. Many slaves would not have been able to follow traditional burial practices when separated from their families and the land and tombs of their ancestors.

CHAPTER FIVE

ISOTOPES AND DIETARY TRACING

CARBON AND NITROGEN ISOTOPES

Light stable carbon and nitrogen isotope measurements have been used to determine the diets of humans (Klepinger 1984; Ambrose 1991; Schwarcz & Schoeninger 1991; Katzenberg 1992; Katzenberg & Harrison 1997). The basis of this phenomenon is fractionation. Fractionation occurs when different isotopes of the same element are separated out, due to differentiation caused by physical and chemical reactions. These variations are predictable and occur in a patterned way in nature.

Concepts and Terminology

Before continuing it is necessary to define certain terms and concepts. Isotopic ratios are expressed as delta (δ) units as follows, (using carbon as an example):

$$\delta^{13}\text{C} = \left(\frac{{}^{13}\text{C}/{}^{12}\text{C}_{\text{sample}}}{{}^{13}\text{C}/{}^{12}\text{C}_{\text{standard}}} - 1 \right) \times 1000 \text{ ‰}$$

Results are reported in parts per thousand (‰) relative to the internationally accepted standard. Marine carbonate fossil from the Peedee formation in South Carolina is the standard for carbon (Craig 1953,1957).

Carbon cycle: natural distribution of ${}^{13}\text{C}/{}^{12}\text{C}$

In the case of carbon there are different pathways through which plants synthesise carbon-containing compounds using carbon dioxide from the atmosphere. There are three photosynthetic pathways, C_3 , C_4 and CAM, of which the first two are by far the most important (Van Der Merwe 1982). C_3 photosynthesis, or the Calvin-Benson pathway, involves the conversion of atmospheric carbon dioxide into the three-carbon molecule phosphoglyceric acid. This pathway occurs in temperate environments and is the most widely distributed. C_3 plants include most trees, shrubs, vegetables and fruits and cultivated foods such as manioc, wheat, barley and rice. Tropical grasses use the C_4

or Hatch-Slack pathway where atmospheric carbon dioxide is converted into a four-carbon compound oxaloacetate (Zelitch 1979). C_4 plants consist of most tropical grasses and also crops such as maize, millet, sugar-cane and sorghum (Van Der Merwe & Vogel 1983; Keegan 1989; Ambrose 1993). Plants in these two groups have different $^{13}C/^{12}C$ ratios. Since most organic materials contain less ^{13}C than the standard they have negative $\delta^{13}C$ values, typically ranging from -28 to -5‰. C_3 plants average -26.5‰, with a range between about -22 and -30‰ (Vogel *et al.* 1978). The $\delta^{13}C$ values of C_4 plants range between -9‰ and -16‰ with an average of -12.5‰. There is a third photosynthetic pathway, CAM or Crassulacean Acid Metabolism. These plants have the ability to switch back and forth between C_3 and C_4 photosynthesis. This pathway is employed primarily by succulents. The $\delta^{13}C$ values fall anywhere between the range of values for C_3 and C_4 type ratios. This third group is not of importance in this thesis.

The isotopic ratios of plants are at the base of the foodweb carried through into the bodies of animals, the consumers, at higher trophic levels. Additional fractionation occurs when animal tissue is formed and it varies according to the metabolic rate of the animal and the composition of the tissue in question. For large herbivores, muscle tissue is on average 3‰ enriched in ^{13}C compared to diet, bone collagen 5‰ enriched and fat 3‰ depleted (Vogel 1978). Therefore, the meat of a herbivore in a C_3 area would have a $\delta^{13}C$ value of -23.5‰, whereas in an area where there are C_4 grasses, a grazer, would have a $\delta^{13}C$ value of -9.5‰. Animals which browse and graze would have intermediate values reflecting the proportions of C_3 and C_4 plants consumed.

The carbon cycle in the ocean is different to that on land. Sources of carbon include dissolved carbon dioxide, bicarbonates and carbonates. Temperature influences $\delta^{13}C$ values in the ocean: warm water produces isotopically heavier (more positive) values than cold water. Algal photosynthesis includes both ribulose diphosphate (the enzyme found in C_3 plants) and phosphoenolpyruvate carboxylase (found in C_4 plants) (Karekar & Joshi 1973). Some seaweeds have $\delta^{13}C$ values that resemble C_3 plants while others resemble C_4 types (Craig 1953; DeNiro & Epstein 1981). These plants form the basis of

the marine foodweb and their $\delta^{13}\text{C}$ values vary from place to place. For example, for the Atlantic Ocean where temperatures range from 8° to 16° C, values for filter feeders range from -19.4 to -15.9‰ (Sealy 1986). There is a stepwise enrichment from one trophic level to another so that $\delta^{13}\text{C}$ values become more enriched, from grazing molluscs to carnivorous fish to fish-eating animals such as seals and coastal birds (Sealy 1986). The average $\delta^{13}\text{C}$ calculated for the southwestern Cape for foodstuffs making up a mixed marine diet is about -16.5‰ (Sealy 1986).

Humans

The isotopic composition of human tissues, including bone, also depend upon the foods eaten so that analysis of calcified tissue tells us, within broad limits, whether diet was based on C₃ or C₄ foods or a mixture of the two (DeNiro & Epstein 1978). The majority of research on stable isotopes in archaeological bone has been done on "collagen" or, more correctly, the acid-insoluble protein component of bone (Chisholm *et al.* 1983; DeNiro 1985). Collagen is the structural protein that forms the organic matrix of bone. Organic material accounts for 30% of dry bone, of which 85-90% is collagen. 70% of dry bone is inorganic, mostly calcium phosphate in the form of hydroxyapatite (Katzenberg 1992).

In a study performed by DeNiro and Schoeninger (1983) on the collagen of rabbits and minks raised on isotopically monotonous diets, only small variations in isotope ratios in different parts of the skeleton, of the order of 1‰ or less, were observed. Differences between males and females were negligible. Thus, if an individual eats a uniform diet throughout life, isotope ratios in different parts of the skeleton are effectively the same (see also Schoeninger 1989). We know, however, that different body tissues have their respective formation histories.

Isotopic analysis of human bone collagen can therefore differentiate between the consumption of tropical C₄ cultigens and C₃ plants or cultigens from temperate environments. $\delta^{13}\text{C}$ measurements can also be used to distinguish between marine and

terrestrial input, provided the terrestrial flora are C₃. Marine stable isotope ratios vary depending on the variables outlined above. However, in the southwestern Cape the area outlined here, marine values are more enriched than the terrestrial flora and individuals consuming a considerable amount of seafood will have more enriched carbon isotope values.

Bone apatite

$\delta^{13}\text{C}$ values for bone apatite are more positive than those for the diet, with a difference of about 10‰ (Tieszen & Fagre 1993). The inorganic phase of bone is "...an impure and poorly crystalline calcium phosphate salt analogous to hydroxyapatite..." (Lee-Thorp *et al.* 1989). Bone apatite contains a small amount of carbon, present as carbonate, with $^{13}\text{C}/^{12}\text{C}$ related to that of the diet. On archaeological and palaeontological material, bone and tooth mineral generally survives for longer than collagen. Carbon isotope analyses of bone apatite therefore enable archaeologists to study diets of hominids and early humans (Lee-Thorp & Van Der Merwe 1987; Lee-Thorp *et al.* 1989; Sponheimer & Lee-Thorp 1997,1999). Isotopic measurements on apatite have only recently become an accepted technique, as it was previously thought that the biogenic apatite signal was contaminated because of exchange with soil CO₂ and bicarbonates (Berger *et al.* 1964). However, suitable chemical pretreatment procedures can eliminate contaminants, enabling measurement of biogenic $^{13}\text{C}/^{12}\text{C}$ (Lee-Thorp *et al.* 1989, Lee-Thorp *et al.* 1997).

We have seen above that $\delta^{13}\text{C}$ in bone collagen is about 5‰ more positive than that of the diet, i.e. the diet-collagen spacing is 5‰. The diet-apatite spacing is still a matter of on going debate. Recent experiments by Ambrose and Norr (1993), using laboratory rats, have yielded a value of 9.4‰. Tieszen and Fagre (1993) have also showed a difference of 9-9.5‰, using mice. Studies of large herbivores have given a larger spacing, c. 11-14‰ (Lee-Thorp *et al.* 1989). It is unclear to what extent those differences may result from differences in diet, or physiological differences (e.g. in metabolic rate) between small and large animals.

Where does the carbon in collagen and bone apatite come from? Recent research has focused on the question of how dietary components are routed into the carbon in bone. Work done by Chisholm and colleagues (1982) argued that collagen $\delta^{13}\text{C}$ reflects the isotopic composition of carbon in the protein part of the diet. Apatite was therefore thought to reflect fats and carbohydrate. Further studies have shown that carbon in bone collagen is, indeed, derived mainly from dietary proteins, so that its isotopic composition reflects mostly the isotopic nature of the dietary protein (Ambrose & Norr 1993; Tieszen & Fagre 1993). Bone apatite, on the other hand, is derived from all components of the diet: its isotopic composition allows us to reconstruct the carbon isotopic composition of bulk diet. The Ambrose and Norr study involved feeding rats on diets with varied C_3 and C_4 components (1993). The Tieszen and Fagre study was similar but used mice (1993). These studies have proved invaluable for our interpretation of the isotopic ratios in collagen and apatite. Thus, there is considerable value in measuring $\delta^{13}\text{C}$ in both collagen and apatite. However, these studies are based on experiments on small animals and it is not clear how closely the metabolic patterns in these species reflect those of humans.

The nitrogen cycle

Nitrogen gas (N_2) is a common constituent of the atmosphere, and is fixed into bound nitrogen through several processes. Nitrogen occurs mainly as the stable isotope ^{14}N , with a small proportion (0.3663%) of rare ^{15}N (Mariotti 1983).

$$\delta^{15}\text{N} = \left(\frac{{}^{15}\text{N}/{}^{14}\text{N}_{\text{sample}}}{{}^{15}\text{N}/{}^{14}\text{N}_{\text{standard}}} - 1 \right) \times 1000 \text{‰}$$

The nitrogen standard is atmospheric air. Nitrogen gas in the atmosphere is fixed into ammonia, and subsequently into nitrites and then nitrates by nitrogen-fixing bacteria. Nitrogen in these forms can be taken up into plants and animals and the humans who eat them. $\delta^{15}\text{N}$ values for organic substances are usually positive relative to the standard (atmospheric air). The study of nitrogen isotopic ratios ($^{15}\text{N}/^{14}\text{N}$) can allow us to distinguish between plants that are nitrogen fixers or non-fixers.

Terrestrial plants have low $^{15}\text{N}/^{14}\text{N}$ values for example plants measured from Cape Point, on the Cape Peninsula had $\delta^{15}\text{N}$ values ranging from 1.3 to 2.6 ‰. 27 terrestrial animals from widely scattered sites in North America had an average $\delta^{15}\text{N}$ of 5.9‰ (Schoeninger *et al.* 1983; Walker & DeNiro 1986). Thus $\delta^{15}\text{N}$ values generally increase by 2-3 ‰ at each successive trophic level. This stepwise fractionation is more marked for nitrogen than for carbon.

The most widespread archaeological application of nitrogen isotope measurements is the determination of marine/terrestrial inputs into the diets of coastal dwellers. The $\delta^{15}\text{N}$ values of marine plants are about 4‰ higher than those of terrestrial ones (Wada *et al.* 1975). 61 marine animals measured from various sites produced an average $\delta^{15}\text{N}$ of 14.8 ‰ (Schoeninger *et al.* 1983; Walker & DeNiro 1986). Thus, in most environments, there is a clear distinction between marine and terrestrial $\delta^{15}\text{N}$ values, with marine values considerably more enriched. As on land, there is progressive enrichment of $\delta^{15}\text{N}$ from lower to higher trophic levels in marine food chains i.e. from phyto-plankton, algae and zooplankton to fish and marine mammals (DeNiro & Epstein 1981; Minagawa & Wada 1984; Schoeninger 1985; Sealy *et al.* 1987). The fractionation is about 2-3‰ at each trophic level. This should be considered when interpreting human bone collagen $\delta^{15}\text{N}$ values (Schoeninger *et al.* 1983).

In some environments, however, the separation between marine and terrestrial $\delta^{15}\text{N}$ is reduced. This is the case especially on arid shorelines, where terrestrial values may be elevated to the point where they cannot be distinguished from marine values. A number of models have been proposed to explain this. The most plausible concerns the role of animal adaption to water stress through the excretion of concentrated urine. Some mammals, in an attempt to conserve water, have the ability to excrete more urea and less water. Urea is ^{15}N depleted so the nitrogen that remains available for tissue synthesis must be enriched in ^{15}N . Therefore water stressed animals should have higher $\delta^{15}\text{N}$ values than unstressed ones (Ambrose 1991). Drought-tolerant herbivores have higher $\delta^{15}\text{N}$ than obligate drinkers from the same habitat (Ambrose 1986,1991; Heaton *et*

al.1986; Sealy *et al.* 1987). Humans who live in areas with low rainfall (less than 400mm per annum) have high $\delta^{15}\text{N}$ values because their food is enriched in ^{15}N (Sealy *et al.* 1987).

Despite these potential complications, in most areas nitrogen isotopes can be used to monitor marine versus terrestrial resource use, because the foods they eat are enriched in the heavy isotope. Clear differences between marine and terrestrial animals have been applied successfully as a way of determining the amounts of marine foods in the diets of humans (Schoeninger *et al.* 1983; Walker & DeNiro 1986). Human $\delta^{15}\text{N}_{\text{collagen}}$ values below 10‰ result from diets which contain little, if any seafood and conversely values above 10‰ reflect the consumption of seafood (Schoeninger & DeNiro 1983)

Carbon and nitrogen isotope techniques can be applied to archaeological human bone so that we can discover what people in the past were eating. This method is a direct way of detecting diet, in addition to traditional archaeological studies of faunal and other subsistence related debris.

Bone growth and turnover

Skeletal structures obey different growth patterns (Sinclair 1989). Growth is the process through which bone increases in size by increasing the number of cells and the intercellular material between them (Stout 1992). The main phase of growth is completed at maturity (adulthood); however this does not mean that bone is 'fossilised' (Hillson 1986:177). Bone continues to 'turn over' in a process known as 'remodelling' (Frost 1964). Remodelling involves the "...sequential removal (resorption) and replacement (formation) of old lamellar bone with new lamellar bone..." (Stout 1992:23). The rate of turnover has not been clearly established and is likely to differ in individuals of different ages. Bone type and metabolic status are also important (Klepinger 1984). The rate of turnover is of importance in isotope studies because it determines the period of dietary history represented within a bone (Kennedy 1988). Bone cartilage in adults reflects a dietary average as it is laid down over a period of about ten or more years (Libby *et al.* 1964). Other estimates range to ≥ 30 years (Lovell *et al.* 1986).

The information that is available on bone turnover comes largely from bio-medical studies, especially those estimating the effects of radioactive isotopes (from both internal and external sources) on body tissues. The 'Report of the Task Group on Reference Man' was an extensive study to estimate the radiation dose to the human body. The idea was to define a reference individual in order to calculate dose. Every part of the human body was analysed, including bone. The annual turnover rate of the skeleton was calculated by using the turnover of calcium and strontium, or was based on various quantitative histological methods [International Commission on Radiological Protection (ICRP) 1975]. The turnover rates listed below are mostly based on the inorganic component of bone, which is not the same as turnover in the organic component. Young children have high rates of annual turnover: at one year 100-200%, at 3-7 years 10%, at 8 years 1%. Turnover during adolescence is small. Values calculated for adults between the ages of 20-60 range from 0,3-3% per annum. According to this study vertebrae turn over faster than other bones: at 1 year of age 72%, 5-6 years 20%, 10 years 30%, 20 years 24% and adults 8%. Trabecular (spongy, cancellous) bone turns over 3-10 times faster than cortical bone (trabecular 10% per year, cortical 2.5% per year) (see also Stenhouse & Baxter 1976).

Bone	Mean (%)	Range (%)
Ribs	4,7	2,2-10
Spine	8,3	3,6-20
Skull	1,8	0,6-4,6
Patella	3,6	2,4-5,0
Ilium	6,5	5,9-7,2
Femur	2,9	1,2-5,6
Proximal or upper end	5,7	2,6-9,4
Distal or lower end	2,5	0,8-4,2
Shaft	2,0	1,5-4,2
Tibia	1,1	0,4-2,6

Table 10: Calculated turnover rates for different bones per year in adults (n=8) between 36-86 years of age (ICRP 1975:75).

Teeth

Dental tissues are not modified much after being deposited. Tooth enamel is formed during childhood and does not undergo remodelling. Dentine occurs in primary, secondary and sometimes tertiary form. Primary dentine is laid down during tooth formation and it is followed later in life by the formation of a smaller amount of secondary dentine around the pulp cavity. If a tooth is injured or decays, tertiary dentine is deposited (Hillson 1986). Teeth develop at different times, with the first permanent molar forming and erupting in the first decade of life. Third molars can appear in the late teens or adulthood or not at all (Hillson 1986).

Therefore isotopic ratios of teeth reflect mainly diet in childhood, compact bone (with its long turnover time) would suggest an average dietary signature and trabecular bone a more recent signature. Therefore we may be able to observe dramatic changes of diet and possibly lifestyle by studying the isotopic ratios from different skeletal elements (Ericson 1985; Schwarcz & Schoeninger 1991; Sealy *et al.* 1993, 1995; Price *et al.* 1994a, 1994b; Cox & Sealy 1997; Grupe *et al.* 1997). Several studies have been carried out using multiple isotopic analyses of historical skeletons found in and near to Cape Town. A discussion of this work will take place below (under life history studies).

Collagen $\delta^{13}C$ and $\delta^{15}N$ in collagen: previous studies

North and South America

The earliest archaeological studies using carbon isotopes as dietary indicators investigated the spread of maize agriculture in the Americas (Vogel & Van Der Merwe 1977; DeNiro & Epstein 1978). Studies using both carbon and nitrogen isotopes have mostly been concerned with the importance of marine resources in the diets of coastal peoples. Since there now exists a very large body of literature on stable isotopes and dietary tracing (See Katzenberg & Harrison 1997 for a review), this review will focus on studies of historical skeletons, since these are the most relevant comparative samples for this thesis.

Schoeninger *et al.* (1983) compared the isotope values of historic people dependent on fish based diets with agriculturists. They also compared prehistoric people with different subsistence bases. The objective of this study was to show that $^{15}\text{N}/^{14}\text{N}$ ratios of bone collagen can be used to reconstruct the relative amounts of marine and terrestrial resources used by prehistoric and historic human populations. Samples were taken from three historic groups whose diets were composed of about 85% marine food. They are Alaskan Inuit and the Haida and Tlingit people from the Northwest Coast of the United States. Their $\delta^{15}\text{N}_{\text{collagen}}$ values ranged from 17 to 20 ‰ and they had enriched $\delta^{13}\text{C}_{\text{collagen}}$ measurements (between -12 and -14.5‰). Havihuh agriculturists from New Mexico and the manioc farmers from Columbia, South America had $\delta^{15}\text{N}$ values that ranged from 6 to 12 ‰, reflecting a terrestrial diet (Table 11). The Havihuh are maize farmers and have the most positive $\delta^{13}\text{C}$ values between -7 and -11‰, because maize is a C_4 plant. Schoeninger *et al.* (1983) concluded that the use of both $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ values can help to clarify ambiguities and form more reliable dietary reconstructions.

Other historical studies include those by Katzenberg (1991a) on 29 skeletons from Snake Hill military cemetery. These foot soldiers of the Northeastern United States were drawn from different regions in which the staple grains eaten varied from wheat and rice (C_3) to maize (C_4). Some soldiers were American Indian and others were of European origin, so Snake Hill isotope results were compared to other studies of indigenous North Americans and Europeans. The results were varied, but the average $\delta^{13}\text{C}$ value was -15.8 ‰, indicating a mix of C_3 and C_4 foods.

Katzenberg (1991b) has analysed individuals who lived in South Ontario, Canada, in the nineteenth century. They were expected to have $\delta^{13}\text{C}$ values reflecting consumption of wheat, barley, oats and rye, all C_3 plants, with some C_4 in the form of maize and sugar cane (molasses and or rum). The mean $\delta^{13}\text{C}$ value for skeletons from the Harvie family was -18.7‰. $\delta^{13}\text{C}$ values for early historic Ontario Iroquois are around -12‰ indicating much greater reliance on maize (Katzenberg *et al.* 1995). The mean $\delta^{15}\text{N}$ for the Harvie family was 12.4‰.

Bone collagen stable carbon isotope measurements have been used to monitor the spread of maize agriculture among prehistoric hunter-gatherer populations in North America, Mesoamerica and South America (see Pate 1994 for a list of references). For example, work in southern Ontario has shown a steady increase in reliance on maize since its introduction to that area in A.D.700 (Katzenberg *et al.*1995). Around 650 A.D. collagen $\delta^{13}\text{C}$ values shifted from -21‰ (a diet lacking in maize) to -10‰ (a diet including a good deal of maize). $\delta^{13}\text{C}$ values in the range of -19 to -13 ‰ represent a transition phase. A number of sites in eastern North America have been compared. Site specific variation exists and results from differences in the extent to which different groups relied upon maize, and also "...regional variation in $\delta^{13}\text{C}$ for maize, proportion of C_3 and C_4 grasses in the diet of the animals consumed...amount and source of fish in the diet and the presence of other C_4 plants..." (Katzenberg *et al.* 1995:345).

Europe

Schoeninger (1989) analysed collagen from six Dutch whalers buried at Spitsbergen. Their average $\delta^{13}\text{C}$ value was -19.2 ‰ and $\delta^{15}\text{N}$ was 12.2‰. Their diet on board ship consisted of bread, cheese, salted or smoked meat and fish, groats (the grain of oats deprived of the husks) peas and beer. They usually undertook one or two trips a year, each lasting four to five months. The whalers were from poorer regions of the country and their diets at home were similar to those on board ship. Their isotope values are tightly clustered: within the range of variation discussed earlier for 'monotonous' diets (DeNiro & Schoeninger 1983).

Kennedy (1989) studied $\delta^{13}\text{C}$ values for various European populations. Nine British soldiers from the Mary Rose (sunk in 1545) had an average $\delta^{13}\text{C}$ of -19.1‰. These measurements were made on rib fragments. The soldiers' shipboard diet included fish, meat (venison, beef, chicken mutton and pork), vegetables (peas), fruits (wild cherries and plums), and nuts (hazelnuts). Fishing was also practised. There was also beer for the regular crewman and wine for the officers. From historical sources sixteenth century English seamen ate well (Kennedy 1989:85-86). Kennedy also analysed rib samples from 35 French skeletons dating from the fifteenth to the seventeenth centuries. French

dietary habits are described as less nutritionally adequate than those of the English but the average $\delta^{13}\text{C}$ value here was -19.0‰ , very similar to the Mary Rose.

Ten tibial shaft fragments were sampled from burials in the city of Tübingen in southern Germany. These graves date to the early part of the sixteenth century. The average $\delta^{13}\text{C}$ value was -19.7‰ . This average is slightly less enriched than the French or British and this has been interpreted as indicating the least input from marine-based carbon (Kennedy 1988).

Johansen *et al.* (1986) studied the carbon isotopes of 30 Norwegians from inland and coastal areas and from prehistoric and historic sites. The $\delta^{13}\text{C}$ range was -12.8 to -22.7‰ . The values from southern Norway from prehistoric coastal sites with agriculture were -19.0 ; -19.8 and -22.2‰ . These rather negative $\delta^{13}\text{C}$ values were due to farming and the consumption of terrestrial rather than marine protein.

Stable isotope analysis of 48 individuals from the Iron Age, Roman and post-Roman periods from Poundbury Cemetery in Dorchester, England revealed variation in diet between individuals from different periods (Richards *et al.* 1998). The average $\delta^{13}\text{C}$ for the Iron Age period was -19.9‰ , $\delta^{15}\text{N}$ 8.5‰ . The isotope values differed from those for the Late Roman period, when isotope ratios corresponded with burial type (Table 11). Late Roman-era skeletons buried in mausolea and lead-lined coffins were high status burials and these people seem to have eaten some marine foods. The majority of people, in the wooden coffins, did not eat seafood. Three individuals have been identified as immigrants who probably moved from a warmer area to Britain.

Africa and South Africa

Ambrose (1986) and Ambrose & DeNiro (1986) have outlined the results of isotope analysis of historic and prehistoric African populations from Kenya, Tanzania and South Africa (Table 11). The populations studied all had reasonably well known diets. Carbon and nitrogen isotopes are used to distinguish marine foragers from people who consumed terrestrial resources, pastoralists from farmers, farmers who consumed grains from those who relied on non-grain crops and camel pastoralists from capri-bovine pastoralists.

REGION	Site/Population	NO.	Mean $\delta^{13}\text{C}$	Mean $\delta^{15}\text{N}$
Americas	Eskimo, Haida, Tlingit (Fisher-gatherer)		\pm -12 and -14.5*	17 to 20*
	Havihuh agriculturalists		-7 to -11*	6 to 12*
	Snake Hill (Ontario)	29	-15.8	9.6 to 13*
	Harvie family (South Ontario)	15	-18.7	12.4
	Manioc farmers from Colombia		-10 to -14*	9.5 to 10.5*
Europe	Spitsbergen (Dutch whalers)	6	-19.2	12.2
	Mary Rose	9	-19.1	-
	France	35	-19	
	Germany	10	-19.7	
	Norway	30	-12.8 to -22.7*	
	England- Poundbury (Iron Age)	13	-19.9	8.5
	Poundbury (Late Roman) mausoleum	10	-18.2	10.1
	Poundbury (Late Roman)Lead coffins	3	-18.3	9.6
	Poundbury (Late Roman) Wooden coffins	21	-19.5	9.3
Africa	Kikuyu (Kenya)	12	-10.6	10.4
	Pokot (Kenya)	2	-14.2	13.9
	Turkana and Dacenech (Kenya)	5	-14.2	13.9
S. Africa	Free State	12	-13	15.1

Table 11: Comparative studies (Schoeninger *et al.* 1983; Katzenberg 1991a, 1991b; Schoeninger 1989; Kennedy 1988; Johansen *et al.* 1986; Richards *et al.* 1998; Ambrose 1986; Ambrose & DeNiro 1986) *Mean values were not available and these cases a range of values was given.

In an extensive study Sealy (1989, 1997) has analysed a large sample of coastal (mostly hunter-gatherer) human skeletons from the southern and western Cape. The $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ for bone collagen and $\delta^{13}\text{C}$ for bone carbonate were analysed and compared. Results were very varied, indicating that different individuals ate widely divergent proportions of marine and terrestrial foods. Isotopic values for some skeletons in the Cape West Coast were extremely positive ($\delta^{13}\text{C}$ of -11‰ $\delta^{15}\text{N}$ of $+17\text{‰}$), reflecting diets in which virtually all protein foods (and perhaps the whole diet) were marine-derived. Other skeletons had values indicating little marine food intake ($\delta^{13}\text{C} \sim -18\text{‰}$, $\delta^{15}\text{N}$ of 10‰) (Sealy 1997). For skeletons from areas with rainfall below about 400mm per annum, elevated terrestrial $\delta^{15}\text{N}$ values may contribute to very positive bone collagen nitrogen isotope signals, however this is not the case around Cape Town. There was clear chronological patterning in $\delta^{13}\text{C}$ values, with many skeletons showing strong reliance on marine foods between 3000-2000 BP. After 2000 BP, more mixed marine/terrestrial diets were the norm. This shift may be due to the emergence of pastoralism, and associated disruption of old hunter-gatherer lifestyles. Only one skeleton can be identified with confidence as the remains of a pastoralist. This is the juvenile (12 year old) individual from the site of Kasteelberg, a coastal pastoralist camp-site about 120kms north of Cape Town. The $\delta^{13}\text{C}$ value is -15.9‰ and the $\delta^{15}\text{N}$ value is 17.6‰ . This enriched $\delta^{15}\text{N}$ value is probably the result of a diet rich in terrestrial animal food, with some seafood (Sealy 1989).

Nitrogen isotope studies and weaning

A number of studies have been carried out to estimate the duration of nursing from juvenile skeletal remains from archaeological sites (Fogel *et al.* 1989; Katzenberg *et al.* 1993,1996; Katzenberg & Pfeiffer 1995; Schurr 1997). Historical demographic studies combined with skeletal stress indicators have been used to study weaning in physical anthropology, with the introduction of chemical methods from around the 1980's. Initial studies used trace elements. The strontium/calcium ratio for milk is very low. In contrast, the Sr/Ca ratios of plants are high and weaning diets are usually based on cereals. Sr/Ca ratios were measured in the bones of infants and young children from a medieval cemetery in Israel. Sr/Ca increased in the bones of older infants and peaked between 1.5

and 3.5 years, very likely as a result of the introduction of supplementary foods (Sillen & Smith 1984).

Fogel and colleagues pioneered the use of nitrogen isotopes to detect weaning in 1989. Their work was based on the principle that nitrogen isotopes reflect trophic level differences. $\delta^{15}\text{N}$ values increase by 2-3% in each trophic level (DeNiro & Epstein 1981). Nursing babies who are consuming their mother's milk have more enriched nitrogen isotope values than their mothers. With the introduction of other protein-containing foods, $\delta^{15}\text{N}$ values in juvenile skeletons are seen to decrease. Studies performed on historic and prehistoric populations have shown that differences between infant and adult $\delta^{15}\text{N}$ values were greater in areas that were pre-horticultural. The duration of nursing was presumably long, in contrast to sites where maize was cultivated and maize gruel could be used as a weaning food (Fogel *et al.* 1989).

Nitrogen derives from protein sources in the diet, so $\delta^{15}\text{N}$ in infants' collagen will reflect breast milk to a greater degree than other foods in which protein is low or absent (Ambrose & Norr 1993). These observations will be discussed further in the section below on bone carbonate.

Life History Studies

The studies discussed above are generally based on the analyses of a single skeletal element from each individual. In this thesis, a more detailed approach will be taken, involving analyses of more than one sample from each skeleton. Studies of this type have been undertaken on skeletons from other historic sites near Cape Town, and one of the objectives of this thesis is to compare the isotopic results for skeletons from Cobern Street, with this earlier work.

One such skeleton was buried under the floor of the ruined slave lodge at Vergelegen in Somerset West, 50 km outside Cape Town (Table 12). This slave lodge was abandoned in the first half of the nineteenth century. The isotopic analysis indicated a tropical origin for this woman in her youth and a change of diet and place of residence during adulthood. This was determined by comparing isotopic values for teeth, long bone and rib. The teeth

have positive $\delta^{13}\text{C}$ values (-13.2, -12.4, -12.7‰) and low $\delta^{15}\text{N}$ (6.7, 7, 7.1‰). Diet during childhood therefore must have included C_4 based foods grown in a tropical environment. More positive $\delta^{15}\text{N}$ values in the femur (10.6‰) and rib (12.4‰), coupled with a slightly enriched $\delta^{13}\text{C}$ (femur = -10.9‰, rib = -11.3‰) are evidence of a significant change in diet, probably to one that incorporated seafood. The isotope signatures have been interpreted as being consistent with a slave identity (Sealy *et al.* 1993). Fish was a resource freely available to slaves and may have caused the increase in the $\delta^{15}\text{N}$ values.

Place	Site	N	Skeletal element	$\delta^{13}\text{C}_{\text{collagen}} (\text{‰})$	$\delta^{15}\text{N}_{\text{collagen}} (\text{‰})$
Somerset West	Vergelegen	1	Rib	-11.3	12.4
			Femur	-10.9	10.6
			I2:occlusal end	-12.7	7.1
			I2:root end	-12.4	7
			Third molar	-13.2	6.7
Saldanha	Oudepost 1	1	Rib	-15.7	16.7
			Femoral shaft	-17.3	15.1
			Mand. 3 rd molar	-18.9	13.7
			Max. 1 st incisor	-19.2	12
Cape Town	Grand Parade	1	rib	-17.8	14.5
			Right humerus	-17.7	14.8
			Max. 3 rd molar	-17.8	15.3
			Max. 1 st molar	-18.4	13.1
	Woodstock beach: slaves	8	Cancellous bone	*-15.3 to -20.1 (n=8)	*7.6 to 11.6 (n=2)
			Cortical bone	*-7.9 to -13.2 (n=8)	*5.2 to 8.6 (n=8)
			Tooth dentine	*-7.9 to -14.2 (n=5)	*7.6 to 9.4 (n=5)
	Woodstock beach-coffin burials	5	Cancellous bone	*-13.5 to -20 (n=5)	*10 to 12.1 (n=4)
			Cortical bone	*-19.1 to -20.2 (n=3)	*11 to 11.9 (n=3)
			Tooth dentine	*-16.8 to -20.3 (n=5)	*11 to 12.1 n=5)

Table 12: Results of life history studies for historic skeletons from the Cape (Sealy *et al.* 1993, 1995; Cox 1995; Cox & Sealy 1997) *Range of values.

A skeleton was also excavated at Oudepost 1, a Dutch East India Company outpost about 100km north of the main settlement at the Cape of Good Hope. The individual was male and was between 45 and 60 years old. The $\delta^{13}\text{C}$ value (-19.2‰) and the $\delta^{15}\text{N}$ value (12‰) for the incisor are similar to values found in Europeans (Kennedy 1988). There is a consistent trend towards less negative $\delta^{13}\text{C}$ values and enriched $\delta^{15}\text{N}$ values in tissues formed later in life. The rib $\delta^{13}\text{C}$ value is -15.7‰ and the $\delta^{15}\text{N}$ value is 16.7‰. These signatures have been interpreted as the result of an increase in marine foods later in life. It is suggested that these are the remains of a soldier in the service of the Dutch East India Company who died in the late seventeenth or eighteenth century. A second possibility is that this individual died on board a passing ship and was buried at Oudepost 1 (Schrire 1995, Sealy *et al.* 1995). (Table 12)

A burial has also been recovered from the original Fort built by the first Dutch colonists in 1652. This fort was mentioned in Chapter 3 in connection with food remains. The precise date of the burial has not been determined but it was probably during the second half of the seventeenth century. There is little variation in stable isotopes within the skeleton. Depleted $\delta^{13}\text{C}$ values (1st molar: -18.4‰ and rib: -17.8‰) are probably the result of eating C_3 based foods produced in temperate environments like Europe. The $\delta^{15}\text{N}$ values are enriched (13.1 to 15.3‰), probably the result of the consumption of marine foods. This individual was probably either a sailor or a soldier (Sealy *et al.* 1995). (Table 12)

The skeletons of slaves shipwrecked at the Cape were also analysed using similar techniques to track dietary change (Cox 1995; Cox & Sealy 1997). (Table 12) These have already been mentioned in Chapter 2 in the discussion on decorated teeth. The C_4 isotopic signatures of the teeth of these slaves are consistent with values expected for people who lived in an African village, and ate a terrestrially based diet. The diets eaten early in life vary from one individual to the next, suggesting that these people were of heterogeneous origins. A comparison of isotope ratios from compact and cancellous bone indicates a change in diet in all these individuals, probably coincident with their enslavement.

The results of isotopic analysis from five individuals buried in coffins on the Cape Town Foreshore reveal little variation in ratios within the skeleton (Cox 1995). For four of these individuals, the maximum variation within the skeleton was 0.4‰. The $\delta^{13}\text{C}$ values for these four range from -19.1 to -20.3 ‰, indicating a diet based on C_3 plants. The $\delta^{15}\text{N}$ values range from 10 to 12.1‰, so their diets probably included some seafood. These values were consistent with a European diet, and these individuals are probably sailors drowned in one of the numerous shipwrecks along this stretch of coast. One coffin burial had more enriched $\delta^{13}\text{C}$ values for palatine bone (-13.5‰) and the maxillary first molar (-16.8‰). This person probably spent at least some of his early life in a tropical country.

APATITE

We have established that poorer residents of eighteenth century Cape Town ate a diet based mostly on rice or wheat with some vegetables. Meat from cattle or sheep was a rare commodity and the poor received only some offcuts. Fish may have been a source of protein. Rice and wheat have relatively little protein and very negative $\delta^{13}\text{C}$ values, whereas fish has more positive $\delta^{13}\text{C}$ values. The stable carbon isotopes in bone collagen from the Cobern Street skeletons are likely to reflect the isotopic composition of fish and the protein components of other foods, rather than the values of the rice or wheat. Analysis of bone apatite carbonate, however, can give us information on the whole diet. In studies of wild animals, the "apatite-collagen spacing" varies according to whether the diet is plant-or animal-food based. In isotopically homogenous diets, large spacings are characteristic of herbivores, and by extension, probably people eating diets including large amounts of vegetable food. Small apatite-collagen spacings are found in carnivores, and probably in people eating considerable amounts of animal foods (Krueger & Sullivan 1984; Lee-Thorp *et al.* 1989; Sealy *et al.* 1993; Ambrose *et al.* 1997; Sealy 1997). For isotopically heterogeneous diets, the situation is more complex. Depending on the components apatite-collagen spacings can be large or small. A combination of carbohydrates from C_3 plants and marine protein is likely to result in small spacings, whereas a diet based on carbohydrates from C_4 plants and some protein from animals

eating C₃ plants may result in large spacings (Ambrose & Norr 1993; Tieszen & Fagre 1993; Ambrose *et al.* 1997).

Apatite $\delta^{13}\text{C}$ measurements of historical skeletons

USA

Bourque and Krueger (1994) used carbon and nitrogen isotopes in collagen and carbon isotopes in bone apatite to attempt to reconstruct the diets of five coastal New England populations. Four of the five groups were prehistoric but one group (seven individuals) from late sixteenth century Penobscot Bay has been analysed. The authors found that there was a strong correlation between the $\delta^{13}\text{C}$ values from carbonate and collagen. They concluded that, in this case, no additional dietary information was provided by the apatite analysis.

Apatite studies on historical skeletons are rare. Analyses by Sealy *et al.* (1993) on the Vergelegen slave skeleton (discussed above) show very similar $\delta^{13}\text{C}$ values for apatite from tooth, femur and rib. The apatite-collagen spacing, however, is relatively large for the tooth and smaller for the femur and the rib. These results are consistent with the suggestion that this woman's diet was C₄ grain-rich and seafood-poor during childhood, but shifted to a diet that included C₃ and seafoods in adulthood.

	$\delta^{13}\text{C}_{\text{collagen}}$	$\delta^{15}\text{N}_{\text{collagen}}$	$\delta^{13}\text{C}_{\text{apatite}}$	Ap-coll spacing	$^{87}\text{Sr}/^{86}\text{Sr}$
Rib	-11.3	12.4	-7.5	3.8	
Femur	-10.9	10.6	-6.9	4	0.71916
Third molar	-13.2	6.7	-6.2	7	0.73298

Table13: Vergelegen (Sealy *et al.* 1993)

Apatite $\delta^{13}\text{C}$ measurements of prehistoric skeletons

A study of the diets of prehistoric people from the Western Pacific has also made use of $\delta^{13}\text{C}$ in organic and inorganic components of bone (Ambrose *et al.* 1997). Individuals from three different sites were analysed and the results compared. The collagen $\delta^{13}\text{C}$ values ranged from -19.5 to -15.7 ‰ and the $\delta^{15}\text{N}$ values range from 7.3 to 11.3 ‰. These people ate C_3 plant based foods and varying proportions of deepwater marine resources. The $\delta^{13}\text{C}$ apatite values ranged from -12.9 to -10.1 ‰. These values correlated poorly with the collagen results. This has been explained as the result of consumption of protein and non-protein resources that have different carbon isotopic compositions. The mean difference between apatite and collagen is 6.5 ‰, "...which indicates the protein $\delta^{13}\text{C}$ was more negative than that of the whole diet..." (Ambrose *et al.* 1997). Very negative collagen $\delta^{13}\text{C}$ would result from eating terrestrial resources such as fruit bats and land crabs. It was found that the collagen-apatite spacing decreased when $\delta^{15}\text{N}$ increased. The reason for this relationship, it was suggested, is that $\delta^{13}\text{C}$ of protein from marine resources is more positive than that of the whole diet.

Individuals from the Saipan group have the lowest $\delta^{15}\text{N}$ values (from 6.1 to 9.2 ‰) and the lowest $\delta^{13}\text{C}$ collagen values (from -19.0 to -18.0 ‰). They have unusually high carbonate values (-10.2 to -7.7 ‰), resulting in collagen-apatite spacings from 7.8-10.6 ‰. This combination suggests protein came from C_3 resources with a small proportion of marine food with low $\delta^{15}\text{N}$ values. In this group, if one simply looked at the results for collagen, one would assume that these people depended upon C_3 resources with little seafood or C_4 plants. However when one considers the results for apatite, the enriched values suggest a significant component of marine and/or C_4 plants. The authors suggest that this included sugar cane.

Island	$\delta^{15}\text{N}_{\text{collagen}}$		$\delta^{13}\text{C}_{\text{collagen}}$		$\delta^{13}\text{C}_{\text{apatite}}$		$\Delta_{\text{collagen-apatite}}$		N
	Min	Max	Min	Max	Min	Max	Min	Max	
Rota	7.3	11.3	-19.4	-15.7	-12.9	-10.1	4.7	8.1	10
Guam	9.0	10.1	-18.1	-16.7	-12.5	-11.6	4.2	6.0	5
Saipan	6.1	9.2	-19.0	-18.0	-10.2	-7.7	7.8	10.6	8

Table 14: Minimum and maximum values for prehistoric humans from Rota, Guam and Saipan (Ambrose *et al.* 1997).

Excavations in the Ecuadorian highlands recovered remains of 32 individuals, dating from c.100 to 450 AD (Doyon 1988). These individuals were split into two groups- high status (n=9) and low status (n=23). Burial bundles laden with artefacts distinguish the high status burials. The $\delta^{13}\text{C}$ signatures of the two groups were significantly different with evidence that the high status group ate more maize (Ubelaker *et al.* 1995). The mean $\delta^{13}\text{C}$ value for the high status group was $-10.3 \pm 1\text{‰}$ compared with $-11.6 \pm 1.5\text{‰}$ for the low status group. Ethnohistorical sources suggested that the high status group would be likely to have eaten more meat (animal protein). There was no difference in the $\delta^{15}\text{N}$ values, or in collagen-apatite $\delta^{13}\text{C}$ spacing between the two groups. The spacing between apatite and collagen for the high-status group is 6 ‰ and for the low-status group, 5.5 ‰. The archaeological diets seem, therefore, to have been different from those in historical times.

Southwestern Cape

The studies of Later Stone Age coastal foragers from South Africa discussed above also included measurements of the $\delta^{13}\text{C}$ in bone apatite (Sealy 1989; Sealy 1997). Values ranged from -7.7 to -13.5‰ . People who lived along the south-western Cape coast show small collagen-apatite $\delta^{13}\text{C}$ spacings, from 0.9 to 4.4 ‰ with a mean of $2.5 \pm 0.9\text{‰}$. These have been interpreted as the result of ^{13}C -enriched marine protein foods and ^{13}C -depleted terrestrial carbohydrate foods (Sealy 1997; Lee-Thorp *et al.* 1989; Sealy 1989). Skeletons with the most enriched $\delta^{13}\text{C}_{\text{collagen}}$ values also had the smallest apatite-collagen spacings. Skeletons from the southern Cape coast, however, have been shown

to have rather larger apatite-collagen spacings ($3.7 \pm 1.0 \text{ ‰}$) (Sealy 1997). The reasons for this remain unclear.

STRONTIUM ISOTOPES

$^{87}\text{Sr}/^{86}\text{Sr}$ in the environment

^{87}Sr is formed by radioactive decay of naturally occurring ^{87}Rb . $^{87}\text{Sr}/^{86}\text{Sr}$ ratio of a rock is determined by its Rb and Sr contents, and by its age (i.e. the amount of time during which ^{87}Rb has been decaying to ^{87}Sr , or the time elapsed since formation). This decay forms the basis of a geological dating technique. Old rocks have higher $^{87}\text{Sr}/^{86}\text{Sr}$ than those recently formed. For the purposes of studies on historical and Holocene material the $^{87}\text{Sr}/^{86}\text{Sr}$ values are effectively constant during this recent period (Sealy 1989). Strontium is taken up into plants and animals from the geological substrate in which they live. In areas where more than one rock type exists and where these have contrasting $^{87}\text{Sr}/^{86}\text{Sr}$, this ratio can be used to track biological organisms from different zones (Ericson 1985; Krueger 1985).

$^{87}\text{Sr}/^{86}\text{Sr}$ reflect the geology of the home environment of the individual whose bone is being studied (Ericson 1985; Sealy *et al.* 1991; Price *et al.* 1994). Bone $^{87}\text{Sr}/^{86}\text{Sr}$ is the same as that of the local geology, as this heavy isotope does not undergo biological fractionation. The $^{87}\text{Sr}/^{86}\text{Sr}$ ratio for seawater is 0.70923 (De Paolo & Ingram 1985). Therefore we would expect humans living in coastal belts eating some marine food to have values around this figure.

There are a number of areas of concern with this method (Sillen *et al.* 1998, Sealy n.d.). Firstly $^{87}\text{Sr}/^{86}\text{Sr}$ ratios measured in plants and animals may differ from those in rocks, because more soluble minerals within the rocks are likely to contribute most of the strontium in groundwater. It is this strontium which is taken up into biological organisms. Thus $^{87}\text{Sr}/^{86}\text{Sr}$ ratios in biological samples show greater variation than those reported in the geochemical literature. One way of countering these possible uncertainties is to measure $^{87}\text{Sr}/^{86}\text{Sr}$ in the foodweb through analyses of plants and

animals that are available in the area (s) of study. A second problem is that strontium isotope composition can be altered in the burial environment, through the addition of secondary (diagenetic) mineral to buried bones. A method has been developed to remove diagenetic mineral, based on its greater solubility, as compared with biogenic material, in most burial environments. Repeated washing in a weakly acidic solution tends to dissolve diagenetic mineral first, thus enabling the isolation of biogenic material (Sillen 1986; Sealy & Sillen 1988; but see also Tuross *et al.* 1989; Sillen 1990).

Strontium isotope measurements on skeletal remains help the analyst discover whether individuals are local or foreign and whether they form a heterogeneous or homogeneous population (Price *et al.* 1994a, 1994b; Sealy *et al.* 1995; Ezzo *et al.* 1997; Cox & Sealy 1997). The results from these studies are illustrated in Table 15. $^{87}\text{Sr}/^{86}\text{Sr}$ can be measured for different skeletal parts in order to determine whether an individual moved to another place during their lives, based on the principles of bone turnover mentioned above. $^{87}\text{Sr}/^{86}\text{Sr}$ in tooth enamel reflect the geology of where the person lived when the teeth were forming; values in bone reflect $^{87}\text{Sr}/^{86}\text{Sr}$ of the area where they lived later in life. Thus values for bone are expected to be similar to those for the environment in which they were buried. Variation of 0.001 within a skeleton was considered to be sufficiently large to indicate movement across different geological zones, and thus to constitute a conservative cut-off for recognising immigrants (Price *et al.* 1994a). Interpreting this significance needs to be approached with caution.

Strontium isotope ratios in this thesis will be used alongside the collagen and apatite results, for skeletons with particularly interesting combinations of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values. As for the light isotopes, $^{87}\text{Sr}/^{86}\text{Sr}$ will be measured for multiple samples from the same skeleton.

$^{87}\text{Sr}/^{86}\text{Sr}$ measurements on humans

USA

Strontium isotope analysis has been used to monitor mobility in the prehistoric Southwest United States (Price *et al.* 1994). Tooth enamel and femoral mid-shafts were sampled

from 10 individuals from Grasshopper Pueblo. Previous models of the archaeology of the area had suggested that diverse groups inhabited the site of Grasshopper Pueblo; groups which came from areas in Arizona that had distinct $^{87}\text{Sr}/^{86}\text{Sr}$ ratios. The strontium isotope results supported the hypothesis that some of the skeletons buried at the site were local and others migrants.

Europe

Residential patterns in Bavaria during the Bell Beaker period (2500 B.C.) have also been investigated (Grupe *et al.* 1997; Price *et al.* 1994; Price *et al.* in press). The approach was the same as that used above. Tooth enamel and femoral mid-shafts of eight individuals were sampled. The $^{87}\text{Sr}/^{86}\text{Sr}$ ratios of enamel for three individuals differed significantly from the isotopic ratios for the bone, the largest difference being 0.00812. These three people were considered to have been immigrants to the region where they were buried, supporting the hypothesis that the Bell Beaker culture was carried across prehistoric Europe by migrating peoples.

South Africa

The old, pre-Cambrian and Cambrian shales and sandstones of the south-western Cape have high $^{87}\text{Sr}/^{86}\text{Sr}$, since a long time has elapsed since their formation, allowing a considerable amount of decay of ^{87}Rb to ^{87}Sr (Allsopp & Kolbe 1965). Indeed, a number of terrestrial $^{87}\text{Sr}/^{86}\text{Sr}$ animal bones from the south western Cape had values between 0.71543 and 0.71794 (Sealy *et al.* 1991). A sheep and cow bone from Vergelegen gave values of 0.71283 and 0.71373 respectively (Sealy *et al.* 1993). It seems that, at the Cape, the terrestrial $^{87}\text{Sr}/^{86}\text{Sr}$ value is higher than the marine (c.0.709), thus enabling us to discover whether an individual's food was primarily marine or terrestrial. $^{87}\text{Sr}/^{86}\text{Sr}$ ratios for the Vergelegen skeleton from the canine enamel (0.73507) and third molar (0.73904) are extremely high values, not recorded elsewhere in the southwestern Cape. They strongly suggest that this woman grew up somewhere other than the Cape.

$^{87}\text{Sr}/^{86}\text{Sr}$ ratios for different skeletal elements from an individual buried at Oudepost 1 (discussed above) are very similar and show variation only in the fourth decimal place.

This is probably nothing more than biological variation. A change of location in this case is not isotopically visible but it could be that this person moved from a region with similar $^{87}\text{Sr}/^{86}\text{Sr}$ to the foods eaten in later life.

The individual buried at the early Fort in Cape Town has $^{87}\text{Sr}/^{86}\text{Sr}$ ratios that show little variation except for the enamel of the first molar, which is 0.0025 different from the value for the rib. This variation may be sufficiently large that it probably reflects a change in environment from childhood to adulthood (Sealy *et al.* 1995).

The strontium isotope results from five of the shipwrecked slaves indicate that all these individuals probably moved from one place to another, and that they are likely to have originated from different areas (Cox & Sealy 1997). The values for enamel ranged from 0.70957 (possibly a marine or coastal signature) to 0.71399 (a terrestrial signature). These slaves did not come from the same place as the Vergelegen slave, since her $^{87}\text{Sr}/^{86}\text{Sr}$ ratio for tooth enamel was much higher, at 0.73298.

Site/Region	Skeletal element	$^{87}\text{Sr}/^{86}\text{Sr}$ range
Southwest United States		
Grasshopper Pueblo (N=7)	Femoral mid-shaft	0.70975 to 0.71034
	Enamel	0.70955 to 0.71448
Walnut Creek (N=3)	Femoral mid-shaft	0.70910 to 0.71079
	Enamel	0.71073 to 0.71091
Bavaria		
Weichering (N=5)	Femoral mid-shaft	0.708509 to 0.708847
	Enamel	0.708821 to 0.712821
Augsburg (N=3)	Femoral mid-shaft	0.708151 to 0.708191
	Enamel	0.708551 to 0.716319

Continued...

Site/Region	Skeletal element	$^{87}\text{Sr}/^{86}\text{Sr}$
South Africa		
Vergelegen (N=1)	Femur	0.71916
	Canine	0.73267
	Third molar	0.73298
Oudepost 1 (N=1)	Rib	0.70973
	Femur	0.70957
	1 st Incisor	0.70974
	3 rd molar	0.70954
Fort/Grand Parade (N=1)	rib	0.71056
	humerus	0.71067
	1 st molar	0.71061
	1 st molar (enamel)	0.71206
	3 rd molar	0.71047
Shipwrecked slaves (N=5)	rib	0.71743
	mandible	0.71910
	parietal	0.71376
	Femoral mid-shaft	0.71356
	Enamel	0.70957 to 0.71399
Fort Knokke: Coffin burials (N=3)	Enamel	0.70937 to 0.70994

Table 15: Strontium results: Southwest United States (Price *et al.* 1994); Bell Beaker (Price *et al.* 1994, in press); Vergelgen (Sealy *et al.* 1993); Oudepost 1 & Fort (Sealy *et al.* 1995), shipwrecked slaves (Cox & Sealy 1997) and coffin burials on the Cape Town Foreshore (Cox 1995).

BONE DENSITY FRACTIONATION

The life history studies outlined above (and the work done in this thesis) have contributed to our understanding of bone turnover and how dietary changes can be monitored through isotopic measurements of different skeletal elements. These developments have occurred because there are many archaeological questions that can be answered if we can monitor the movement of people in the past. In 1986, John Parkington commented, "An obvious limitation of carbon isotope readings is that they represent a distillation of several distinct constituents, an average of a set of averages, an answer for which there are numerous questions." (1986:145-146). The use of multiple isotopic indicators ($\delta^{13}\text{C}_{\text{collagen}}$, $\delta^{15}\text{N}_{\text{collagen}}$, $\delta^{13}\text{C}_{\text{apatite}}$, $^{87}\text{Sr}/^{86}\text{Sr}$) goes some way towards resolving the various constituents of a single isotope reading. Analysis of multiple skeletal elements, too, can be helpful in this respect. The approach outlined below is a further step towards obtaining finer-grained dietary reconstructions using isotopic methods. This study presents the application of a new method of accessing dietary history during the last years and months of an individual's life (Bell *et al.* 1999).

The bone density fractionation technique was originally developed to measure and characterise bone mineral maturation in avian species (Roufosse *et al.* 1979). The density fractionation method depends on the premise that tissues of differing densities exist together as discrete units (Richelle 1964). We have established (above) that bone is continually turning over: young, newly formed, poorly mineralised bone packets exist alongside older, more highly mineralised packets. Thus packets of bone of different ages, with varying densities, can potentially be separated. The first and most important step in this method is the pulverising of the bone into a powder composed of particles between 5-10 microns in diameter (see Chapter on Analytical methods). Bone particles of these dimensions represent the "liberation size" where particles consists only of bone of one age (rather than being composite particles made up of some older and some more recently formed tissue) (Fincham 1969). This powder is suspended in a series of organic solvents of known densities. Each suspension is ultracentrifuged, the supernatant recovered and the remaining pellet resuspended in a solution of greater density, until no powder

remains. The density of normal human bone falls between 1.7-2.4 g/cm³ (Simmons *et al.* 1991). The low weight fraction (2.0-2.1 g/cm³) represents the last weeks and months of bone maturation in an individual's life (Grynopas 1993). In modern human bone, most material resides in the 2.0-2.2 g/cm³ range (Engfeldt & Hjerpe 1974). The 2.3-2.4 g/cm³ fraction represents the most highly mineralised, oldest bone, representing formation approximately 15-18 years before death (Grynopas 1993).

Bell (1996) has established that archaeological bones and teeth, from terrestrial and marine contexts, can maintain their characteristic range of densities for at least 6000 years. There are, however, types of microstructural change that can cause diagenetic change, which increase bone density values (Bell *et al.* 1991,1996). The most common change derives from bacterial alteration, which degrades the collagenous fraction, so that the bone increases in density beyond the 2.4g/cm³ range (Bell *et al.* 1996). This bacterial attack may not affect all tissue, and within a sample some bone may remain intact and be retrievable using the density fractionation method (Bell 1996).

To date, only a single pilot study has been completed, applying the bone density fractionation approach to archaeological dietary reconstruction (Bell *et al.* 1999). In that study, modern bovine bone and samples from five archaeological human skeletons were analysed. These included three pre-colonial inhabitants of the south-western Cape and two historical skeletons, the remains of slaves. The samples were examined for diagenetic alteration in a scanning electron microscope. A range of preservation states was observed, from perfect (modern bovine) to typical bacterial microstructural change in some of the archaeological specimens. All specimens, however, retained substantial quantities of bone not affected by post-depositional degradation. The fractionation approach was, therefore, pursued. The bovine bone yielded the characteristic fractions associated with cow, as almost all the bone separated into the 1.8 to 2 g/cm³ and the 2.0 to 2.1 g/cm³ fractions (Richelle 1964). Collagen was extracted for each density fraction, and the C/N ratios of these extracts were within the range characteristic of collagen, between 2.9 and 3.6 (DeNiro 1985). This provides a degree of confirmation that the material isolated is, in fact, collagen. The method of collagen extraction had to be modified because only very small amounts of bone powder were available and particle

size was so small (see Chapter 7 for detailed analytical methods). The $\delta^{13}\text{C}$ values for the collagen obtained from powdered bone (fractionated or not) were about 1‰ more negative than those measured on collagen from 'chunks' of bone from the same specimens. This shift is not fully understood but has been interpreted as a methodological artefact occurring during the process of acid dissolution. The bone powders used in this study are much finer than those used in other studies and this increased surface area may be the reason for the shift in $\delta^{13}\text{C}$ values. The results for the archaeological specimens were encouraging. Although it is difficult to compare results for the powder fractions directly with analyses of whole bone, due to the powder/chunk offset, clear trends in $\delta^{13}\text{C}$ were visible in previous studies of several of the archaeological skeletons. These trends were also observed in the $\delta^{13}\text{C}$ values of the density fractions. Thus, for one skeleton in particular, the $\delta^{13}\text{C}$ values of tooth, formed early in life, were more enriched than those of cancellous bone, which formed later in life. In the density-fractionated bone, the $\delta^{13}\text{C}$ values of the heavy fractions (formed early in life) were more positive than those of the higher fractions, which formed shortly before death. Thus it seems that the method can provide us with useful insights into the nature of the diet eaten, especially in the latter part of life, since this is difficult to access by isotopic analysis of whole bone.

The Cobern Street samples were chosen as an extension of this pilot study. The people buried here came from diverse origins and many of them underwent a change in diet. It was hoped that applying the density fractionation method to this group would elucidate these changes.

CONCLUSION

This survey has focussed on applications of stable isotope analysis similar to that planned for the Cobern Street skeletons. $\delta^{13}\text{C}_{\text{collagen}}$ and $\delta^{15}\text{N}_{\text{collagen}}$ will be measured for each individual, supplemented by other techniques in cases where the initial results look especially interesting. As in many studies summarised above, the stable carbon and nitrogen isotopes in collagen will be used to reconstruct the C_3/C_4 character of the food base and monitor the intensity of marine food use. Bone collagen probably reflects

mainly the protein content of the diet. Stable carbon isotopic analysis of bone apatite should reveal aspects of the whole diet consumed. The differences between the carbon isotope ratios for collagen and apatite inform us about the isotopic heterogeneity or homogeneity of the diet, and perhaps about the amount of protein and/ or plant foods that were eaten. Strontium isotope ratios differ depending on the geological environment, so that individuals growing up in different regions can often (but not always) be differentiated. Bone density fractionation is a new technique and it is hoped that the isotopic analysis of the retrieved fractions will reveal detailed dietary histories for the last fifteen or so years of life.

CHAPTER 6

SAMPLING

INTRODUCTION

Of the 65 in situ burials excavated from Cobern Street, 53 were sampled for isotopic analysis (See Appendix 1). Those chosen excluded neonates, pre-term babies and children under the age of 10 (with two exceptions). There are 11 child burials and many more fragmentary juveniles represented in the scatters of bone. This could become an interesting project for someone who wanted to investigate weaning and diets in small children. The objective of this project was to examine the adults in order to determine their origins and to collect information on the diet of 18th century residents of Cape Town. Some burials included more than one individual and these were avoided unless individuals could be clearly distinguished. Priority was given to burials with contextual information, for example, distinctive burial patterns, unusual physical features eg. decorated teeth, and grave goods.

More complete individuals were chosen so that samples could be taken from multiple skeletal elements, including cortical and cancellous bone and teeth, to assess diet at different stages of life. The initial phase of sampling involved taking small fragments of both cortical and cancellous bone from the selected skeletons. Cortical bone was sampled, where possible, at the left femoral mid-shaft, otherwise other mid-shaft long bone was sampled. Cancellous bone was taken, preferably, from rib bone; where ribs were not available vertebrae were taken. If broken ribs were available these were sampled. Sternal ends of ribs were not sampled, because these can be used for age estimation techniques. Pathological features were avoided.

$\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ in bone collagen from this initial sample set were measured. Some individuals showed significant isotopic differences between cancellous and cortical bone, consistent with changes in diet during life. To investigate these differences further, and to

36 individuals were taken. In most cases loose teeth were available. In all cases, roots were sampled, to avoid damaging the crown. The 36 include; individuals with decorated teeth, those buried on their sides or in niche type burials, those with a dietary change and those with contextual information. Teeth were not available for all skeletons, since many of the burials were disturbed and no teeth were excavated.

Ear ossicles were sampled from five individuals. It was thought that ear ossicles were fully formed at birth and do not undergo any further turnover during life (Pers comm L. Bell). A subsequent literature search has revealed that ossicles do continue to turn over after formation. The incus and malleus appear during the latter half of the fourth fetal month, approximately one month or so earlier than the stapes. Growth of all three ossicles continues after birth (Schwartz 1995).

Fifteen of the Cobern Street individuals were sampled for stable isotope analysis of bone mineral. Strontium isotopes were measured in four skeletons.

The following descriptions of the skeletons selected for isotopic analysis are based on excavation notes and the descriptions of Apollonio (1998) as well as my own observations. Constant and Louw (1997) determined age and sex. Holtzhausen & Slater (1997) identified the pathologies.

DESCRIPTIONS OF BURIALS AND SAMPLES TAKEN FOR ISOTOPIC ANALYSIS

Burial 3: UCT 460

Burial 3 was an adult male of approximately 20 years at death. There is no evidence of a coffin. The body was extended on its back with the hands folded over the pelvis (Type B). The right foot was missing, probably due to a later disturbance. An iron shackle was found around the left leg. Additional artefacts included buttons. Three samples were taken: one each from a rib, the left femur (anterior, mid-shaft) and the maxillary first premolar.

Burial 4: UCT 458.1

Burial 4 was a female of approximately 17-18 years, buried in a coffin. The body was extended on its back and the arms were folded over the pelvis (Type B). Coffin nails were recovered. Samples were taken from rib and right femur (anterior, mid-shaft).

Burial 5: UCT 461

Burial 5 was a female of 20-30 years, buried in a coffin. The body was extended on its back and the hands were folded over the pelvis (Type B). No cranium was recovered, and the feet were only partially recovered as they ran into the sides of the foundation trench. The skeleton was associated with coffin nails, and clear dark soil stains indicate the sides of the coffin. Samples were taken from a rib and the left femur (anterior, mid-shaft).

Burial 6: UCT 459.1

Burial 6 was male between 20-30 years old. There was no evidence of a coffin. The body was extended on his back (Type B). Only the lower half of the skeleton was recovered, from the lumbar vertebrae down, and the bones were in poor and fragmentary condition. Samples were taken from the one of the lumbar vertebrae and the left femur (anterior, mid-shaft).

Burial 7: UCT 459.2

Burial 7 was a male of approximately 18 years. There was no evidence of a coffin. The body was extended on its back (Type B). The burial was only partially recovered. A single sample was taken from the right tibia (mid-shaft).

Burial 8: UCT 459.3

This individual was too young to sex (about 9-10 years old at death). There was no evidence of a coffin. Burial 8 was classified as a bone scatter (Type D) and appears to have been disturbed during the process of interring Burial 3. Two samples were taken, one from a rib and one from the left humerus (mid-shaft).

Burial 9: UCT 458.2

Burial 9 was 10-12 years at death and was too young to sex. There was no evidence of a coffin. The body was extended on its back and the hands were folded over the pelvis (Type B). There was no cranium present, however the burial was only partially excavated due to time constraints. One sample was taken from the left femur (anterior, mid-shaft).

Burial 10: UCT 498

Burial 10 was female, between 35-40 years old at death, buried in a coffin. The body was extended on its back with the arms crossed over the torso (Type B). She had scoliosis and osteoarthritis on the clavicles. The right talo-calcaneal joint was fused and she probably had to use crutches to walk. Artefacts consisted of iron nails and some wood fragments. Three samples were taken; rib, right femur (anterior, mid-shaft) and maxillary right first premolar.

Burial 11: UCT 499

Burial 11 was a female older than 40 years, buried in a coffin. The body was extended on its back with the arms folded across the body and the legs crossed (Type B). There was no cranium present. Artefacts consisted of iron nails and wood fragments, probably from the coffin. Samples were taken from rib and right femur (anterior, mid-shaft).

Burial 12: UCT 500

Burial 12 was a male of about 35-40 years, buried in a coffin. The body was extended on its back with the hands folded over the body and the legs crossed (Type B). The cranium was missing, possibly due to an earlier disturbance. Burial items consisted of iron nails and wood fragments from the coffin. Associated with Burial 12 and/or Burial 11 were metal buttons found between the femora, in midline below the pelvis (probably trouser buttons) and one eyelet. The skeleton is well preserved. There was labial wear on all four of this individual's maxillary incisors. This is probably task related wear. Samples were taken from a rib, left femoral anterior mid-shaft, ear ossicle and the maxillary right first incisor.

Burial 13: UCT 501

Burial 13 was a male aged 30-40 at death, buried in a coffin. The coffin was an oblong trapezoid shape. The body was extended on its back with the hands folded over the pelvis (Type B). The observed pathologies include left leg trauma and infection with subsequent ankylosis of left knee and spondylosis. He also had dental impactions and possible pipewear. Artefacts consisted of nails, wood from the coffin and shroud pins. Samples were taken from the rib, right femoral anterior mid-shaft and the mandibular left central incisor.

Burial 14: UCT 502 & 503

Burial 14 included a female adult (14A) of 45-55 years and a child (14B) of approximately one year. Both of these individuals appear to have been buried in the same coffin. The adult lay extended on her back, with the child's skull next to the woman's left femur (Type B). The woman's arms lay at the sides of her body. Burial 14 A had calcification of the fourth lumbar vertebra. There were copper stains on the chin of Burial 14A, and a pin found adhering to a piece of cloth suggests a burial shroud. Artefacts consisted of coffin hardware, and beads found around the neck area of the adult. Associated with the child was a clay pipe stem. Samples were taken from the rib, right femur (anterior distal shaft), lumbar vertebra and maxillary left second molar of the adult.

Burial 15: UCT 504

Burial 15 was a male of 25 years, buried in a coffin. The body was extended on its back and the arms lay at the sides (Type B). Artefacts associated with Burial 15 were coffin hardware, buttons, cuff links, and wood. Samples were taken from a rib, left tibia (mid-shaft) and the maxillary right third molar.

Burial 18: UCT 508

Burial 18 was a female aged 40 –50 years, buried in coffin. The body was extended on its back, with the hands clasped at the waist (Type B). She suffered from widespread osteoarthritic changes to the humeri, scapulae and vertebrae. The ankle was fused. Artefacts included a clay pipe, coffin hardware, pins, wood fragments and shell fragments. Samples were taken from the rib, right femur (anterior mid-shaft) and mandibular right central incisor.

Burial 19: UCT 509

Burial 19, an adult male of undetermined age, was disturbed by the construction of the new building. Thus this skeleton is represented only by a pelvis and leg fragments and is classified as a 'scatter' (Type D). One sample was taken from the right femur (anterior mid-shaft).

Burial 20: UCT 510, 511 & 512

Burial 20 contained three individuals. Burial 20A (a male) was approximately 25-30 years at death. Burial 20B was female, 16 years old at death. Burial 20c was an infant of 1 ½ -2 years. The site notes say that this was probably a coffin burial, as a coffin handle was found, however it is not clear which individual the handle was associated with, or if the bodies were buried in the same coffin or separate ones. 20A and 20B lay back to back (on their sides) and appear to be a couple buried together (Type B?). One individual

(20A) had its hand resting on the shoulder of the other (20B), indicating that they were most likely buried at the same time. The cranium of the child lay between the two adults.

Burial 20A and Burial 20B both have dental decorations (for discussion of dental decorations see Chapter 2). 20A had semicircular chips removed from the medial margins of the two central maxillary incisors, and from the lateral margins of the maxillary second incisors. 20B had a similar pattern except that the chips are deeper (Figure 8). 20 C does not have decorated teeth. Burial 20B has cribra orbitalia, with pitting of the parietal bones. There was also an extensive abscess affecting the central and lateral maxillary incisors. Artefacts in association with this burial include coffin hardware.

For 20A, samples were taken from a rib, right femur (anterior mid-shaft), maxillary left second premolar and maxillary left second molar. Samples were taken from Burial 20 B's rib, left tibial shaft (proximal), maxillary left first and second premolars. Samples were taken from Burial 20C's rib, right femoral anterior mid-shaft and both maxillary central incisors.

Burial 21: UCT 514

Burial 21 was a female of 25-35 years, buried in a coffin. The body was extended on its back with the hands placed partially underneath the hips, as opposed to over them (Type B). The mandible was pushed beneath the maxilla. The incisors were shovel-shaped. There was no right hand, possibly a result of disturbance from the interment of Burial 20. She had osteoarthritis of the lumbar vertebrae. Slight traces of copper stains may indicate shroud pins. Artefacts included coffin hardware, snapped cane beads, and limpet shells. Samples were taken from rib, left femur (anterior mid-shaft) and mandibular left first premolar.

Burial 22: UCT 515

Burial 22 was 12-14 years old and too young to sex. The site notes do not specify whether this individual was buried in a coffin. This incomplete skeleton was lying on its back (Type B). The torso, neck, and pelvis were found articulated. Part of the right arm, the clavicles and scapulae were missing. Part of the left femur was present but the lower legs appear to have been lost during a disturbance. The burial was disturbed by Burial 15, a portion of which may have encroached on the grave. Artefacts consisted of iron nails that may have been from a coffin. Two samples were taken: one from a rib and one from the left femur (anterior proximal shaft).

Burial 23: UCT 516

Burial 23 was female, aged between 17-19 years and buried in a coffin. The arms were placed at the sides of the torso and the legs extended under the section of the trench, and hence were incompletely excavated (Type B). She had arthritis of the vertebrae, and a tooth abscess on the right-hand side of the mandible. Burial items consisted of coffin hardware and wood fragments. Three samples were taken: one each from the rib, right femur (anterior distal shaft) and mandibular right central incisor.

Burials 24: UCT 517

Burial 24 was a male of 20-25 years of age at death. Burial 24 was classified as a bone scatter (Type D). Burial 24 had iron nails and an earthenware sherd. An iron strap was recovered that could be associated with Burial 24 or Burial 25. Burial 24's rib and mandibular right second premolar were sampled.

Burial 25: UCT 518

Burial 25 was an older male of approximately 35-40 years at death. Burial 25 has been classified as a bone scatter (Type D). Burial 25's rib, left humerus (distal shaft) and maxillary right first premolar were sampled.

Burial 27: UCT 521

Burial 27 was a male of between 40-50 years, buried in a coffin. The body was extended on its back with the hands folded over the pelvis (Type B). The skull was crushed, with the face in two pieces. The burial shaft contained numerous fragments of human bone, with indications of multiple disturbances of previous graves. Pathologies included arthritis of the right glenohumeral (shoulder) and the right elbow joint. Artefacts consisted of coffin hardware, an iron cutthroat razor blade, shroud pins, various buttons, about 57 beads, and a coarse porcelain sherd. Most of the buttons were found on the right side and perhaps clothes were placed on this side during burial. Three samples were taken: one each from a rib, right femur (anterior proximal shaft) and maxillary left third molar.

Burial 28: UCT 522

Burial 28 was a female aged approximately 50 years. The body was extended on its back with the left arm bent and extended up to the shoulder (Type B). The feet were crossed. The burial was poorly preserved, and very close to the surface. The skull was crushed and tilted to the right. There was some evidence of disturbance to the legs. This individual had osteoarthritis of the sacrum and vertebrae. Artefacts consisted of nails, and fragment of glass. Two samples were taken from the rib and right femur (anterior proximal shaft).

Burial 32: UCT 526

Burial 32 was a male aged 50-60 years at death. There was no evidence of a coffin, instead the body was in a pit dug into the underlying yellowish gravel. Burial 32 was

positioned partially on its right side with the arms folded over the body (Type C) (Figure 6). The burial was disturbed and the pit may have intersected the pit of Burial 37. This person had general arthritis, which was especially prevalent in the temporal mandibular joint. He had labial wear on the maxillary incisors and dental caries was marked. The wear pattern was the same as that seen on Burial 12 and is thought to be the result of using the teeth as a tool. Artefacts consisted of an intrusive Khoi pot fragment. Burial 32's rib, left femur (anterior distal shaft) and maxillary left central incisor were sampled.

Burial 34: UCT 528

Burial 34 was female, aged between 14-15 years at death. There was no evidence of a coffin. The body was extended on its back with the hands folded over the pelvis (Type B). There were no artefacts recovered. She had enamel hypoplasia with clear ridges on all four maxillary incisors. Three samples were taken from rib, left femur (anterior proximal shaft) and mandibular right second molar.

Burial 37: UCT 531 & 532

Burial 37 is a Later Stone Age burial c.1000 years old, containing two individuals (Type A). Later Stone Age burials are relatively common all along the Cape coast, in middens and sand dunes (Morris 1992). It is likely that Burials 37 and 42 just happened to be in an area that later became a graveyard (Apollonio 1998).

Burial 37A was a female aged 50-60 years at death. Burial 37B was too young to be sexed at 10-12 years. 37A was interred in a vertical flexed position facing east, the body leaning back against the pit wall with the knees drawn up and the chin apparently resting on the knees. She suffered from osteoarthritis of the vertebrae. The edge of the pit is what appears to be a cache of mixed shell. A cairn was built over the burial. Two of the rocks from the cairn were grindstones, and dense pockets of shell were interspersed among the rocks of the cairn.

The second individual, 37B, was interred beneath the first lying on its side and economically packed into the pit base. This burial appears to have been disturbed as no cranium was found. Artefacts included a Khoikhoi pot, a cow phalange, and stone tools.

Burial 37 A's rib, distal end of the anterior right femoral shaft and maxillary left first molar were sampled.

Samples were taken from the rib and left femoral anterior mid-shaft of Burial 37B.

Burial 40: UCT 535

Burial 40 was 12 years old and too young to estimate sex reliably. There was no sign of a coffin. Burial 40 was extended on its back, the left arm was over the body and the right arm was drawn up to the shoulder (Type B). No artefacts were recovered. This individual had dental decoration: an inverted V-shaped notch between the maxillary central incisors, with possible ablation of the mandibular central incisors (Figure 9). Samples were taken from a rib, left humerus (anterior mid-shaft) and maxillary left canine.

Burial 41: UCT 536

Burial 41 was an adult male of 35-40 years at death. The body was extended on its back with the arms at the sides and the fingers placed over the upper thighs (Type B). There was no cranium but the mandible was present. He had a healed medial fracture on the tibial plateau (knee joint injury). Additionally two unrelated crania were found in the trench fill above the upper femur and pelvis region of this burial. Samples were taken from the rib, left femur (anterior distal shaft) and mandibular right first premolar.

Burial 42: UCT 539 & 540

Burial 42 was a Later Stone Age burial containing two individuals deep in a confined shaft. 42A was a male of 40-50 years at death. 42A was interred in a vertical flexed position with the knees drawn up to the chest and the head placed between the knees. A cairn was built over the burial. His teeth were worn to stumps and he had a fractured left radius and lipping of first sacral and fourth or fifth lumbar vertebra. There was some

crushed and displaced bone in the bottom of the hole. Burial 42A had a patch of red ochre on the forehead and large red ochre stains were associated with the other finds, especially in the area of the cranium.

Burial 42B was female and was between 40-50 years at death. Burial 42B interred beneath 42A in the same vertical flexed position, but was pushed down and slightly displaced to make room for the interment of Burial 42A (Type A). The pelvis of Burial 42B was pushed against the edge of the pit. Burial 42B had a displaced non-united fracture of the distal half of the left ulna and a fibrous union in joint. Artefacts consisted of fragments of a tortoise carapace bowl stones from the cairn and fragments of a Khoi pot.

Samples were taken from Burial 42A's rib, left femur (anterior mid-shaft) and mandibular right and second incisors. Samples were taken from Burial 42 B's rib and the right femoral anterior mid-shaft.

Burial 43: UCT 541

Burial 43 was an adult male of 35-50 years at death, classified as a bone scatter due to the extreme disturbance of the grave (Type D). He had an infection of the left radius. Samples were taken from the rib and the right femoral shaft (anterior distal).

Burial 44: UCT 542

Burial 44 was a female between the age of 40-50 years at death, buried in a coffin. The body appeared to be extended on its back with the right arm folded over the body (Type B). Both feet were missing in addition to the left tibia and fibula, and the left side of the chest. Only a few vertebrae were found. She had arthritis of the clavicle and avulsion of the right foot, evidenced by the distal right tibia and fibula. Teeth were very worn and also small in size. Small wood fragments with nails in them were found lying below the mandible, and may be part of the coffin lid. North of the burial and close to the surface a small bone accumulation, including animal bone was found. Artefacts consisted of coffin

hardware. Samples were taken from the rib, right femur (anterior mid-shaft) and maxillary left incisor.

Burial 45: UCT 543

Burial 45 was a male of 50+ years, buried in coffin. The body lay extended on its back with the arms crossed over the pelvis (Type B). He had generalised osteoarthritis and ankylosing spondylitis. The teeth were worn lingually, perhaps as a result of chewing on an abrasive substance for a long period. Many of the teeth were carious. Associated artefacts consisted of iron nails. Three samples were taken: one from the rib, one from the right femur (anterior distal shaft) and one from the maxillary right first premolar.

Burial 46: UCT 544

Burial 46 was a female, 35-50 years old at death, buried in a coffin. The body was extended on its back with the arms folded over the pelvis (Type B). She had new bone growth on the left calcaneus and osteophytic vertebrae. She also had teeth worn in the same pattern as Burial 45. All the maxillary teeth have been worn away lingually, especially the incisors, canines and premolars. Wood fragments, probably from a coffin, were found over the top of the skull. Samples were taken from the rib, right femur (anterior mid-shaft) and mandibular right second premolar.

Burial 47: UCT 545

Burial 47 is an adult male aged 30-40 years. There was no evidence of a coffin. The body was extended on its back with the left hand placed on the waist (Type B). There were no burial items. The skeleton was nearly complete. He had osteoarthritis and lipping of the lumbar vertebrae. Samples were taken from a rib, left tibia (proximal shaft) and maxillary left first molar.

Burial 48: UCT 546

Burial 48 was a female of 40+ years at death, buried in a coffin. The body was extended on its back (Type B). There were metal stains on the forehead. The burial was cut off at the waist by a subsequent grave shaft. She had very marked changes caused by osteoarthritis in the shoulders, elbows and vertebrae. She was edentulous. Artefacts consisted of coffin hardware, a pin with fabric, and wood fragments. A rib and the left ulna (mid-shaft) were sampled.

Burial 49: UCT 547

Burial 49 was a male aged approximately 40 years, buried in a coffin and extended on his back (Type B). He had extensive changes caused by generalised osteoarthritis. He had dental decorations (sharpened maxillary incisors) (Figure 10) and pipewear bilaterally. Burial 49 was buried with a number of burial items: a tinderbox, striker, flint, deteriorated fabric and a clay pipe with 'TD' imprinted on one side of the bowl and a heart on other. Samples were taken from a rib, right femur (anterior mid-shaft), ear ossicle and maxillary first premolar.

Burial 50: UCT 548

Burial 50 was a male aged 35-50 years, buried in a coffin. The body was extended on its back and the arms were folded over the body (Type B). The cranium was badly crushed. He had dental decoration, with the maxillary first incisors chipped distally, and the second incisors chipped mesially (Figure 9). This was the only individual with this pattern. Artefacts consisted of coffin hardware and a metal loop or ring. This individual has been sampled extensively in order to determine whether he was born in the Cape or elsewhere and whether he underwent a dietary change during life. Samples were taken from a rib, thoracic vertebra, left femur (anterior mid-shaft) and mandibular second premolar.

Burial 51: UCT 549

Burial 51 was a male of approximately 35-40 years at death. The individual was crammed into a very narrow coffin, which overlapped Burial 47. The body was extended on its back with the arms were at the sides (Type B). Pathological features include cribra orbitalia, and early calcification of vertebrae. Artefacts consisted of coffin hardware, buttons, and a perforated coarse earthenware sherd. Two samples were taken, from a rib and from the left femur (anterior mid-shaft).

Burial 52: UCT 550

Burial 52 was a female aged 25-35 years, buried in a coffin. There was green staining over large areas of the coffin wood, indicating that there was either copper plating in the coffin or it was painted green inside. The body was extended on its back with the arms at the sides (Type B). The skull was damaged, probably post-mortem, and no maxilla was recovered, only some mandibular teeth. All four incisors were filed to points (Chapter 2). She had inflammatory disease in her feet, which could be the result of trauma or osteoarthritis. Associated artefacts include coffin hardware, an iron penknife, fragments of wood, fragments of fabric, a pipe bowl, a flint, and buttons. Samples were taken from a rib, right femur (anterior mid-shaft) and maxillary left first and second premolars.

Burial 53: UCT 551

Burial 53 was a male aged 35-40 years. There was no coffin. Burial 53 was classified as a bone scatter as it consisted of a cluster of bone that was seemingly piled together, possibly a body disinterred during the opening of another grave and then re-buried (Type D). Samples were taken from a rib and the right femur (anterior mid-shaft).

Burial 54: UCT 552

Burial 54 was a male aged between 30 –35 years. There was no evidence of a coffin. The body was extended on its back and the hands were folded over the pelvis (Type B). He had tuberculosis of spine (sixth to twelfth thoracic vertebrae) with a paraspinous mass affecting the rib notches. The left tibia was also affected. Artefacts recovered were a

shovel blade, a bone handled knife, a pipe stem, and a musket ball. Three samples were taken: one from a rib, one from the left femur (anterior mid-shaft) and one from the maxillary left first premolar.

Burial 56: UCT 554

Burial 56 was a male aged 35 years. There was no evidence of a coffin. The body was extended on its back and the hands folded over the pelvis (Type B). Two samples were taken, from a rib and from the left femur (anterior mid-shaft).

Burial 57: UCT 555

Burial 57 was a female aged 20-30 years. There was no evidence of a coffin. She was interred lying on her right side, in a niche (Type C)(Figure 6). The axial orientation was north. Samples were taken from a rib, left femur (anterior mid-shaft) and mandibular left first molar.

Burial 58: UCT 556

Burial 58 was a female of 35-40 years at death. She was buried in a coffin. The body was extended on its back (Type B). Her teeth were very worn and both first and second molars in her mandible may have been extracted some time before death. Burial items included coffin hardware, and a pin. Burial 58's rib, left femur (anterior mid-shaft) and mandibular left first incisor were sampled.

Burial 59: UCT 557

Burial 59 is a male of 40+ years. There was no evidence of a coffin. Burial 59 was interred on its right side (Type C). The axial orientation was north. There were no burial items. This person had osteoarthritis of the vertebrae. His teeth were in poor condition with considerable caries. Two of the loose incisors have labial wear, probably task-related, like Burials 12 and 32. Samples were taken from a rib, left femur (anterior distal shaft) and maxillary and mandibular left central incisors.

Burial 60: UCT 558

Burial 60 was a female of about 30 years at death, buried in a coffin. The body was extended on its back and only part of the burial was recovered as it extended under the unexcavated section at an angle (Type B). The cranium, one arm, some vertebrae, the scapulae and ribs were recovered. She had dental decoration, all four maxillary incisors were chipped to points (Figure 10). Coffin hardware was recovered. Samples were taken from the rib, mid-shaft of the left humerus, ear ossicle and maxillary left first molar.

Burial 61: UCT 559.1

Burial 61 was female and was approximately 20 years of age at death. She was buried in a coffin. The body was extended on its back and the arms were folded over the torso (Type B). The burial disturbed an older interment, since skeletal remains of another individual were present along the edges of the shaft fill. Artefacts included coffin hardware, shells, a needle case, a snuffbox (initialed with the letters MHK and a date of 1764), and buttons. Samples were taken from the rib, left femur (anterior mid-shaft) and the maxillary left second premolar.

Burial 64: UCT 562

Burial 64 was a male of about 35-45 years. There was no evidence of a coffin. He was interred lying on his right side with the arms positioned over the pelvis (Type C). The feet and head were placed in small niches cut into the sides of the burial pit. The axial orientation was northwest. The wear pattern on the labial surface of the maxillary incisors was the same as that observed on Burials 12, 32 and 59. Samples were taken from a rib, left femur (anterior mid-shaft), ear ossicle and mandibular left first molar.

Burial 65: UCT 563

Burial 65 was female and was about 22-25 years of age at death. There was no evidence of a coffin. Burial 65 was interred on its right side, in a niche (Type C). The axial orientation was northwest. There was a stone lining down the side of the grave opposite the body. She also had wear on the labial surfaces of the incisors. This is not as

pronounced as in the other burials, perhaps because this person is younger. Artefacts included iron nails, and a coarse earthenware sherd, but these were not in direct association with the grave. Samples were taken from a rib, left femur (anterior mid-shaft), ear ossicle and mandibular left canine.

The following chapter will describe the laboratory procedures applied to the samples of bone and tooth listed above.

CHAPTER 7

ANALYTICAL METHODS

$\delta^{13}C$ AND $\delta^{15}N$ MEASUREMENTS ON BONE COLLAGEN

Carbon and nitrogen isotope ratios were determined for “collagen” extracted from bone and tooth dentine following the methods of Kennedy (1988), Sealy & Van Der Merwe (1986), and Lee Thorp *et al.* (1993). The term “collagen” is used here, as in other dietary studies, to mean “acid-insoluble bone protein”. This consists mostly, but not entirely, of bone collagen in the strict biochemical sense.

The following technique was employed in this study to extract collagen from bone. Bone chunks approximately 1 cm across were surfaced cleaned and decalcified in 1-2% hydrochloric acid (HCl) until all the mineral had dissolved. This process took between 10 days and two weeks. The acid-insoluble protein was then placed in 0.1M sodium hydroxide (NaOH) overnight to remove any humic acids. It was then rinsed repeatedly in distilled water over a period of a week or more until it reached neutrality. Finally, the samples were freeze-dried.

Approximately 0.3mg of the resulting collagen was weighed out into special foil capsules. The capsules were carefully pressed to remove air and manipulated into small balls with the help of tweezers and a spatula. These small balls were placed in special tray that keeps each sample separate until it can be loaded into the mass spectrometer.

Mass Spectrometry

Mass spectrometry was carried out on a Finnigan MAT 252 ratio mass spectrometer, coupled to an on-line Carlo Erba preparation unit. Each sample is dropped in turn into the oxidising tube and combusted at a temperature of 1600° C. The products of combustion flow into a reducing column that converts nitrogen oxides into nitrogen gas. The gas moves into the Conflo device that regulates the admission of CO₂ and N₂ in sequence into the mass spectrometer. The ratios of the analyte isotopes in the sample gases are measured against those of laboratory reference gases. The values of the

reference gases are known, relative to internationally recognised standard material PDB (for carbon), and to atmospheric nitrogen. Results are referred to in the δ notation as explained in Chapter 5. During the runs, commercially available Merck gelatin was used as an internal standard. It has $\delta^{13}\text{C}$ of -20‰ and $\delta^{15}\text{N}$ of +7.5‰. Precision of repeated measurements of homogenous materials is better than 0.2 ‰ for both carbon and nitrogen.

$\delta^{13}\text{C}$ MEASUREMENTS ON BONE APATITE

Bone apatite was prepared according to methods described in Lee-Thorp (1989) and Lee-Thorp *et al.* (1993). Samples of bone were powdered in a Spex Model 6700 freezer mill under liquid nitrogen. In order to remove organic material 40ml of 1.5 % sodium hypochlorite (NaHClO_3) solution was added to approximately ½-1 gram of powdered bone, in a 50ml centrifuge tube. The sample was stirred and left to react until effervescence ceased. This solution was centrifuged and the supernatant discarded. The resultant powder was washed repeatedly in distilled water. 40ml of 1M acetic acid (CH_3COOH) was added to the powder, stirred, and allowed to react overnight. The acetic acid removed the more soluble carbonate ions. The resultant material, called apatite here for convenience, was rinsed repeatedly in distilled water until neutral and freeze-dried.

Approximately 0.050g of apatite was weighed and introduced into one arm of a reaction vessel, shaped like an inverted Y. 3-4ml of 100% phosphoric acid (H_3PO_4) was introduced into the other arm. The vessel was evacuated and sealed and allowed to equilibrate for a half-hour at 25°C in a waterbath. The acid was then tipped on the apatite and allowed to react, overnight. Clean dry CO_2 was collected by cryogenic distillation in a stainless steel vacuum line. Gas samples were introduced manually into the Finnigan-MAT 252 ratio mass spectrometer. $^{13}\text{C}/^{12}\text{C}$ ratios were measured against a calibrated reference gas. Precision of duplicate analyses is better than 0.2‰.

In some cases only a small amount of finely powdered sample was available. The pretreatment procedures had to be scaled down according to the method of Lee-Thorp *et al.* (1997). The sample sizes used in this study were nevertheless much larger than the

3mg of fossil enamel used in Lee-Thorp *et al.* (1997). If, for example, only 60mg of sample were available, this was divided into three aliquots of 20mg. Each was placed into a 2 ml micro-centrifuge tube. The powder was steeped overnight in 1ml of 1.5 % sodium hypochlorite (NaHClO₃) solution. The sample was then centrifuged in a high-speed micro-centrifuge and rinsed three times in distilled water. Thereafter it was reacted in 1ml of 0.1M acetic acid for three hours, then centrifuged and rinsed thoroughly, and freeze-dried. The ratio of powder to reagents, acid and reaction time remains the same as in Lee Thorp *et al.* (1997), but the absolute quantities of materials used are larger.

STRONTIUM ISOTOPES

Strontium isotope ratios were measured on bone mineral and tooth enamel and dentine following the methods of Sealy *et al.* (1991). Biogenic material was isolated, as far as possible, by the solubility profile method.

Solubility profiles: method

This technique relies on the difference in solubility between biogenic and diagenetic apatite (Sillen 1986). The diagenetic material is usually more soluble, particularly if it incorporates carbonates.

Each sample was surface-cleaned and milled in a Spex model 6700 freezer-mill under liquid nitrogen. 50mg of powdered sample was poured into an Eppendorf microcentrifuge tube. One ml of 100 mM acetic acid / sodium acetate buffer adjusted to pH 4.5 was added to the powder. The tube was then tapped hard in order to mix the sample and the buffer, placed in an ultrasonic bath for 1 minute, then centrifuged for 10 seconds. The buffer was decanted and saved for elemental analysis. This extraction procedure was repeated eighteen times on each powder. The series of supernatants thus represented a profile of soluble mineral.

The strontium and calcium concentrations in each wash were then measured in an inductively coupled plasma atomic fluorescence spectrometer, model Jobin Yvon 70C, housed in the Chemistry Department. This instrument offers simplicity of operation and freedom from spectral interference. The sample solution is introduced into a very hot

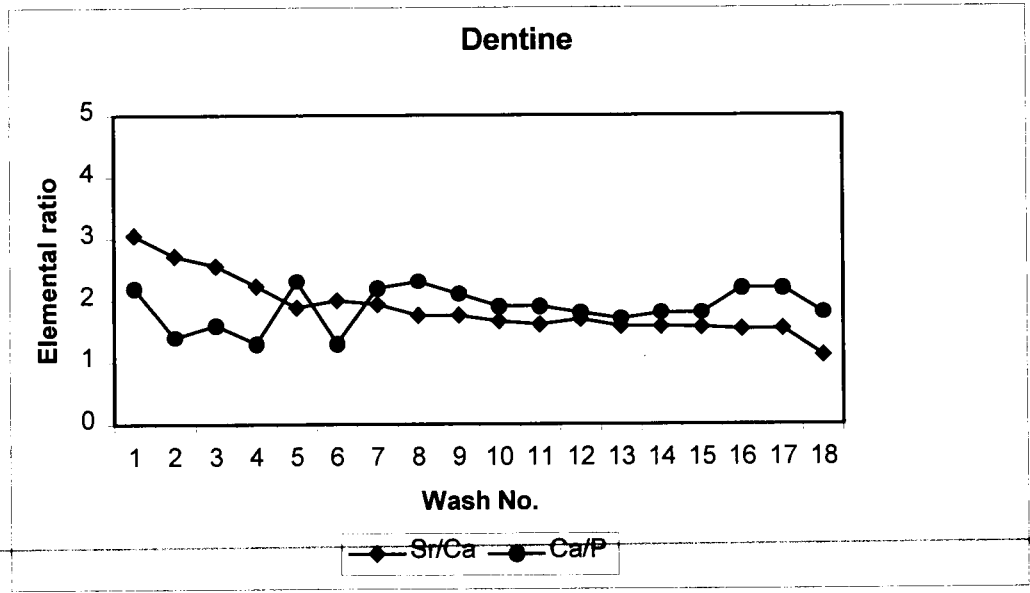
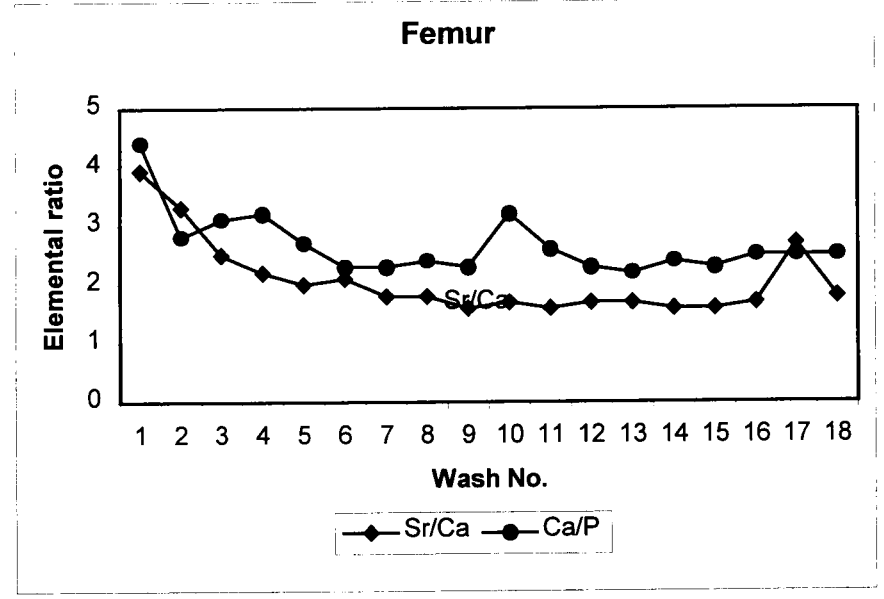
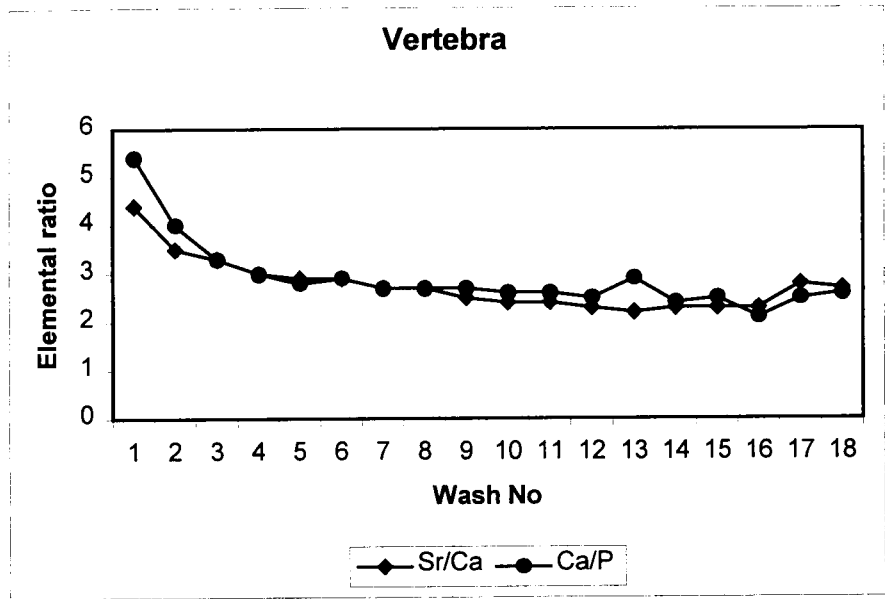


Figure 22: Solubility profiles for Burial 50. Washes were pooled for strontium isotope measurement as follows: vertebra, 7-10; femur, 12-18 and dentine, 10-15

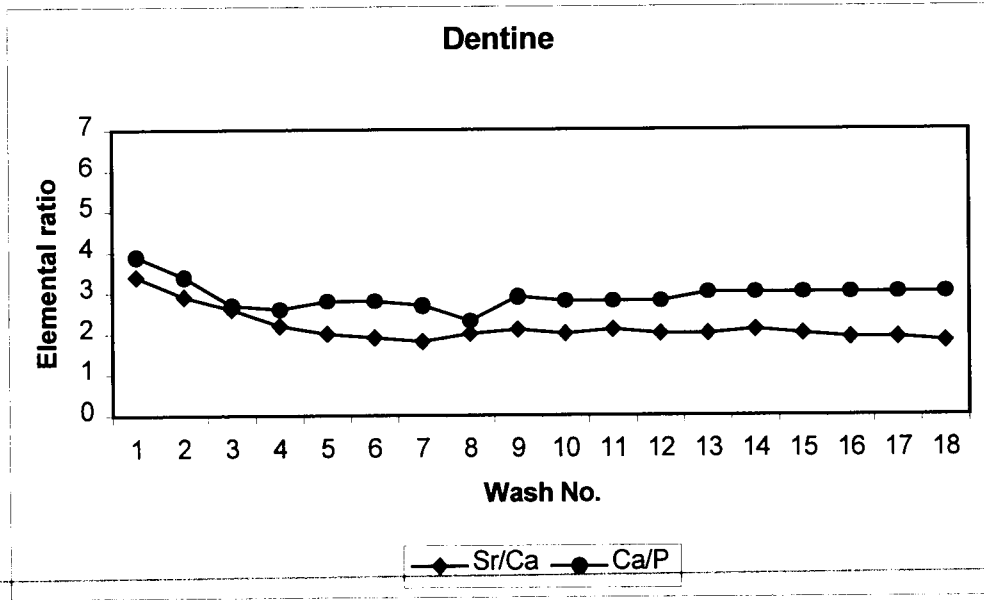
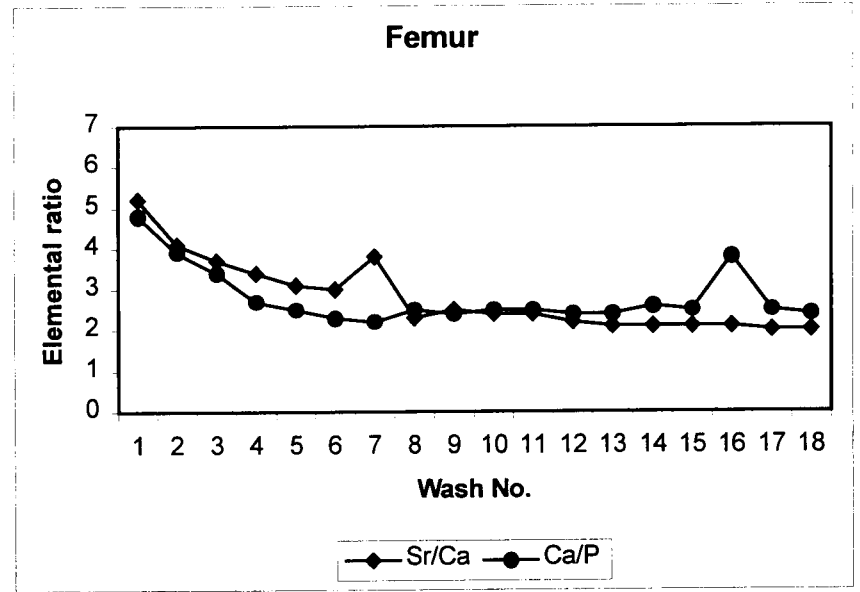
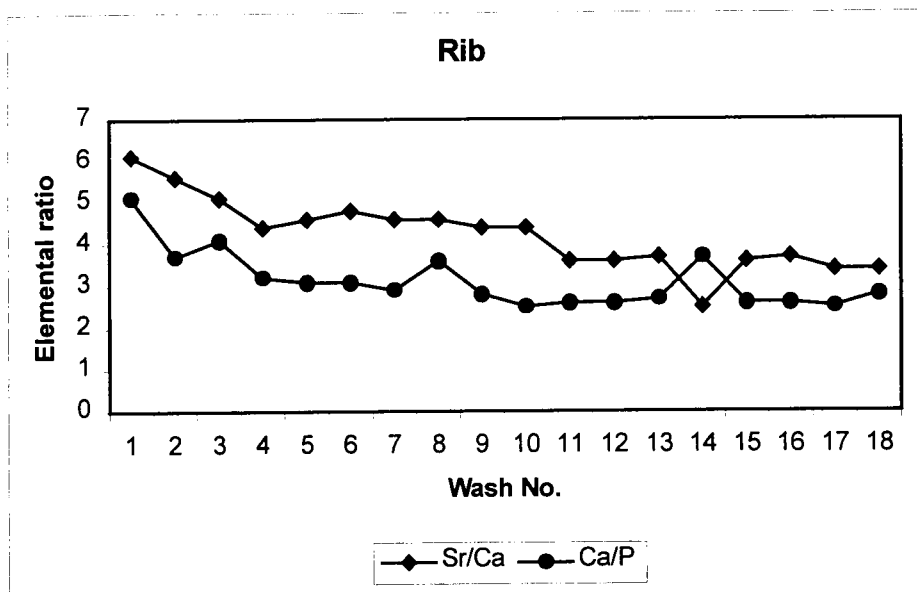


Figure 23: Solubility profiles for Burial 59. Washes were pooled for strontium isotope measurements as follows: rib, 9-12,15-17; femur 9-12; and dentine 10-15

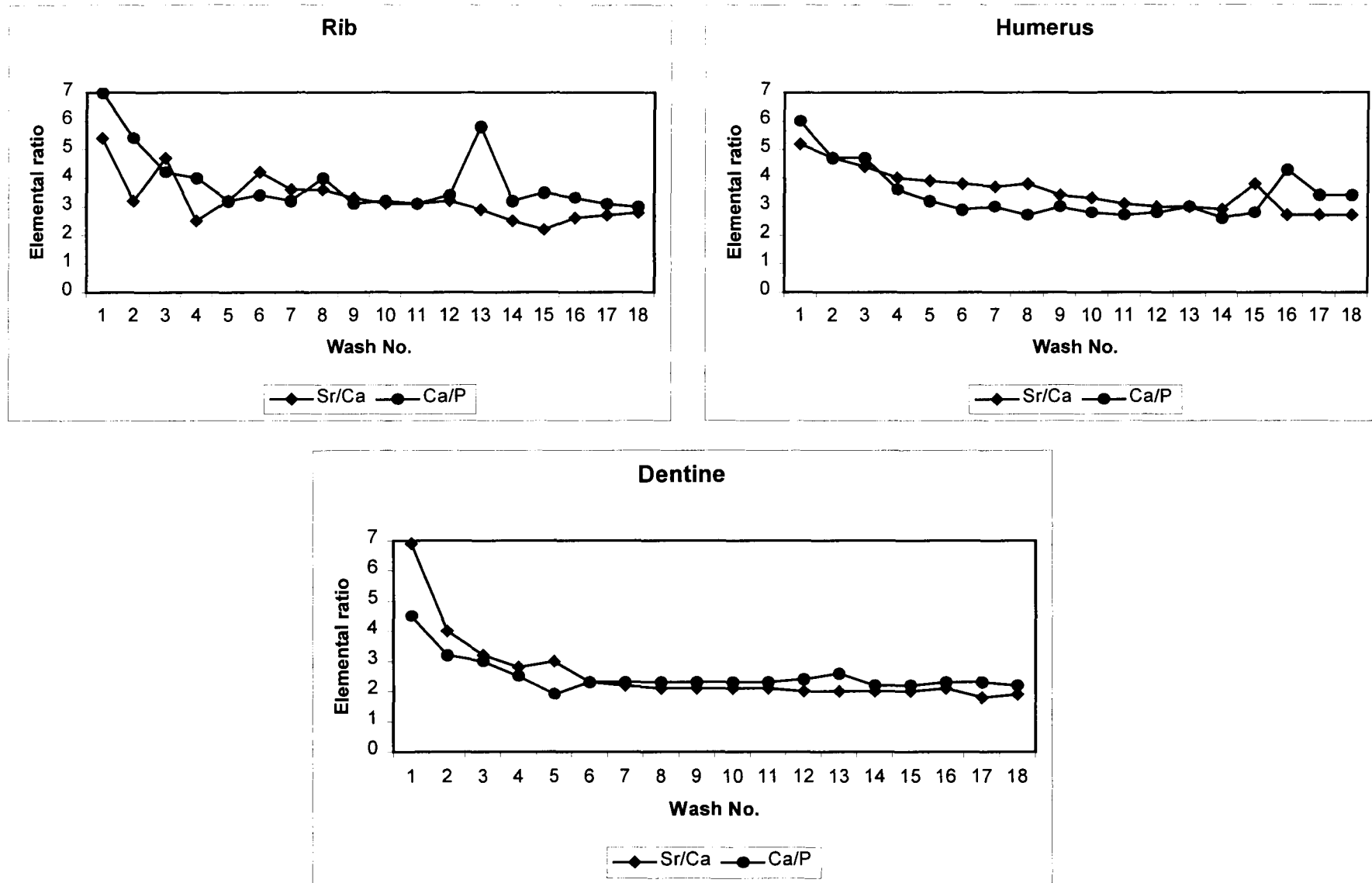


Figure 24: Solubility profiles for Burial 60: Washes were pooled for strontium isotope measurement as follows: rib, 9-12; humerus, 7-10 and dentine, 7-10

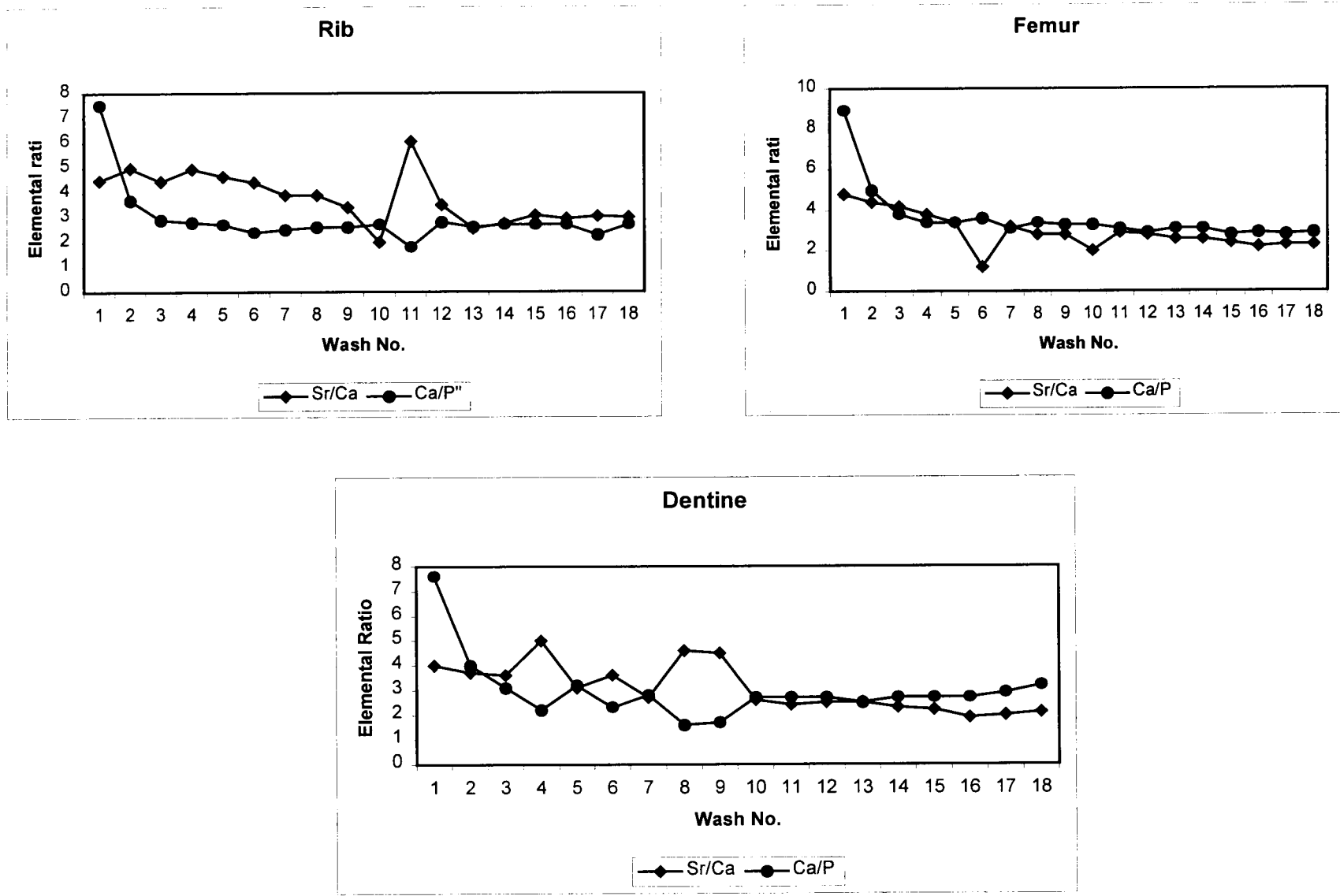


Figure 25: Solubility profiles for Burial 64. Washes were pooled for strontium isotope measurements as follows: rib, 13-17; femur, 11-14 and dentine, 10-16

'flame' (plasma) and the characteristic wavelengths emitted by the various elements monitored. The high temperature of the plasma virtually eliminates inter-element interference. In this study, calcium and strontium concentrations were measured on the ICP. Concentrations of phosphate were measured colourimetrically using the molybdenum blue method of Fiske & SubbaRow (1925), as modified by Rouser *et al.* (1970).

These measurements can be seen in Figures 22 to 25. Sr/Ca in the washes is usually at a maximum at the start of the profile, representing some post-depositional strontium contamination in the bones. The amount of contamination is, however, relatively small compared with published studies of prehistoric archaeological material (Sillen 1986; Sealy *et al.* 1991). This is probably due to the relatively short duration of burial of these historic skeletons. The curves for Ca/P generally stabilise at about 2.1 the expected ratio for bone. Mineral in these washes is therefore considered to be biogenic material. Washes from the plateau sections of the curves were pooled and strontium isotope ratios measured. The staff members in the Geology Department at the University of Cape Town made these measurements on a VG Sector mass spectrometer.

Strontium isotope results are given to five decimal places, and they have been normalised to a value of 0.71023 for the NBS standard SRM 987. This normalisation is necessary in order to compare these values with earlier studies.

BONE DENSITY FRACTIONATION

3-6 grams of bone were cut into small chunks and defatted in tetrahydrofuran (THF) for 2-3 days. The THF was replaced daily. Finally, the THF was poured off and the bone was allowed to dry at room temperature.

Next, the chunks were powdered in a SPEX freezer mill at liquid nitrogen temperature, for about forty minutes. The powder was then sieved through 11 µm mesh and washed through with acetone. If insufficient sample passed through the sieve the powder was milled again for a further forty minutes. The sieves clog up almost immediately so the most effective way of sieving was to use more than one sieve per sample and pour only small amounts of bone into the sieve at a time. When the acetone had dried off the bone

still remaining in the sieve was put aside for re-milling. The sieve was washed and dried and the process was repeated. It is imperative that the bone particles are less than 10-11 μm (the "liberation size") "...so that the probability that one particle belongs to more than one morphologic structure (± 200 microns) is remote....' (Richelle 1964). Bone particle size was checked on a scanning electron microscope, to ensure that there were no longer particles that might have passed through invisible holes in the sieves. This was not the case.

Solutions of known densities (1.8, 2.0, 2.1, 2.2, 2.3 and 2.4 g/cm^3) were made with mixtures of bromoform (2.89 g/cm^3) and toluene (0.87 g/cm^3). 300-450 mg of sieved bone powder was placed in a centrifuge tube, and suspended in a bromoform-toluene mixture of 1.8 g/cm^3 . The tube was sonicated to achieve good suspension. The tube was ultracentrifuged at 10 000 rpm for 30 minutes on a Beckman L5-65 ultra centrifuge. After centrifugation the supernatant or "float" containing the fraction of the sample with a density equal or lower than 1.8 g/cm^3 was poured off. The remaining pellet or "sink" was resuspended in a solution of higher density. This process of separating float and sink in liquids of successively higher densities was continued using the range of density solutions available. The separated bone fractions were air-dried, washed free of organic solvent by rinsing and centrifuging in ethanol, and then freeze dried. The amount of bone present in each density interval was quantified by weighing.

Next, collagen was extracted from each fraction as follows.

10 mg of bone powder was weighed into Eppendorf 3ml centrifuge tubes. $\frac{1}{2}$ ml of 0.1 M hydrochloric acid (HCl) was added to the tube to dissolve the mineral component. The sample was tapped on the bench to dislodge any sample at the base of the tube and then mixed and ultrasonicated. It was left to soak for 30 minutes, during which time it was tapped, mixed and ultrasonicated at 10 minute intervals. A further $\frac{1}{2}$ ml of 0.1 M hydrochloric acid was added to the tube, and the process repeated for 30 minutes. The sample was centrifuged for approximately 20 seconds and the acid poured off. The sample was then rinsed three times in distilled water. Then 1 ml of 0.1M sodium hydroxide was added to the acid- insoluble fraction in order to remove any humic acids.

The tube was tapped, mixed and ultrasonicated and left to stand for 10 minutes. It was then centrifuged, the sodium hydroxide poured off and the sample was rinsed in distilled water three times. Finally, the samples were freeze-dried.

This method produced a collagen yield approximately 20% by weight of the original bone powder, the same percentage in fresh bone. C/N ratios were measured and fell within the accepted range for collagen: 2.9 to 3.6 (Ambrose 1993).

Samples with yields above 20 % were considered to retain bone mineral, and were treated further with 0.1M HCl. Samples with C/N ratios above 3.6 were discarded. Carbon and nitrogen isotope ratios were measured on a Finnigan MAT 252 light isotope ratio mass spectrometer, with on-line Carlo Erba preparation unit, as described above.

Apatite was extracted from some fractions using the method discussed above.

The results of these procedures are reported in the following chapter.

CHAPTER 8

RESULTS

This chapter presents the results of the isotopic analyses of the Cobern Street skeletons. It is divided into four sections:

- 1) Collagen
- 2) Apatite (bone mineral)
- 3) Strontium isotopes
- 4) Bone density fractionation: a) collagen b) apatite

$\delta^{13}\text{C}$ AND $\delta^{15}\text{N}$ IN COLLAGEN

Appendix 1 summarises the results of the analyses of all the skeletons. The Later Stone Age burials form a separate group on the grounds of burial style. They will be discussed separately.

THE HISTORIC SKELETONS

This data set has been approached in two ways. First, the entire set of results has been examined, to ascertain the extent to which values cluster into groups and to identify skeletons with outlying isotopic ratios. Second, isotopic values are compared for skeletons grouped according to archaeological criteria such as grave style, or individuals with decorated teeth versus those with undecorated teeth.

The first question to be answered when looking at the entire historic sample is: what is the range of variation in diet among the individuals buried at Cobern Street?

The results for all the skeletons are plotted in Figure 26. The tooth dentine values represent the diets of these individuals during youth whereas the cancellous bone values represent the diets consumed later in life. The cortical bone values represent an average value of diet over at least 15-20 years.

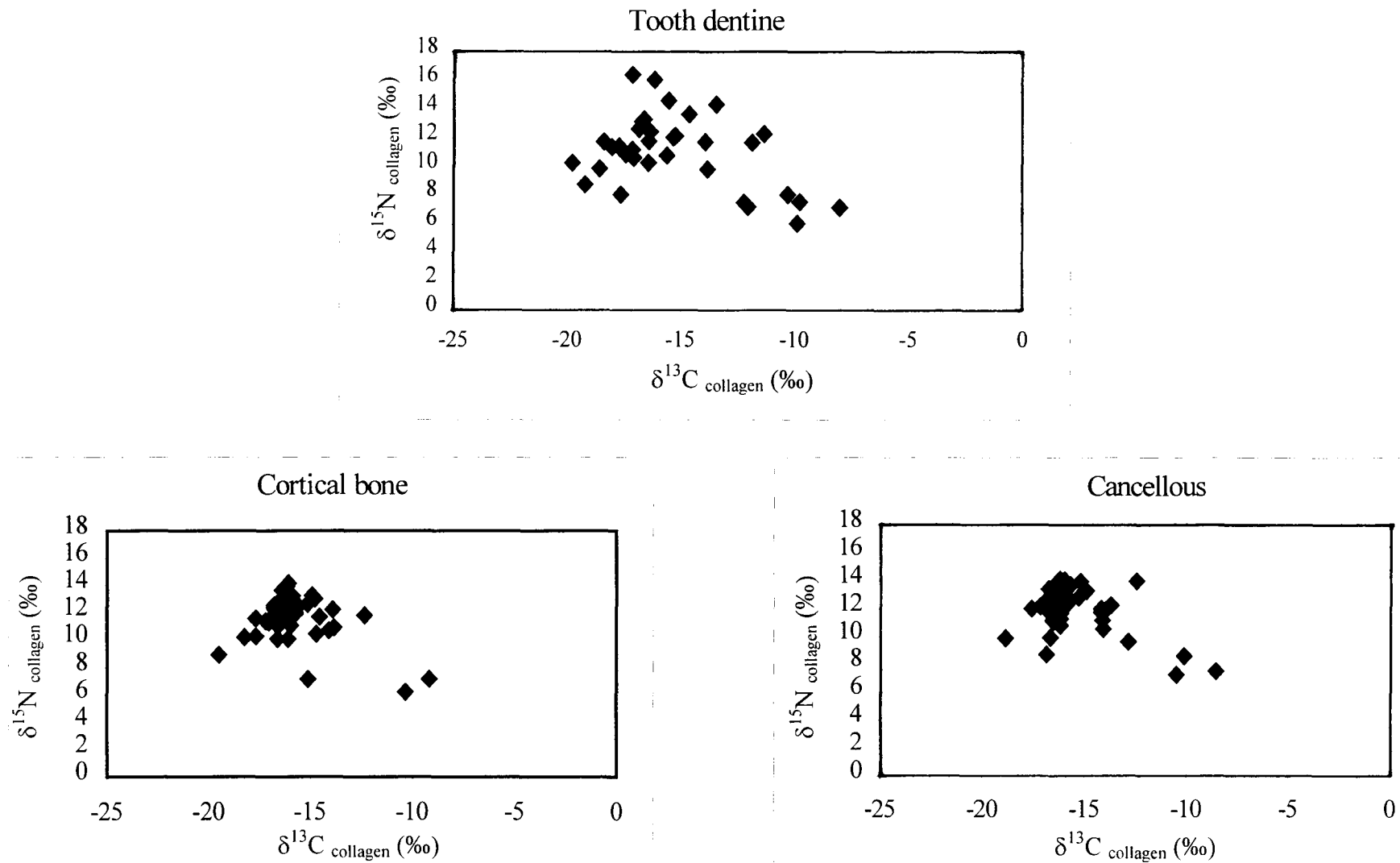


Figure 26: Plot of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ results for collagen from all skeletons, teeth, cortical and cancellous bone

$\delta^{13}\text{C}$ values for the teeth of the Cobern Street skeletons ranged from -8 to -19.8 ‰ (Appendix 1 and Figure 26). The most enriched carbon values reflect a diet that included C_4 plants. Marine foods, too, lead to enriched $\delta^{13}\text{C}$ values, and many of the Cobern Street skeletons (those with enriched $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values) ate marine foods. Values as high as -8 ‰ however, certainly represent C_4 foods. The depleted values are the result of a diet based on C_3 plants. $\delta^{15}\text{N}$ values for the teeth of the Cobern Street skeletons ranged from 6.1 to 16.1 ‰. $\delta^{15}\text{N}$ values of less than 10 indicate little, if any consumption of marine foods (Schoeninger *et al.* 1983). Values above 10 result from eating seafood or terrestrial foods from arid environments. The most enriched values indicate a great deal of marine food. Figure 27 shows $\delta^{15}\text{N}_{\text{collagen}}$ plotted against $\delta^{13}\text{C}_{\text{collagen}}$. The fitted regression equation is $\delta^{15}\text{N} = 5.8 + 0.35 \delta^{13}\text{C}$, with $r^2 = 0.17$ ($n = 36$). A hypothesis test of no correlation between the two variables was carried out and rejected at the 5% level (Zar 1984:268). A correlation between $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ is to be expected for diets which included seafood, since this is enriched in both ^{13}C and ^{15}N .

$\delta^{13}\text{C}$ values for cortical bone range from -9.2 to -19.5 ‰. This range is only slightly smaller than the tooth dentine values. (Appendix 1 and Figure 26). $\delta^{15}\text{N}$ values for cortical bone vary from 6.2 to 14.2 ‰. Figure 26 shows $\delta^{15}\text{N}_{\text{collagen}}$ plotted against $\delta^{13}\text{C}_{\text{collagen}}$. The fitted regression equation is $\delta^{15}\text{N} = 5.95 + 0.36\delta^{13}\text{C}$, with $r^2 = 0.15$ ($n = 52$). A hypothesis test of no correlation between the two variables was carried out and rejected at the 1% level (Zar 1984:268).

$\delta^{13}\text{C}$ values for the cancellous bone of the Cobern Street skeletons ranged from -8.6 to -18.8 ‰ and $\delta^{15}\text{N}$ from 7.3 to 14.1 ‰ (Appendix 1 and Figure 26). Figure 26 shows $\delta^{15}\text{N}_{\text{collagen}}$ plotted against $\delta^{13}\text{C}_{\text{collagen}}$. The fitted regression equation is $\delta^{15}\text{N} = 5.31 + 0.43 \delta^{13}\text{C}$, with $r^2 = 0.26$ ($n = 36$). A hypothesis test of no correlation between the two variables was carried out and rejected at the 1% level (Zar 1984:268).

A comparison of the scatter of values for cancellous bone, compared with those for teeth (Figure 27) shows that there is greater clustering of points for the cancellous values. The

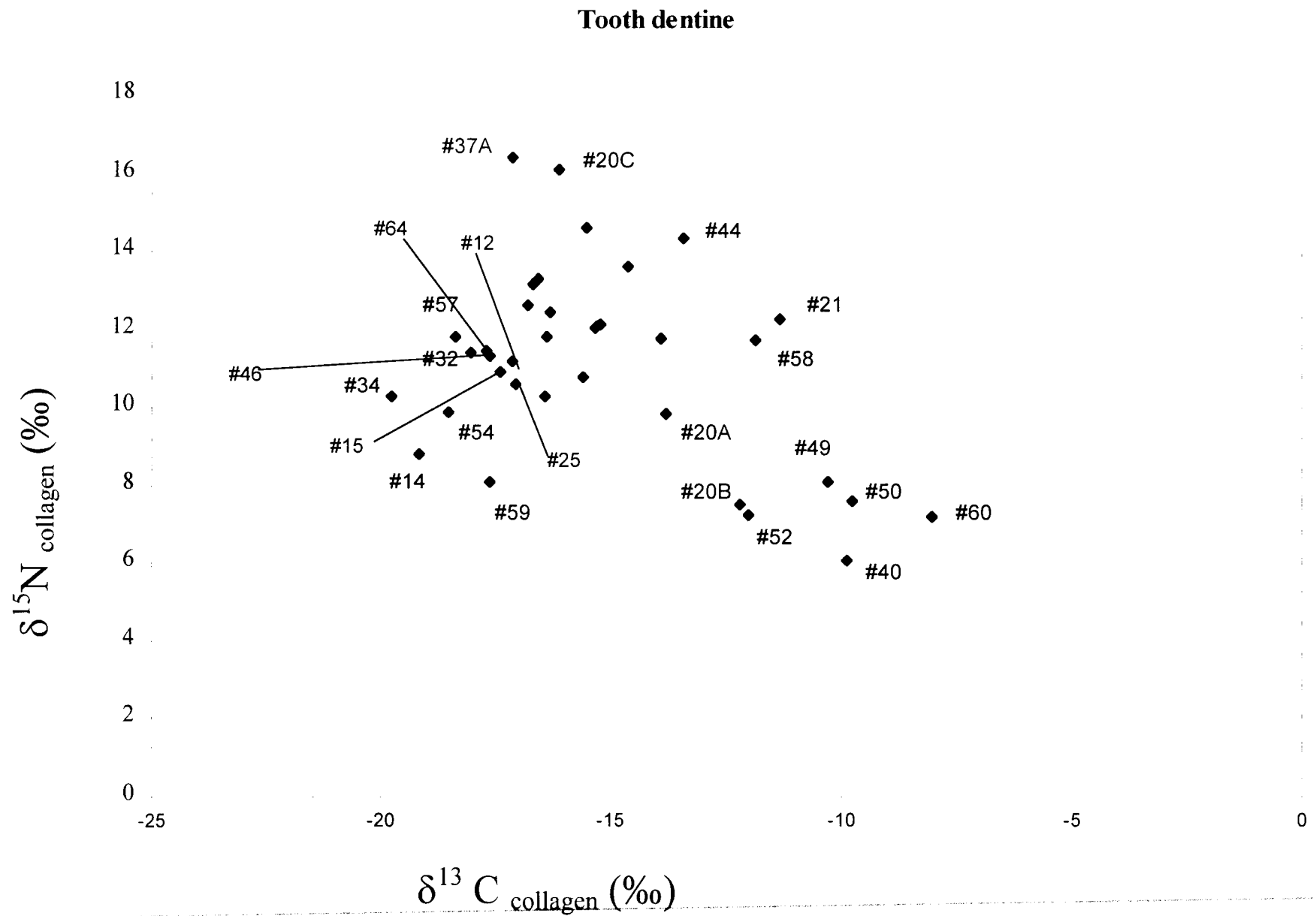


Figure 27: Plot of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ results for all skeletons for tooth dentine

range of values is slightly smaller. Thus the diets of individuals in the group were more similar in later life than in their early years; an indication of the diverse origins of the people buried at Cobern Street. However, the isotope ratios never became homogeneous. The Cobern Street cemetery represents the cultural mix that was eighteenth century Cape Town.

We have established that the range of isotope values, and hence diets consumed, is considerable.

(i) The most enriched $\delta^{15}\text{N}$ value, 16.1 ‰, for tooth dentine is from Burial 20C. Burial 20C was 1.5-2 years of age at death. The reason for this enriched diet will be discussed in detail later (Figure 27).

ii) There are three individuals who have $\delta^{13}\text{C}$ values for tooth dentine around -10 ‰ and $\delta^{15}\text{N}$ around 8 ‰ for teeth. They are Burials 40, 50 and 60. These values must derive from C_4 foods and as such the people must be of tropical origin. Shipwrecked slaves found in Cape Town have similar isotopic ratios (Cox & Sealy 1997). There are five other points on the right hand side of the main group in the tooth dentine graph. They are Burials 20B, 21, 49, 52 and 58 who all have $\delta^{13}\text{C}$ values greater than -12.5 ‰, and $\delta^{15}\text{N}$ values below 12.3 ‰.

(iii) Burials 14, 34, 54 and 59 all have tooth dentine with negative $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values of around 10 and less. These individuals ate diets based on C_3 plants with very little marine food. Burials 12, 15, 25, 32, 46, 57 and 64 all have $\delta^{13}\text{C}$ values more negative than -17 ‰ and $\delta^{15}\text{N}$ values between 10 and 12 ‰. C_3 plant resources were available to this group and they may also have had access to seafood (Figure 27).

The outliers discussed above have been helpful in identifying groups of individuals who may have eaten similar diets during their youths and perhaps came from similar regions. Six out of seven individuals with decorated teeth appear as outliers on the right hand side of the plots. Burials 21 and 58 plot out in the same region of the graph, as they also have positive $\delta^{13}\text{C}$ values but relatively low $\delta^{15}\text{N}$ values. The outliers on the left-hand side of the graph, with very negative $\delta^{13}\text{C}$ values, include four out of five of the Type C burials.

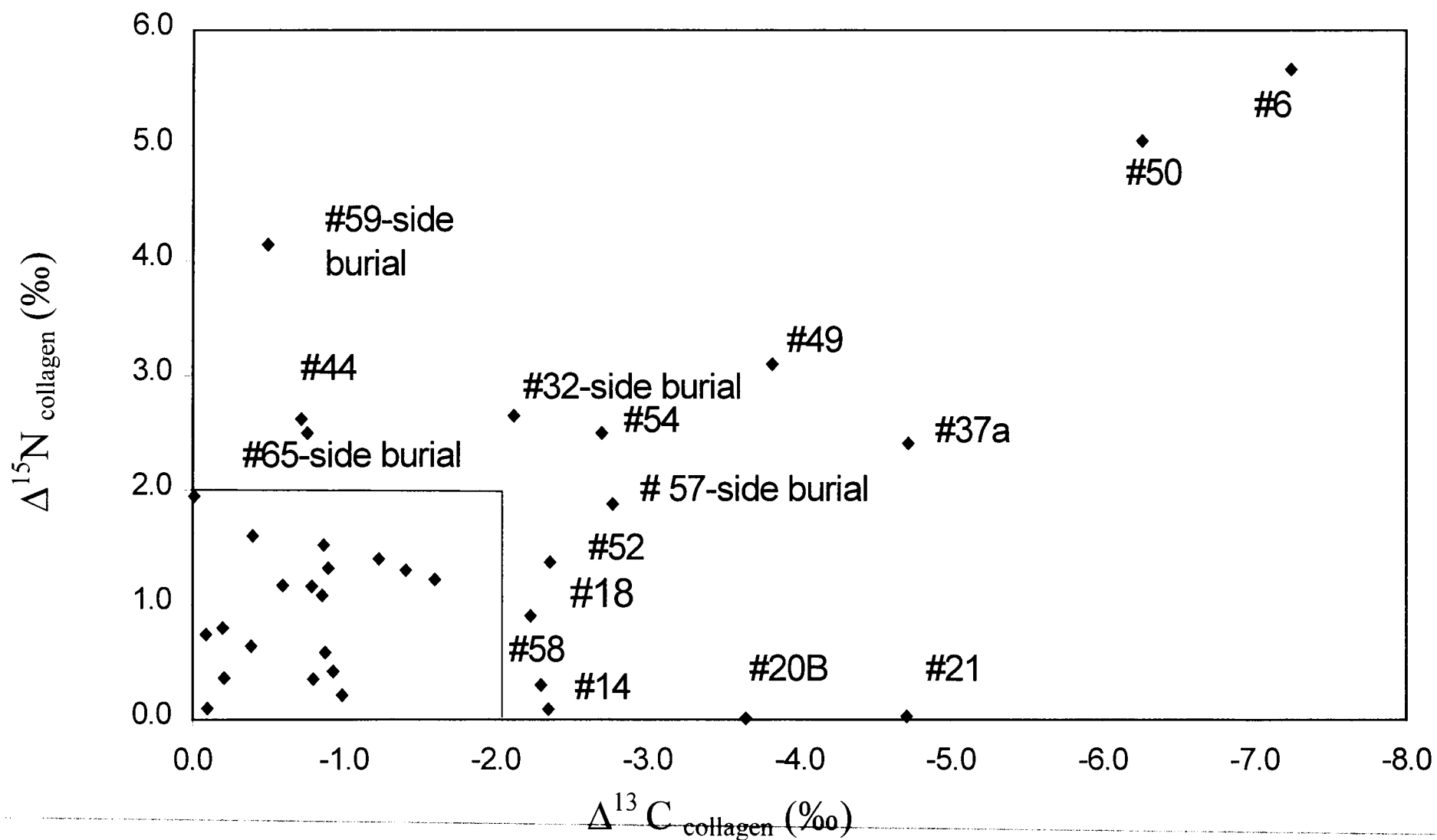


Figure 28: Change in diet: difference between rib and teeth values ($\Delta^{13}\text{C}$ refers to the difference in $\delta^{13}\text{C}$ between rib and dentine samples from the same individual, similarly for $\Delta^{15}\text{N}$).

It has been established, amongst animals raised on controlled diets, that there may be inter-individual variation in isotope values of up to 2 ‰ (Schoeninger & DeNiro 1983). Thus isotopic variation within a human skeleton of up to 2 ‰ could be the result of normal variation and not necessarily a change of diet. In Figure 28 the tooth dentine $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ have been subtracted from the rib values of the same individual in order to observe the amount of change in the isotope ratios. The 16 individuals that show a change of more than 2 ‰ have been labeled. Burial 37A is one of the Later Stone Age individuals. Burials 50, 60, 52, 49 and 20B all have decorated teeth: they constitute 5 out of 7 skeletons with decorated teeth. Burials 32, 57, 59 and 65 were interred on their sides (Type C burials); they constitute 4 of the 5 such burials analysed for this thesis. The $\delta^{13}\text{C}$ values of Burials 54 and 14 become more positive in later life whereas the $\delta^{13}\text{C}$ values of Burials 18, 21 and 58 become more depleted. Burial 44's $\delta^{15}\text{N}$ values become more depleted.

In the following section the entire skeletal sample will be divided according to the archaeological criteria discussed above and the isotope ratios of the various groups will be compared.

TYPE A

The Type A burials (Later Stone Age burials) will be discussed after the historical skeletons. With the exception of 37A, the Type A burials fall within the central cluster of points illustrated in Figure 26 and show a less than 2 ‰ change in isotope ratios during life.

TYPE B

The Type B burials, bodies interred lying extended on their backs, are illustrated in Figure 29. The points are widely dispersed, especially the teeth. There is some clustering of points for the rib values, suggesting that this group ate a more uniform diet before death. However there are still a number of outliers and it seems that despite the fact that these people were buried the same way they ate diverse diets, and do not necessarily share a cultural affinity.

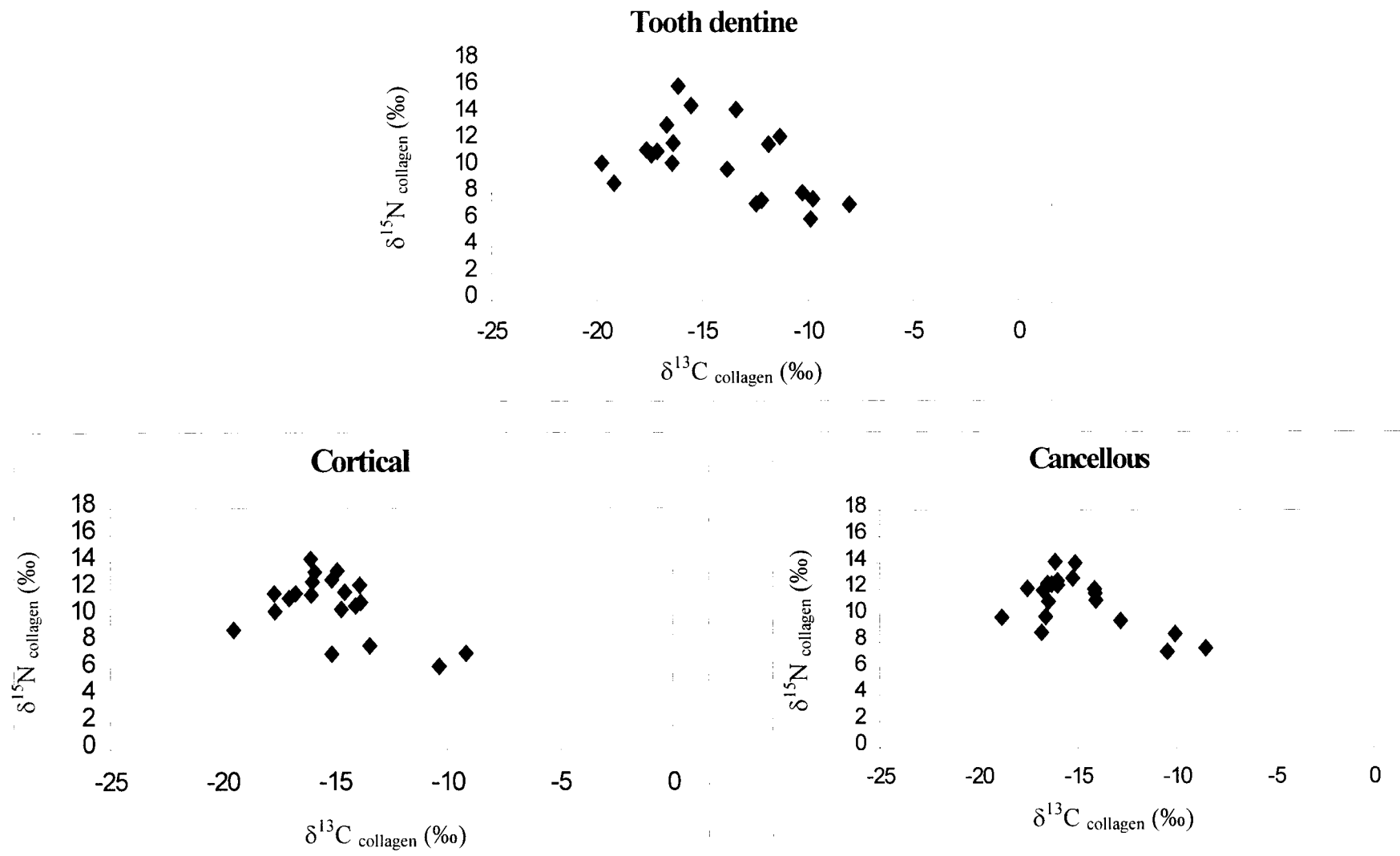


Figure 29: Plot of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ results for Type B burials, teeth, cortical and cancellous bone

Type B: Individuals with decorated teeth

7 individuals buried at the Cobern Street cemetery have decorated teeth. All were Type B burials with five individuals represented by peripheral points on the Type B graphs (Figure 30) with the most positive $\delta^{13}\text{C}$ values and yet low $\delta^{15}\text{N}$ values. They show considerable dietary change during their lives (Figures 28 and 31) It was suspected, based on the tooth decoration, that they were brought to the Cape as slaves. Their isotopic signatures are consistent with this hypothesis.

Anat omy *	Lab nos. †	Burial #	Age	Sex	Cancellous bone		Cortical		Tooth dentine		Ear ossicle	
					$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)	$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)	$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)	$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)
510	6219-20, 6463	20a	25-30	M	-12.8	9.6	-15.1	7.1	-13.8	9.8		
511	6221-2, 6465	20B	16	F	-8.6	7.5	-9.2	7.1	-12.2	7.5		
535	6246-7, 6473	40	12	?	-10.5	7.3	-10.4	6.2	-9.9	6.1		
547	6266- 7,6478,6494	49	30-35	M	-14.1	11.2	-15.1	12.6	-10.3	8.1	-12.5	8.6
548	6268-9,6479	50	35-50	M	-16.0	12.6	-15.9	13.2	-9.8	7.6		
550	6272-3,6480	52	25-35	F	-10.1	8.6	-12.3	11.8	-12.0	7.2		
558	6286- 7,6484,6495	60	30	F	-15.3	12.8	-14.0	10.9	-8.0	7.2		

Table 16: Type B: Individuals with decorated teeth

* Skeleton accession numbers, Department of Anatomy and Cell Biology

† Archaeometry laboratory numbers, Department of Archaeology

Burial 20 contained three individuals. 20 A (a male) and 20 B (a female) appear to have been buried together. They both had dental decorations. 20C was a juvenile, and did not have decorated teeth.

Burial 20A lived to around 25-30 years. The $\delta^{13}\text{C}$ value for third molar is -13.8‰ . The results for the third molar, a tooth formed in the teens or early twenties, represent the diet around the middle of this person's life rather than the beginning, as other tooth samples may do. The results discussed here therefore represent dietary choices for probably the last fifteen to twenty years. The $\delta^{13}\text{C}$ value for the femur is -15.1‰ and for the rib -12.8‰ . The third molar and rib may represent a similar period of life when more C_4 based foods were eaten.

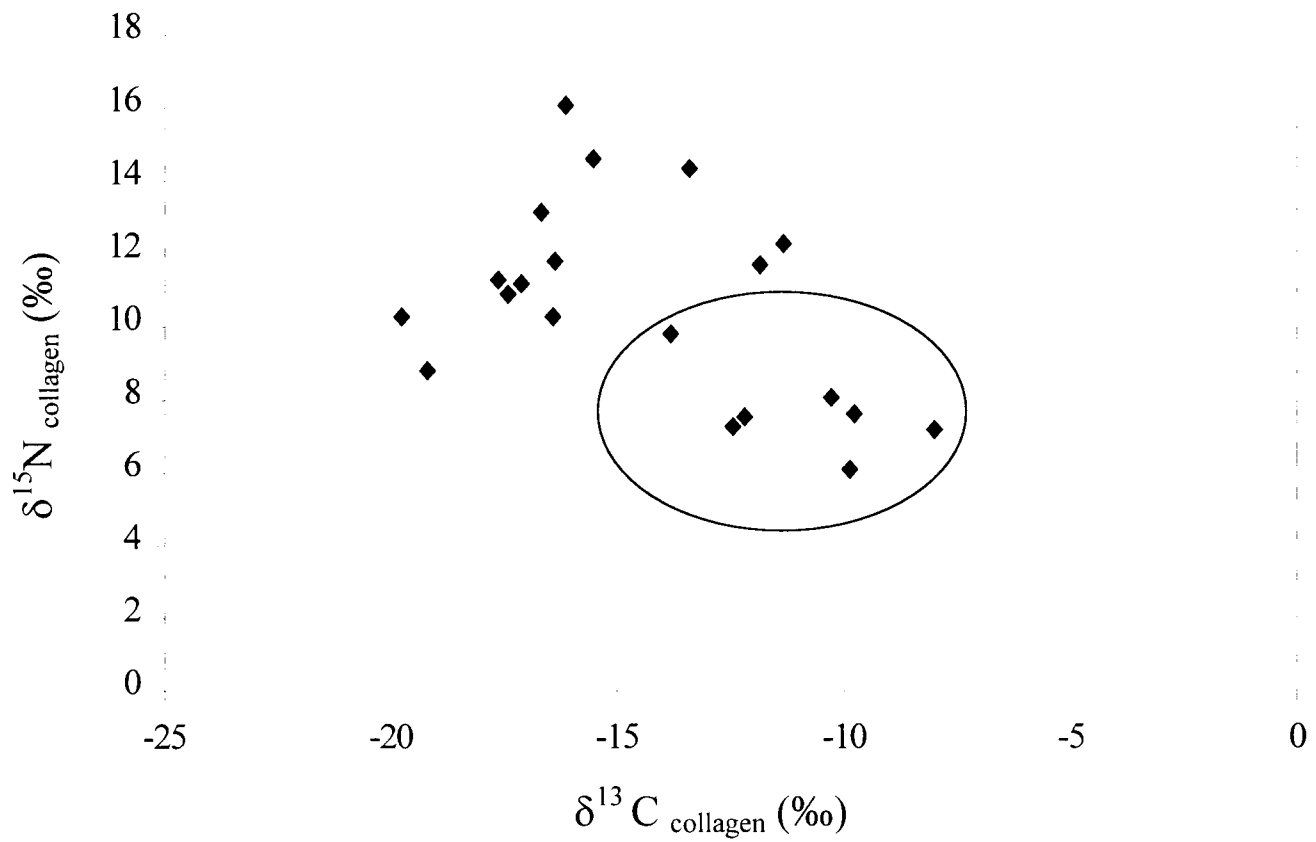
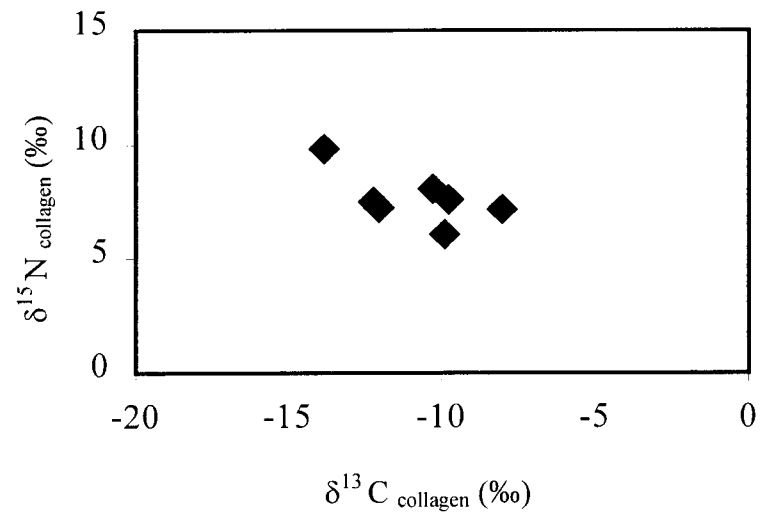


Figure 30: Plot of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ results for Type B burials for tooth dentine. Individuals with decorated teeth are circled.

Individuals with decorated teeth-dentine



Individuals with decorated teeth-rib

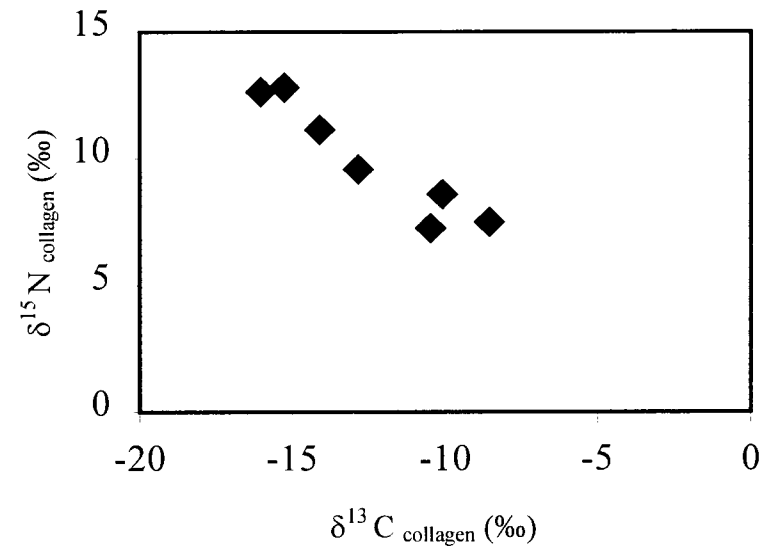


Figure 31: Plot of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ results for individuals with decorated teeth. Tooth dentine and rib results compared

The $\delta^{15}\text{N}$ values follow a similar pattern. The $\delta^{15}\text{N}$ values for tooth (9.8 ‰), femur (7.1 ‰) and rib (9.6 ‰) are all less than 10 which suggest little or no seafood. Again the values for the tooth and rib are similar.

The first premolar of Burial 20B was sampled and in the case of this individual who only lived to 16 years, the tooth signature probably reflects diet between the ages of 12-15. The premolar is fully formed by age 15 (Ubelaker 1994). It is difficult to pin down, for someone of this age, the periods represented by tissue in the rib and femur. The $\delta^{13}\text{C}$ values are first premolar -12.2 ‰, femur -9.2 ‰ and rib -8.6 ‰. Individual 20B ate mostly C_4 based foods, especially during the period of formation of the rib. She lived in a tropical region, almost certainly in Africa. Results from the analyses of her first premolar show a 3 ‰ depletion that may be the result of the introduction of C_3 based food. Burial 20 B's $\delta^{15}\text{N}$ isotope values are tooth dentine 7.5 ‰, femur 7.1 ‰ and rib 7.5 ‰, figures which indicate reliance on terrestrial resources. 20B's diet was different from that of 20A and although it appears that they were buried in the same burial shaft they do not seem to have similar life histories. It is possible that they arrived on the same ship or both belonged to the same slave owner, and therefore were buried together.

It seemed from the way that 20C, an infant of approximately 1 ½ to two years old was buried, that this baby was associated with Burial 20B. Four bone samples were taken from different skeletal sites. The $\delta^{13}\text{C}$ values of 20C average -16.2 ‰, and are consistent, with a range of only 0.5 ‰. Burial 20B's carbon isotope values average -10 ‰. The infant's values are depleted by an average of 6.2 ‰. Katzenberg *et al.* (1993) found that $\delta^{13}\text{C}$ values for infants were slightly enriched compared to the adults at the same site.

Nitrogen isotope values are of particular interest here as a number of studies (discussed earlier) have examined $\delta^{15}\text{N}$ in infants of different ages. This was the only infant to be analysed in this study, but there are a number of others at the site and there is considerable potential for a comprehensive study. $\delta^{15}\text{N}$ for tooth dentine (incisor) from 20C is 16.1 ‰, for the ear ossicle 15.1 ‰, for the femur 14.2 ‰ and for the rib 14.1 ‰ (average: 14.9 ‰). Which tissue was laid down first, the ossicle or the tooth dentine? If

the ossicle turned over after it was formed then the $\delta^{15}\text{N}$ value is intermediate between the tooth and postcranial bones. The difference in values is less than 2 ‰ and could simply be the result of normal variation. The $\delta^{15}\text{N}$ values decrease in the femur and rib, presumably with the introduction of weaning foods, in this case were probably C_3 plant based. These $\delta^{15}\text{N}$ values are on average 7.5 ‰ more enriched than those of 20B, whose nitrogen values average 7.4 ‰.

Does this child belong to the woman buried alongside? At first glance the results suggest not. Such large isotope spacings between mother and child have not been recorded in any previous study. If the child was not breastfed by 20B, what food could have resulted in such enriched values? Could he or she have been fed cow's milk? This seems unlikely, if it was a slave child, particularly if it had recently been in transit with 20B en route to the Cape. The C_4 -derived isotope values in 20B's rib mean that she probably didn't spend any length of time at the Cape before her death.

Another possibility is that 20C was the child of 20B, but all its bones were formed after 20B was taken into slavery, and fed a diet relatively enriched in ^{15}N and depleted in ^{13}C . If the diet was just adequate or inadequate, and 20B was pregnant and/or lactating, it is possible that all the nutrients may have gone to the foetus and milk for the new born, rather than to the mother's bones, so we do not see the change in 20B. Unfortunately our current understanding of isotopes and metabolism is inadequate to predict whether this scenario is likely to be true.

Perhaps this baby was born in Cape Town and happened by accident to be buried in the same burial shaft as 20A and 20B. The average rib $\delta^{15}\text{N}$ value for adult females at Cobern Street is 12.2 ‰ (n=20). $\delta^{15}\text{N}$ enrichment of 2-3 ‰ between mother and child has been found in another study (Katzenberg *et al.* 1996). The average $\delta^{15}\text{N}$ value for the infant is 2.7 ‰ more enriched than the average female buried at Cobern Street. This child will be discussed again below when the results of the bone apatite analyses are explored.

Burial 40 was a 12 year old individual. The $\delta^{13}\text{C}$ values of various skeletal elements are as follows: -9.9‰ for teeth, -10.4‰ for femur and -10.5‰ for rib. These C_4 -derived isotopic ratios indicate that he or she probably grew up in a tropical or subtropical area and probably ate mostly sorghum, millet or maize. $\delta^{15}\text{N}$ values for teeth (6.1‰), femur (6.2‰) and rib (7.3‰) suggest that this person's diet was based on terrestrial resources. There is no detectable change in diet during life, despite the fact that this individual should have been growing rapidly, and hence laying down a good deal of new bone, at this time of life. Historical records state that millet was sometimes included in slaves' rations on slaving ships, if it was cheap and readily obtainable (Bozarth 1987 and see Chapter 3). In general, however, Cobern Street individuals who ate C_4 -based diets in early life seem to have eaten more C_3 foods in later years, and C_4 foods were not a major part of Cape diets. On balance it seems that Burial 40 probably died before or on arrival at the Cape after a short period of captivity and a short sea voyage.

Burial 49's tooth dentine values are $\delta^{13}\text{C} = -10.3\text{‰}$, and $\delta^{15}\text{N} = 8.1\text{‰}$, indicating that he started out life in a tropical region eating no marine food, subsisting on C_4 staple foods. The values for the ear ossicle ($\delta^{13}\text{C} = -12.5\text{‰}$ and $\delta^{15}\text{N} = 8.6\text{‰}$) are intermediate between the signatures in the tooth, for diet in early life, and the adult cortical and cancellous bone signatures. The values for his femur ($\delta^{13}\text{C} = -15.1\text{‰}$ and $\delta^{15}\text{N} = 12.6\text{‰}$) testify to a marked increase in C_3 foods and seafood. He was probably captured as a slave and then spent 15 or more years at the Cape. He might have changed diet in the last year or so of life as the $\delta^{13}\text{C}$ values in the rib became more enriched (-14.1‰) and the $\delta^{15}\text{N}$ values slightly depleted (11.2‰). This slight shift may, however, also be the result of normal variation.

Burial 50 was also male and lived to between 35-50 years of age. This person, like Burial 49, ate C_4 grains and no marine food during childhood. His tooth dentine values are $\delta^{13}\text{C} = -9.8\text{‰}$ and $\delta^{15}\text{N} = 7.6\text{‰}$. He was captured and ended up at the Cape where he ate a diet that included C_3 plant food (cortical $\delta^{13}\text{C} = -15.9\text{‰}$) and seafood (cortical $\delta^{15}\text{N} = 13.2\text{‰}$). He continued to eat these foods until his death: his rib values are $\delta^{13}\text{C} = -16.1$

‰ and $\delta^{15}\text{N} = 12.6$ ‰. Although his dietary life history seems very similar to Burial 49, the decorative pattern on his teeth is different. Chips have been removed from the lateral or distal surfaces of the maxillary central incisors (unlike other tooth decoration observed at the Cape, where the chips are mesial). The maxillary lateral incisors have mesial chips removed from them. This suggests that 50 could be from a different population group, one that has not been observed so far at the Cape. See below for results of analyses of $\delta^{13}\text{C}$ in apatite and $^{87}\text{Sr}/^{86}\text{Sr}$ for this individual.

Burial 52 was female and she was buried in a coffin, with a number of grave goods. The results for dentine suggest that this woman ate C_4 plants ($\delta^{13}\text{C} = -12$ ‰) and very little, if any, seafood ($\delta^{15}\text{N} = 7.2$ ‰) when she was growing up. $\delta^{13}\text{C}$ of -12.3 ‰ for cortical bone suggest that she ate a mix of C_4 and C_3 plants for much of her life except for the period prior to death. The rib $\delta^{13}\text{C}$ value of -10.1 , ($\delta^{15}\text{N} = 8.6$) indicates that at this stage her diet was made up largely of C_4 based food. For part of her adult life she may have eaten some marine food, as her femur has a $\delta^{15}\text{N}$ value of 11.8 ‰, 4.5 ‰ more enriched than tooth dentine. However, the rib $\delta^{15}\text{N}$ value is low (8.6 ‰), much like her tooth dentine.

Burial 60 was a female of around 30 years. Her $\delta^{13}\text{C}$ values show a steady depletion from -8.0 ‰ (tooth) to -13.8 ‰ (cortical) to -15.3 ‰ (cancellous). Her dietary trajectory shows a steady enrichment in $\delta^{15}\text{N}$ from 7.2 ‰ to 10.9 ‰ to 12.8 ‰. Her change in diet is a particularly dramatic one, with a 5.7 ‰ shift in $\delta^{15}\text{N}$, and 7.2 ‰ in $\delta^{13}\text{C}$. Her diet changed from one based on terrestrial C_4 plants to one that included C_3 plants and some seafood. Burial 60 will be discussed further in the sections below, where the results for $\delta^{13}\text{C}$ for apatite carbonate and $^{87}\text{Sr}/^{86}\text{Sr}$ ratios are described.

The combination of dental decoration (known to have been practised in central, south/central and eastern Africa) and the reliance on C_4 foods during childhood, together with the morphological features of these skeletons (Morris 1999) make it almost certain that these skeletons are the remains of Africans from tropical or sub-tropical parts of the continent, brought to the Cape as slaves. They derive from heterogeneous populations.

Teeth

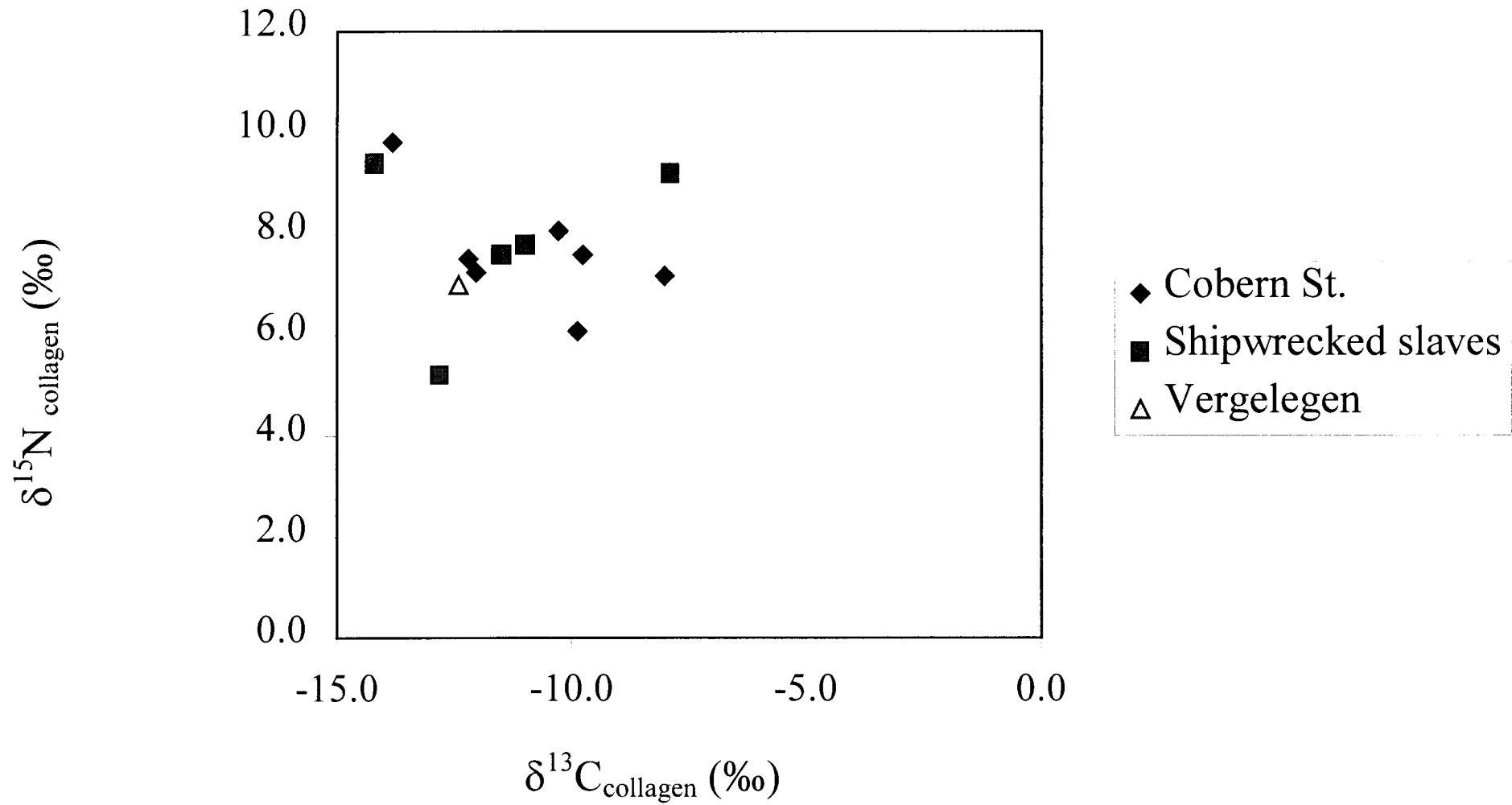


Figure 32: Cobern Street slave skeletons compared to the shipwrecked slaves found on the Cape Town Foreshore and the Vergelegen slave

Burials 20A , 20B and 40 have similar tooth decoration but they do not have corresponding similarities in diet. Burials 49, 52, and 60 have all had their incisors chipped to points, yet the amounts of C₄ plant-based food eaten during childhood varied and their changes in lifestyle occurred at different times, according to each individual's life history.

Comparisons can be made between these Cobern Street individuals and slave skeletons found at two other sites in and near to Cape Town (Figure 32). Variations within the same individual in isotope signatures have been witnessed in a slave skeleton excavated at Vergelegen, outside Cape Town (described in Chapter 5, see Figure 1). This woman did not have decorated teeth. Her $\delta^{13}\text{C}$ values were -13.2‰ for third molar, -10.9‰ for femur and -11.3‰ for rib. The $\delta^{15}\text{N}$ value for the third molar is 6.7‰ , the femur is 10.6‰ and the rib is 12.4‰ , therefore becoming enriched during life. It is, however, important to keep in mind that she was living on a farm and her diet would probably have been different from that of a slave living in 18th century Cape Town. The increase in marine foods also has a slight enriching effect on carbon values (Sealy *et al.* 1995).

The remains of eight shipwrecked slaves have also been analysed (See Chapters 2 and 5). The isotopic results were strongly patterned. Tooth dentine had the most positive $\delta^{13}\text{C}$ values, averaging -11.5‰ ($n=5$); cortical bone, -12.2‰ ($n=8$); and bones with a fast turnover rate (such as sinus, palatine, rib, and trabecular bone) were most negative, at -16.2‰ ($n=8$). In each of these skeletons $\delta^{13}\text{C}$ values became more depleted during life. The average $\delta^{15}\text{N}$ for tooth dentine was 8.4‰ ($n=5$); cortical bone, 7‰ ($n=6$) and for bones with a fast turnover rate 9.6‰ ($n=2$).

Thus the shipwrecked slaves and the individuals with decorated teeth from Cobern Street tended to have more negative $\delta^{13}\text{C}$ values for cancellous bone, indicating a greater intake of C₃-based foods in later life. The pattern for the Vergelegen woman is different. Her $\delta^{13}\text{C}$ values become slightly more positive, and her $\delta^{15}\text{N}$ values more enriched. This trend in $\delta^{15}\text{N}$ values may also be present in the slave skeletons from Woodstock beach

(although the sample is small) and some of the Cobern Street skeletons (Burials 49, 50, 59 and 60).

Type B: Individuals without decorated teeth (change in isotope ratios)

Ten of the Type B burials do not have any distinguishing features such as decorated teeth; however isotopic signatures vary within each skeleton. These variations of more than two per mil may be the result of moving from one place to another, with a resultant change of diet (Table 17).

These ten all have different life histories. Tooth dentine was sampled for eight of the ten. Certain similarities can be seen between individuals, but similarities that are present in youth are seldom present in adulthood as each person embarks on their individual life trajectory.

Anat omy *	Lab Nos†	Burial #	Age	Sex	Cancellous bone		Cortical bone		Tooth dentine		Ear Ossicle	
					$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)	$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)	$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)	$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)
500	6208-9	12	35-45	M	-16.4	12.4	17.0	11.3	-17.1	11.2	-18.6	13.2
502	6212-3	14	45-55	F	-16.9	8.7	-14.7	10.4	-19.2	8.8		
508	6216-7	18	>50	F	-16.2	12.6	-16.4	12.9	-13.9	11.8		
522	6236-7	28	50	F	-13.9	11.9	-15.8	11.9				
551	6274-5	53	35-40	M	-14.1	10.5	-16.5	11.9				
542	6256- 7,6475	44	40-50	F	-14.1	11.7	-13.9	12.3	-13.4	14.3		
549	6270-1	51	35-40	M	-16.0	12.8	-16.6	10.1				
556	6282- 3,6482	58	35-40	F	-14.2	12.0	-14.6	11.7	-11.9	11.7		
514	6225- 6,6468	21	25-35	F	-16.0	12.3	-14.1	10.7	-11.3	12.3		
552	6276-7	54	30-35	M	-15.8	12.3	-16.6	11.0	-18.6	9.9		

Table 17: Type B: Individuals without decorated teeth. All individuals with a more than two ‰ change in isotope ratios

* Skeleton accession numbers, Department of Anatomy and Cell Biology

† Archaeometry laboratory numbers, Department of Archaeology

Samples from the ear ossicle, the maxillary right incisor, the femur and rib were taken from Burial 12, an adult male. There is a small amount of variation in the isotopic

signatures that could simply be normal variation, but will be discussed below. The $\delta^{13}\text{C}$ values become more positive during the course of this person's life. The isotope values for the ear ossicle are $\delta^{13}\text{C} = -18.6\text{‰}$ and $\delta^{15}\text{N} = 13.2\text{‰}$. The depleted carbon values indicate a diet that included C_3 based foods. The enriched nitrogen value suggests that marine resources were probably also consumed. These isotope ratios are not unlike those found in Europe (Kennedy 1988, Schoeninger 1989).

The values for tooth dentin are $\delta^{13}\text{C} = -17.1\text{‰}$ and $\delta^{15}\text{N} = 11.2\text{‰}$ and for the femur $\delta^{13}\text{C} = -17.0\text{‰}$ and $\delta^{15}\text{N} = 11.3\text{‰}$. It could be that the marine food intake decreased and the carbon isotope values became slightly enriched. Alternatively, if the ossicle consists mostly of bone laid down in very early life, the enriched $\delta^{15}\text{N}$ value could reflect a diet rich in animal food (breast milk) consumed by the infant (cf Katzenberg *et al.* 1993). The fact that, for the other three skeletons for which ossicles have been analysed, this pattern is not observed makes this explanation unlikely. The rib values are $\delta^{13}\text{C} = -16.4\text{‰}$ and $\delta^{15}\text{N} = 12.4\text{‰}$.

The results of the analysis of the tooth dentine of Burial 14 suggest that she grew up eating C_3 based foods ($\delta^{13}\text{C} = -19.2\text{‰}$) with little, if any, seafood ($\delta^{15}\text{N} = 8.8\text{‰}$).

Later, she changed her diet, perhaps increasing her intake of seafood for a number of years, long enough for this signature to register in the isotope ratios. The isotopic signatures for the femur are $\delta^{13}\text{C} = -14.7\text{‰}$ and $\delta^{15}\text{N} = 10.4\text{‰}$. The increase in seafood and/or other foods high in ^{13}C has caused the enriched carbon isotope value.

During her last years (represented in the results from her rib) she may have eaten less C_3 based foods ($\delta^{13}\text{C} = -16.4\text{‰}$) and no longer included seafood as part of her diet ($\delta^{15}\text{N} = 8.7\text{‰}$), unlike many of the other Type B individuals.

These results suggest that this person may have had more than one change of lifestyle. A possible explanation is that she began life in temperate C_3 environment, and she lived inland. She may have eaten animal foods during youth but not marine resources. Later in life she may have moved to a coastal location, or a place where she ate more protein. Toward the end of her life she may have been eating some animal foods but probably not

seafood. All these dietary choices could have been voluntary, but were probably the result of making the best use of what was available. (She will be discussed further in this chapter under the headings Apatite and Bone Density Fractionation)

Burial 18's tooth dentine $\delta^{13}\text{C}$ value is -13.9‰ . The skeleton from Vergelegen and some of the Woodstock Beach skeletons have similar $\delta^{13}\text{C}$ values (Sealy *et al.* 1995; Cox & Sealy 1997). The $\delta^{13}\text{C}$ values become depleted in later life. The $\delta^{13}\text{C}$ value for cortical bone is -16.4‰ and for rib -16.2‰ , probably because more C_3 based foods have been included in the diet.

The $\delta^{15}\text{N}$ isotope signature for the tooth dentine is 11.8‰ , which may reflect the intake of some marine food. The $\delta^{15}\text{N}$ values for the Vergelegen woman and the shipwrecked slaves are below 10‰ (Sealy *et al.* 1995; Cox & Sealy 1997). The $\delta^{15}\text{N}$ values become slightly more enriched. The femur value is 12.9‰ and the rib value 12.6‰ .

Burial nos. 28 and 53 show the same pattern in their carbon values. The carbon isotopic values are enriched by approximately 2‰ . Burial 28 has a $\delta^{13}\text{C}$ value of -15.8‰ for femur and -13.9‰ for rib. Burial 53 has a $\delta^{13}\text{C}$ value of -16.5‰ for femur and -14.1‰ for rib. The $\delta^{15}\text{N}$ results for both individuals are above 10‰ . There are no tooth dentine values available.

Burial no 44 is an adult female. The $\delta^{13}\text{C}$ value for dentine from a maxillary incisor is -13.4‰ . The $\delta^{13}\text{C}$ values become slightly depleted in the femur (-13.9‰) and rib (-14.1‰). The $\delta^{15}\text{N}$ value for dentine (14.3‰) suggests that during her early years she ate seafood, had access to large quantities of animal protein or came from an arid area. The $\delta^{15}\text{N}$ values are lower in the femur (12.3‰) and rib (11.7‰). The isotopic ratios are similar to those obtained for historic skeletons from Kenya. These people had cattle, caprines and camels and C_4 agriculture. They gathered C_3 wild plants and did some fishing. Their $\delta^{13}\text{C}$ values average -14.2‰ and $\delta^{15}\text{N}$ values 13.9‰ (Ambrose 1986).

Burial 51's rib and femur were analysed. There is a more than 2 ‰ difference in the nitrogen values, possibly the result of an increased intake of seafood during later years. The $\delta^{15}\text{N}$ value for the femur is 10.1 ‰, whereas the rib has a $\delta^{15}\text{N}$ value of 12.8 ‰. The $\delta^{13}\text{C}$ values are enriched by less than one ‰ from -16.6 ‰ for femur to -16 ‰ for rib.

Burial no 58's $\delta^{13}\text{C}$ value for tooth dentine (-11.9 ‰), in combination with a $\delta^{15}\text{N}$ value of 11.7 ‰ suggest she was eating C_4 based foods. These values are similar to those of individuals who grew up in tropical or subtropical environments (Sealy *et al.* 1993; Sealy *et al.* 1995; Cox & Sealy 1997). A number of other individuals buried at Cobern Street have similar $\delta^{13}\text{C}$ signatures, (Burials 20A, 20B, 40, 49, 50 and 60). All these skeletons had decorated teeth and are thought to be slaves brought to the Cape from further north in Africa. Burial 21 (discussed below) also had similar signatures. Burial 58's $\delta^{13}\text{C}$ values become more depleted during life (femur = -14.6 ‰, rib = -14.2 ‰), due to the addition of C_3 based foods to the diet. $\delta^{15}\text{N}$ values are constant throughout life and average 11.8 ‰. The individuals with decorated teeth listed above all have $\delta^{15}\text{N}$ values of less than 10 ‰. Burial 58 may have come from a coastal tropical area where she ate some seafood. This continued to be a component of her diet in later life.

Burial 21 started life eating a diet similar to that of Burial 58. $\delta^{13}\text{C}$ values vary by almost 5 per mil from -11.3 ‰ for tooth dentine to -14.1 ‰ for femur and -16.0 ‰ for rib. This is the same pattern as that seen for Burial 58, but much more marked. An increase in C_3 plant food probably caused this depletion. Diet during childhood probably included C_4 based foods. The $\delta^{15}\text{N}$ value for tooth dentine is 12.3 ‰ and the diet probably included marine food. She may have lived on a tropical coast. Another possible reason for the enriched nitrogen values could be reliance on animal products such as milk. $\delta^{15}\text{N}$ values do not vary significantly during life.

Burial 54's tooth dentine $\delta^{13}\text{C}$ values suggest a diet based on C_3 based foods (-18.6 ‰). These plant foods could have included wheat, barley or rye. Similar $\delta^{13}\text{C}$ values have

been reported in Europe (Schoeninger 1989) and in Canada (Katzenberg 1991B). The carbon isotopic signatures for Burial 54 become more enriched in the femur (-16.6‰) and rib (-15.8‰). The $\delta^{15}\text{N}$ value for the tooth dentine is 9.9‰ . The $\delta^{15}\text{N}$ signature for femur is 11.0‰ , and for rib 12.3‰ , probably indicating a shift from a terrestrially – orientated diet in childhood to one that included seafood in later life.

Type B: Individuals without decorated teeth (no change in isotopic ratios) and inferences about diets at the Cape during the 18th century

The results of the stable carbon and nitrogen isotope analysis indicate that 26 of the Type B skeletons did not undergo any substantial change of diet during life, or at least not one recognisable isotopically. (These individuals exclude those with decorated teeth discussed above). (Table 18). Their skeletons show a less than 2‰ variation in isotopic values. Cortical and cancellous bone, and in some cases teeth, were analysed from each individual. They may have lived in Cape Town all their lives, or moved from other areas where they ate foods with similar isotopic values to those they ate in Cape Town. The average $\delta^{13}\text{C}$ value for all individuals is $-16.5 \pm 0.8\text{‰}$ and the average $\delta^{15}\text{N}$ value is $12.1 \pm 1\text{‰}$. These values may be taken to indicate the diets of poorer Capetonians at this time. How do these results fit with the historical accounts of diet, discussed in Chapter 3?

Wheat and rice were recorded to have formed a large part of the diets of Cape Town residents during the 17th and 18th centuries. Fish and some mutton and beef were also eaten. The $\delta^{13}\text{C}$ value for an individual whose diet was based solely on C_3 plant-derived foods would be approximately -21‰ (Schoeninger 1989; Kennedy 1988; Katzenberg 1991b). The average $\delta^{13}\text{C}$ value for this group of 26 Type B burials is -16.5‰ a considerably more enriched value. If collagen represents the protein component of the diet then this more positive $\delta^{13}\text{C}$ is derived from fish, or perhaps meat of animals eating C_4 grasses. In eighteenth century Cape Town C_3 plants were staple foods of the underclass together with marine protein. The average $\delta^{15}\text{N}$ value of 12.1‰ for these Type B burials confirms that marine food formed part of their diets. The considerable

variation in isotope values among Type B burials reflects the cosmopolitan nature of the port of Cape Town.

Anato my	Lab nos†	Burial #	Age	Sex	Cancellous		Cortical		Tooth dentine		Average values			
					$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)	$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)	$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)	$\delta^{13}\text{C}$ (‰)	No.	$\delta^{15}\text{N}$ (‰)	No.
458.2	6194	9		?			-16.8	12.2			-16.8	1	12.2	1
459.2	6197	7	18	M			-16.2	12.7			-16.2	1	12.7	1
515	6227-8	22	12~14	?	-16.9	12.5	-17.1	11.5			-17	2	12	2
458.1	6192-3	4	17-18	F	-16.8	12.7	-16.7	12.3			-16.7	2	12.5	2
461	6202-3	5	20	F	-16.7	12.2	-16.7	11.9			-16.7	2	12.1	2
517	6231	24	20-25	M	-16.7	12.7			-16.8	12.6	-16.8	2	12.7	2
545	6262-3	47	30's	M	-16.7	13.4	-16.1	12.9	-15.3	12.1	-16	3	12.8	3
518	6232-3	25	35-40	M	-16.6	12.2	-16.6	11.8	-17.1	10.6	-16.8	3	11.5	3
509	6218	19	adult	M			-16.4	13.0			-16.4	1	13	1
516	6229-30	23	17-19	F	-16.6	13.4	-16.0	13.4	-15.3	12.0	16	3	12.9	3
546	6264-5	48	40+	F	-16.5	12.7	-17.2	11.4			-16.9	2	12.1	2
460	6200-1	3	20	M	-16.5	11.1	-16.8	11.6	-16.4	11.8	-16.5	3	11.5	3
499	6206-7	11	<40	F	-16.4	13.1	-16.4	13.7			-16.4	2	13.4	2
541	6254-5	43	35-50	M	-16.4	12.6	-16.6	12.8			-16.5	2	12.7	2
501	6210-1	13	30-40	M	-16.2	13.2	-15.9	12.5	-16.3	12.4	-16.1	3	12.7	3
536	6248-9	41	35-50	M	-16.2	10.8	-16.0	11.1	-15.3	12.1	-15.8	3	11.4	3
459.3	6198-9	8		?	-16.1	11.7	-16.2	12.2			-16.2	2	11.9	2
498	6204-5	10	35-40	F	-15.9	12.9	-16.1	13.9	-16.6	13.3	-16.2	3	13.4	3
459.1	6195-6	6	20-30	M	-13.7	12.3	-15.6	12.5			-16.3	2	10.6	2
504	6214-5,6462	15	25	M	-16.6	12.4	-16.0	12.5	-17.4	10.9	-16.4	3	10.6	3
528	6240-1,6471	34	14-15	F	-18.8	9.9	-19.5	8.9	-19.8	10.3	-16.7	3	11.9	3
543	6258-9,6476	45	50+	M	-17.6	12.1	-17.7	11.6	-16.7	13.1	-14.6	2	12.4	2
544	6260-1,6477	46	35-50	F	-16.8	11.9	-17.7	10.3	-17.7	11.3	-19.4	3	9.7	3
559	6288-9,6485	61	20	F	-15.2	14.0	-14.9	13.3	-15.5	14.6	-17.3	3	12.3	3
554	6278-9	56	35	M	-16.5	11.2	-16.1	10.1			-17.4	3	11.2	3
521	6234-5	27B	40-50	M	-16.7	9.9	-16.1	11.5	-16.4	10.3	-15.2	3	14	3
26 individuals									Average		-16.5	n:62	12.1	n:62

Table 18: Type B without decorated teeth. All individuals with a less than 2 ‰ change in isotope ratios

* Skeleton accession numbers, Department of Anatomy and Cell Biology

† Archaeometry laboratory numbers, Department of Archaeology

Within the Type B group (with no change in isotopic ratios) there are some individuals whose average lifetime values differ from the general pattern. For example, Burial 27B shows little intra-skeletal variation, with an average $\delta^{15}\text{N}$ value of 10.6 ‰. The $\delta^{15}\text{N}$ for

his femur is 11.5 ‰ so he ate seafood during part of his life, although probably not to the same extent as the rest of this group.

Burial 6 (an adult male) has $\delta^{13}\text{C}$ values which average -14.6 ‰ and $\delta^{15}\text{N}$ values averaging 12.4 ‰. This individual could have had access to C_4 based foods, not common at the Cape, or he was eating more seafood or animal foods. The average $\delta^{15}\text{N}$ of 12.4 ‰, indicates that Burial 6's diet may have included more protein than the rest of the burials represented in Table 18.

Burial 34 was only 14 to 15 years old when she died. Her diet throughout life remained isotopically constant. Her $\delta^{13}\text{C}$ value, at -19.4 ‰, indicates that she consumed mostly C_3 -based foods such as rice or wheat and very little, if any, seafood ($\delta^{15}\text{N} = 9.7$ ‰). These carbon isotope values are the most depleted in the Cobern Street collection. Isotopic ratios of Europeans who are known to have eaten wheat, barley, oats and rye in various combinations have $\delta^{13}\text{C}$ values of around -19 ‰ (Kennedy 1988, Schoeninger 1989).

The average $\delta^{13}\text{C}$ value for Burial 45 is -17.3 ‰. This, too, is a rather negative value when compared with the group overall. It is the result of a diet that included a considerable amount of C_3 based food.

Burial 46's rib $\delta^{13}\text{C}$ value (-16.8 ‰) is slightly more enriched than the tooth dentine value (-17.7 ‰). This may simply be normal variation, or it could be related to a small increase in marine food intake. $\delta^{15}\text{N}$ values are 11.3 ‰ for the tooth dentin and 11.9 ‰ for rib.

Burial 61's isotopic signatures remain constant, with an overall fluctuation of less than two per mil. The average $\delta^{13}\text{C}$ value at -15.2 ‰, is more enriched than usual for this group. $\delta^{15}\text{N}$ values average 14 ‰. The $\delta^{15}\text{N}$ for tooth dentin, representing diet during youth is 14.6 ‰, a relatively enriched value which probably reflects marine protein.

TYPE C

5 skeletons (Nos. 32,57,59,64 and 65) were buried on their sides (Table 19 and Figure 33). Analysis of the teeth suggests that they ate different food during their youth to that consumed later in life.

Anat omy	Lab nos.	Buri al #	Age	Sex	Cancellous bone		Cortical bone		Tooth dentine		Ear ossicle	
					$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)	$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)	$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)	$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)
526	6238-9	32	50-60	M	-15.9	14.1	-16.8	12.4	-18.0	11.4		
555	6280-1,6481	57	20's	F	-15.6	13.7	-15.1	12.7	-18.4	11.8		
557	6284-5,6483	59	40	M	-17.1	12.2	-18.3	10.2	-17.6	8.1		
562	6290-1,6496	64	35-45	M	-16.2	12.6	-16.8	12.5	-17.7	11.4	-17.7	11.7
563	6292- 3,6486,6497	65	22-25	F	-14.9	13.3	-15.9	12.8	-15.6	10.8		

Table 19: Type C burials

Burial 32's $\delta^{13}\text{C}$ values became more enriched during life from the tooth dentine value of -18.0‰ , to a value for the femur of -16.8‰ and rib -15.9‰ . $\delta^{15}\text{N}$ values increased; tooth dentine 11.4‰ , femur 12.4‰ , and rib 14.1‰ . This trend is most parsimoniously explained as the result of the addition of seafood to the diet.

Burial 57 (an adult female) had $\delta^{13}\text{C}$ values that became enriched by almost 3‰ during life. The $\delta^{13}\text{C}$ value for tooth dentine is -18.4‰ , for femur -15.1‰ and for rib -15.6‰ . The $\delta^{15}\text{N}$ values record a 2‰ enrichment, from 11.8‰ for dentine to 12.7‰ for femur to 13.7‰ for rib. The picture is very similar to that seen above for Burial 32.

Burial 64's isotopic signatures do not alter significantly. The $\delta^{13}\text{C}$ values follow a trend during life and become more enriched by just over one per mil. The ossicle $\delta^{13}\text{C}$ value is -17.7‰ and the tooth dentine value is -17.7‰ . The femur $\delta^{13}\text{C}$ value is -16.8‰ and the rib is -16.2‰ . The ear ossicle $\delta^{15}\text{N}$ value is 11.7‰ the tooth dentine value is 11.4‰ . The cortical $\delta^{15}\text{N}$ value is 12.5‰ and the rib bone is 12.6‰ . This small enrichment can be explained as normal variation or an increase in the consumption of seafood. The subtle isotopic shifts are similar to those observed in Burials 32 and 57.

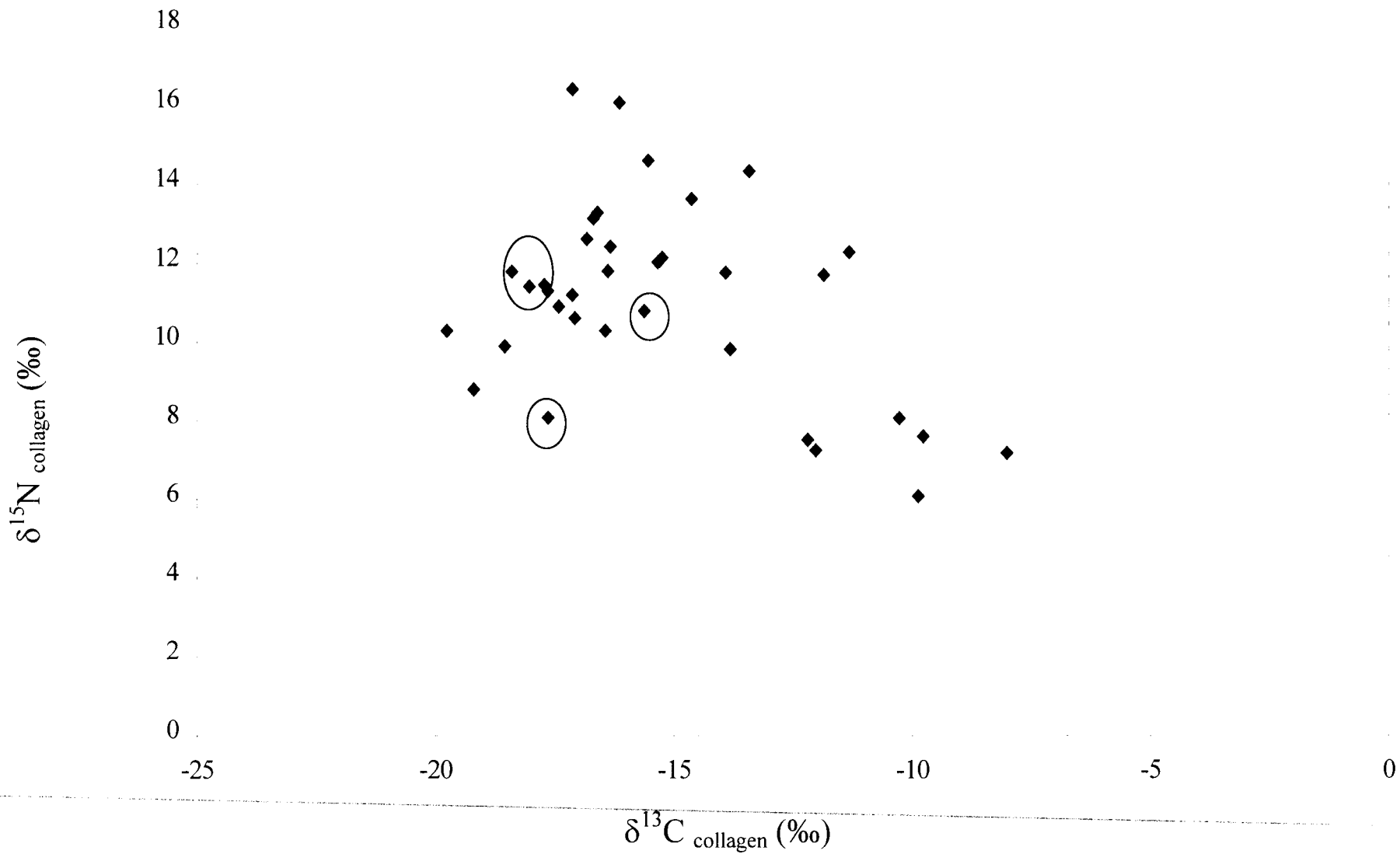


Figure 33: Plot of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ results for all skeletons for tooth dentine, Type C burials are circled

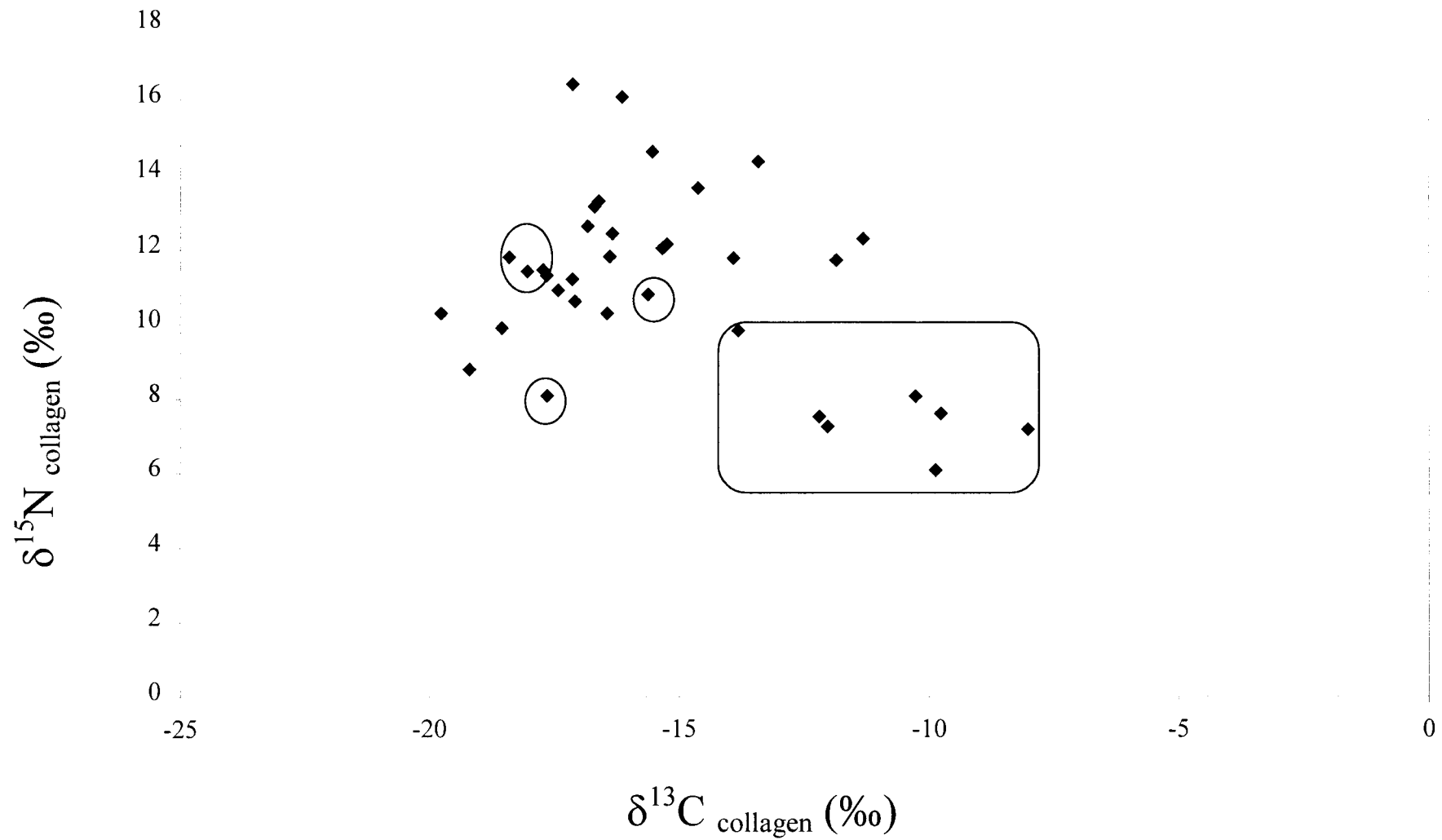


Figure 34: Plot of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ results for all skeletons on tooth dentine, individuals with decorated teeth (rounded rectangle) compared to Type C burials (circled)

For Burial 59, the tooth dentine $\delta^{13}\text{C}$ signature is -17.6‰ . The $\delta^{13}\text{C}$ value for the femur is -18.3‰ , and for the rib -17.1‰ . The $\delta^{15}\text{N}$ value for tooth dentine is 8.1‰ , femur is 10.2‰ , for the rib 12.2‰ . This person did not eat seafood as a child, but probably consumed small quantities of C_4 -based foods. Although the $\delta^{15}\text{N}$ values become more enriched during life there is no corresponding enrichment in carbon values. This could result from a dietary change in which seafood was added to the diet, and the C_4 -based component removed. (See apatite and strontium)

The $\delta^{13}\text{C}$ value for tooth dentine of Burial 65 is -15.6‰ , femur -15.9‰ and rib -14.9‰ . This $\delta^{13}\text{C}$ value for tooth dentine is more enriched than values for the rest of the side burials by at least 2‰ . The $\delta^{15}\text{N}$ value for tooth dentine is 10.8‰ for femur 12.8‰ and for rib 13.3‰ . The diet during youth of Burial 65 probably consisted of C_3 and C_4 based foods, perhaps with a little marine food. The $\delta^{15}\text{N}$ signatures become more enriched during life like the others in the group, most likely also a result of an increased marine food component.

These people may have been brought to the Cape from the Indian Ocean world. Their ^{13}C -depleted isotope values in early life suggest diets mostly based on C_3 plants such as rice, and the $\delta^{15}\text{N}$ values indicate that they ate little seafood. The $\delta^{13}\text{C}$ values are not as depleted as those found in Europeans (Kennedy 1988, Schoeninger 1989) and at least two individuals, Burials 59 and 65, ate detectable amounts of C_4 -based foods as children. The others may have eaten smaller quantities. For those individuals in whom dietary changes during life can be seen, these changes led to more positive $\delta^{13}\text{C}$ values and $\delta^{15}\text{N}$ values. This is most likely to result from the addition of seafood to the diet. 32, 57 and 64 follow a similar trajectory during their lives. 59 and 64 have different life histories to each other and to the rest of the group.

THE LATER STONE AGE SKELETONS

TYPE A

Burial 42A's $\delta^{13}\text{C}$ values become slightly more depleted through life (-14.6 ‰ for dentine; -15.9 ‰ for cortical bone and -16.2 ‰ for rib) as do his $\delta^{15}\text{N}$ values (13.6 ‰; 13.1 ‰ and 12.4 ‰) respectively. This change is small, less than 2 ‰ and could simply be a result of normal variation. It could also reflect a slight decrease in seafood consumption, which will result in depleted $\delta^{13}\text{C}$ values if the other food resources are C_3 based.

Burial 42 B's diet is similar to that of 42A's with little variation between femur and rib values. The $\delta^{13}\text{C}$ value for femur is -16.5 ‰ and the $\delta^{15}\text{N}$ value is 12.2 ‰. The $\delta^{13}\text{C}$ value for rib is -16.4 ‰ and $\delta^{15}\text{N}$ = 12.4 ‰. These values are consistent with those of other prehistoric people from the Western Cape with $\delta^{15}\text{N}$ values above 10 ‰ and $\delta^{13}\text{C}$ values between -10 and -17.9 ‰ (Sealy 1997).

Anatomy	Lab Nos	Burial #	Age	Sex	Cancellous bone		Cortical bone		Tooth dentine	
					$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)	$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)	$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)
531	6242-3,6472	37A	50-60	F	-12.4	14.0	-14.8	13	-17.1	16.4
532	6244-5,	37B	10-12	?	-16.2	11.3	-15.8	12		
539	6250-1,6472	42A	40-50	M	-16.2	12.4	-15.9	13.1	-14.6	13.6
540	6252-3	42B	40-50	F	-16.4	12.4	-16.5	12.2		

Table 20: Type A burials

Burial 37A's teeth, femur and rib signatures testify to a considerable dietary change during her life. The $\delta^{15}\text{N}$ value for tooth dentin (16.4 ‰) is consistent with a diet including large amounts of seafood, probably including shellfish, fish and marine mammals and birds. This enriched nitrogen value could be caused by the nitrogen isotope ecology of the home environment. It could be that she grew up in an area where the rainfall was less than 400mm per year. The area north of Saldanha receives less than 400mm (Weather Bureau 1965). The corresponding $\delta^{13}\text{C}$ value is rather depleted at -17.1 ‰, consistent with a C_3 environment. Enriched nitrogen values of 16 and 17 ‰ have been recorded on prehistoric skeletons from the Southern and Western Cape (Sealy

& Van Der Merwe 1988; Sealy 1997). A young individual from the pastoralist site of Kasteelberg had a $\delta^{13}\text{C}$ value of -15.9‰ and a $\delta^{15}\text{N}$ value of 17.6‰ . This enriched nitrogen value has been interpreted as being the result of a diet rich in terrestrial animal food with high $\delta^{15}\text{N}$ values (Sealy 1989).

The $\delta^{13}\text{C}$ value for the femur of Burial 37A is -14.8‰ , with $\delta^{15}\text{N}$ of 13‰ . Thus the carbon isotope value becomes more enriched, relative to dentine, while the nitrogen isotope value is depleted. Her rib $\delta^{13}\text{C}$ value is -12.4‰ and the corresponding $\delta^{15}\text{N}$ value is 14‰ . The $\delta^{15}\text{N}$ values of $13\text{--}14\text{‰}$, together with $\delta^{13}\text{C}$ values of -12 to -15‰ are similar to other values for prehistoric skeletons in the south-western Cape, and suggest a diet based on marine foods in the latter part of her life. (See discussion below of the apatite results which help to clarify this argument)

The diet eaten by 37B was different from that of 37 A. The $\delta^{13}\text{C}$ values for the femur and rib are -15.7 and -16.2‰ respectively. The $\delta^{15}\text{N}$ values are 12‰ and 11.3‰ . The results for the two skeletal elements are consistent and suggest the same diet for the duration of this child's life, a diet that included C_3 based food and marine resources.

CONCLUSION

Tooth dentine from skeletons recovered from Cobern Street has a wide range of isotopic values: $\delta^{13}\text{C}$ values have a range of 11.8‰ and $\delta^{15}\text{N}$ values have a range of 10.0‰ . This means that these people ate varied diets during youth, many of them based on food resources not available at the Cape. Isotopic values for rib are more tightly clustered, indicating less variation between individuals in diet in later life.

When $\delta^{13}\text{C}$ values are plotted against $\delta^{15}\text{N}$ values for dentine, several groupings of points can be identified. Two groups, on opposite ends of the $\delta^{13}\text{C}$ axis, correspond to groups of burials recognised earlier in the classification of burial styles and morphological features. The group with the most positive $\delta^{13}\text{C}$ values has decorated teeth. The isotopic measurements are consistent with the suggestion that these individuals were brought to

the Cape from elsewhere, and that they are likely to have had a tropical African origin. It is noteworthy that none of the individuals with decorated teeth were Cape-born. The group with the most negative $\delta^{13}\text{C}$ values consisted of individuals buried on their sides (Type C burials) (Figure 34). On the basis of their diets in childhood, the Type C burials are unlikely to be the graves of missionised Khoi, as was thought possible in the early stages of this project. They are more likely to be people from the Indian Ocean world.

Many of the Type B individuals have isotopic ratios that show no change between the different skeletal elements. It could be that these people did change their diets but this change is not detectable isotopically, or it could be that they stayed in Cape Town all their lives. The dietary reconstruction from the $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values for collagen corresponds with that of the historical accounts. The Later Stone Age skeletons are similar to those previously analysed from this area.

Any discrepancies (if there are any) between the dietary reconstruction based on isotope data and the reconstruction based on historical accounts will hopefully become apparent in the following sections of this chapter when $\delta^{13}\text{C}$ in apatite and strontium isotope ratios are analysed.

$\delta^{13}\text{C}$ IN APATITE RESULTS

Carbon isotope measurements of bone apatite are of interest because they may provide the best estimate of the isotopic composition of the whole diet (compared with measurements of collagen, which probably derives mainly from the protein in the diet) (Ambrose & Norr 1993; Tieszen & Fagre 1993). In addition, apatite-collagen spacings may provide information on the importance or otherwise of animal foods in the diet. $\delta^{13}\text{C}$ values for bone apatite were determined for 15 skeletons, one Later Stone Age and 14 historic individuals (Table 21). For the purposes of making certain generalised statements about the results of the bone carbonate analysis, the LSA individual has been excluded. It will be discussed in detail at the end of this section.

Burial No.	Bone	UCT#	$\delta^{13}\text{C}$ apatite (‰)	$\delta^{13}\text{C}$ collagen (‰)	$\delta^{15}\text{N}$ collagen (‰)	$\Delta^{13}\text{C}_{\text{collagen-apatite}}$ (‰)
11	rib	6206	-9.5	-16.4	13.1	7.0
14	rib	6212	-8.5	-16.9	8.7	8.3
14	femur	6213	-9.1	-14.7	10.4	5.6
14	vertebra		-8.2	-15.6		7.4
14	dentine	6461	-11.6	-19.2	8.8	7.6
15	rib	6214	-8.4	-16.6	12.4	8.2
20A	rib	6219	-4.5	-12.8	9.6	8.4
20B	rib	6221	-2.9	-8.6	7.5	5.7
20B	tooth	6466	-3.8	-12.2	7.5	8.4
20C	incisor	6467	-8.4	-16.2	16.1	7.8
37A	rib	6242	-9.9	-12.4	14.0	2.5
	femur	6243	-7.8	-14.8	13.0	7.0
	1st molar	6472	-9.7	-17.1	16.4	7.5
40	rib	6246	-3.7	-10.5	7.3	6.8
50	vertebra	6268	-9.7	-16.0	12.6	6.3
	femur	6269	-10.5	-15.9	13.2	5.4
	premolar	6479	-4.7	-9.8	7.6	5.1
58	femur	6283	-8.3	-14.6	11.7	6.3
	incisor	6482	-7.3	-11.9	11.7	4.6
59	rib	6284	-8.4	-17.4	12.2	9.0
	femur	6285	-7.2	-18.2	10.2	11.0
	incisor	6483	-12.8	-17.6	8.1	4.9
60	rib	6286	-8.3	-15.3	12.8	6.9
	humerus	6287	-7.5	-14.0	10.9	6.5
	1st molar	6484	-4.4	-8.0	7.2	3.6
61	rib	6288	-8.7	-15.2	14.0	6.5
64	rib	6290	-7.9	-16.2	12.6	8.3
	femur	6291	-6.8	-16.8	12.5	10.0
	1st molar	6936	-6.3	-17.7	11.4	11.4
65	rib	6292	-7.3	-14.9	13.3	7.6

Table 21: Results of $\delta^{13}\text{C}_{\text{apatite}}$ measurements, the corresponding $\delta^{13}\text{C}_{\text{collagen}}$ and $\delta^{15}\text{N}_{\text{collagen}}$ values and the difference between $\delta^{13}\text{C}_{\text{collagen}}$ and $\delta^{13}\text{C}_{\text{apatite}}$.

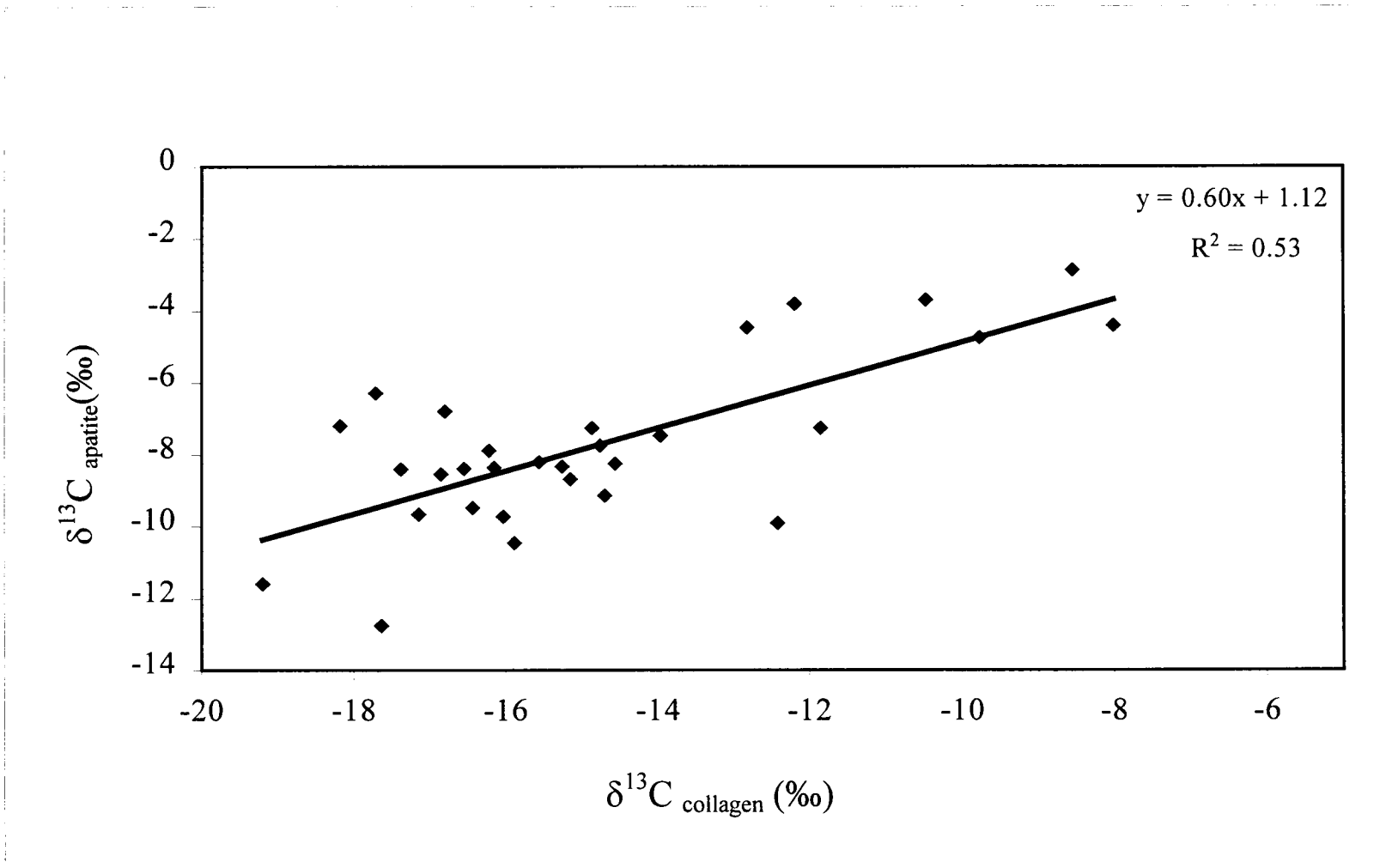


Figure 35: Plot of $\delta^{13}\text{C}_{\text{collagen}}$ versus $\delta^{13}\text{C}_{\text{apatite}}$ all skeletal elements

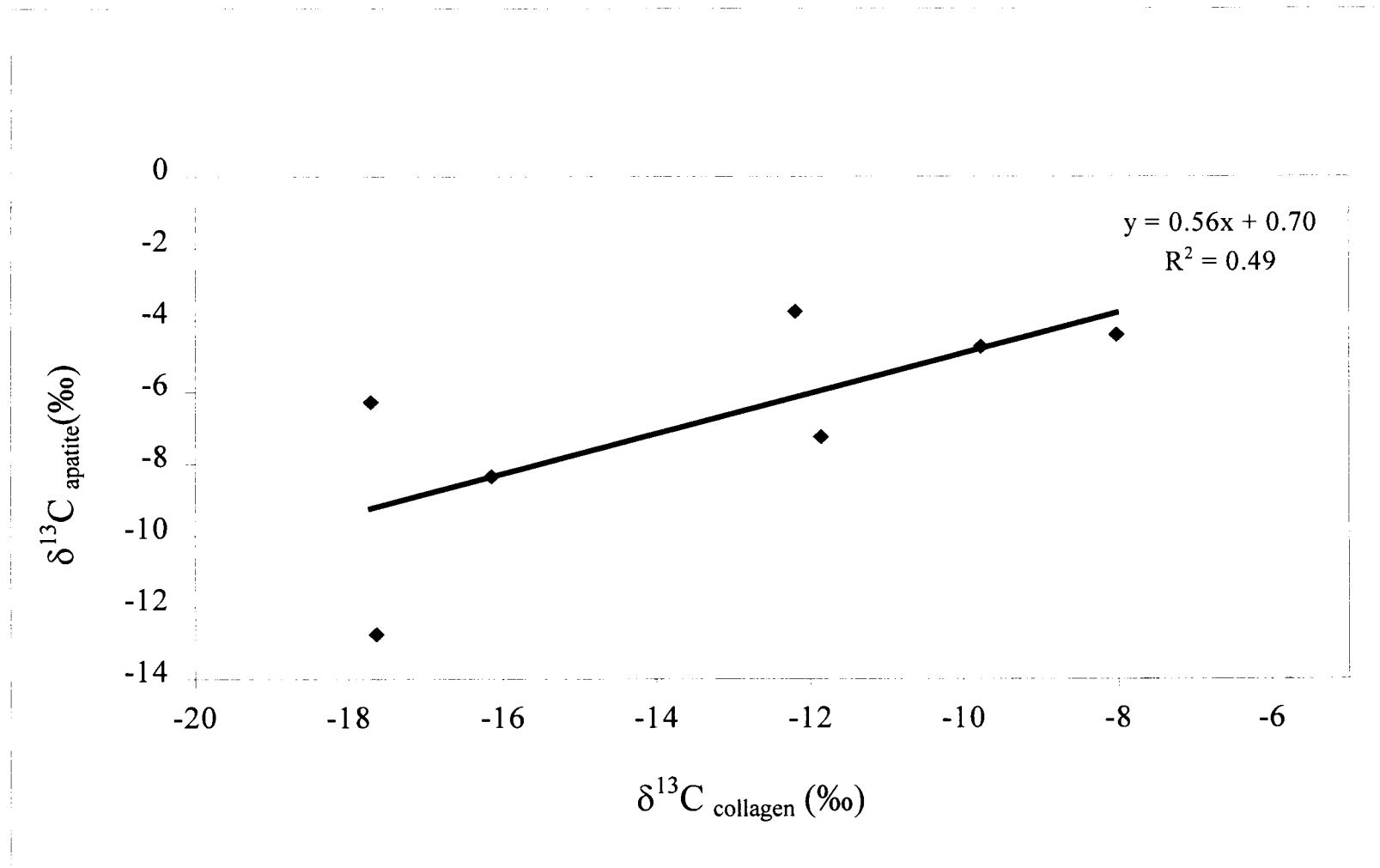


Figure 36: Plot of $\delta^{13}\text{C}_{\text{collagen}}$ versus $\delta^{13}\text{C}_{\text{apatite}}$ for tooth dentine

THE HISTORIC SKELETONS

Bone apatite was sampled from different sites on some skeletons, i.e. rib, cortical bone and teeth. $\delta^{13}\text{C}_{\text{apatite}}$ values range from -2.9‰ to -12.8‰ on all skeletal parts sampled, a range of 9.9 per mil. The corresponding $\delta^{13}\text{C}_{\text{collagen}}$ values for the tissue discussed above range from -8.6‰ to -17.7‰ , a range of 9.2 per mil (Table 21). Figure 35 shows $\delta^{13}\text{C}_{\text{apatite}}$ plotted against $\delta^{13}\text{C}_{\text{collagen}}$. The fitted regression equation is $\delta^{13}\text{C}_{\text{apatite}} = 1.76 + 0.66 \delta^{13}\text{C}_{\text{collagen}}$, with $r^2=0.60$ ($n = 27$). A hypothesis test of no correlation between the two variables was carried out and rejected at the 1% level (Zar 1984:268)

The $\delta^{13}\text{C}_{\text{apatite}}$ values for dentine range from -3.8‰ to -12.8‰ ($n=8$), a range of 9.0‰ (Table 21). Figure 36 shows $\delta^{13}\text{C}_{\text{apatite}}$ plotted against $\delta^{13}\text{C}_{\text{collagen}}$. The fitted regression equation is $\delta^{13}\text{C}_{\text{apatite}} = 1.42 + 0.63 \delta^{13}\text{C}_{\text{collagen}}$, with $r^2=0.61$ ($n = 8$). A hypothesis test of no correlation between the two variables was carried out, and accepted at the 1% level but rejected at the 5% level (Zar 1984:268).

This large range of variation in isotope results is indicative of the mix of different people buried at Cobern Street. The most positive values represent diets that were probably based almost exclusively on C_4 plants that grow in tropical or sub tropical environments. Conversely individuals whose isotope signals are the most depleted grew up in a temperate environment, where C_3 crops such as wheat and rice are grown.

$\delta^{13}\text{C}_{\text{apatite}}$ values for cortical bone range from -6.8‰ to -10.5‰ ($n=7$), a difference of 3.7‰. The rather small sample size is likely to contribute to this small range.

$\delta^{13}\text{C}_{\text{apatite}}$ values for cancellous bone range from -2.9‰ to -9.7‰ ($n=14$), a range of 6.8‰. The range is smaller than that for the teeth, but still shows variation. The values for cancellous bone was expected to be slightly more uniform if most of these individuals were eating similar food (Table 21 and Figure 37). Figure 38 shows $\delta^{13}\text{C}_{\text{apatite}}$ plotted against $\delta^{13}\text{C}_{\text{collagen}}$. The fitted regression equation is $\delta^{13}\text{C}_{\text{apatite}} = 4.28 + 0.79 \delta^{13}\text{C}_{\text{collagen}}$, with $r^2=0.87$ ($n = 12$). A hypothesis test of no correlation between the two variables was carried out and rejected at the 1% level (Zar 1984:268).

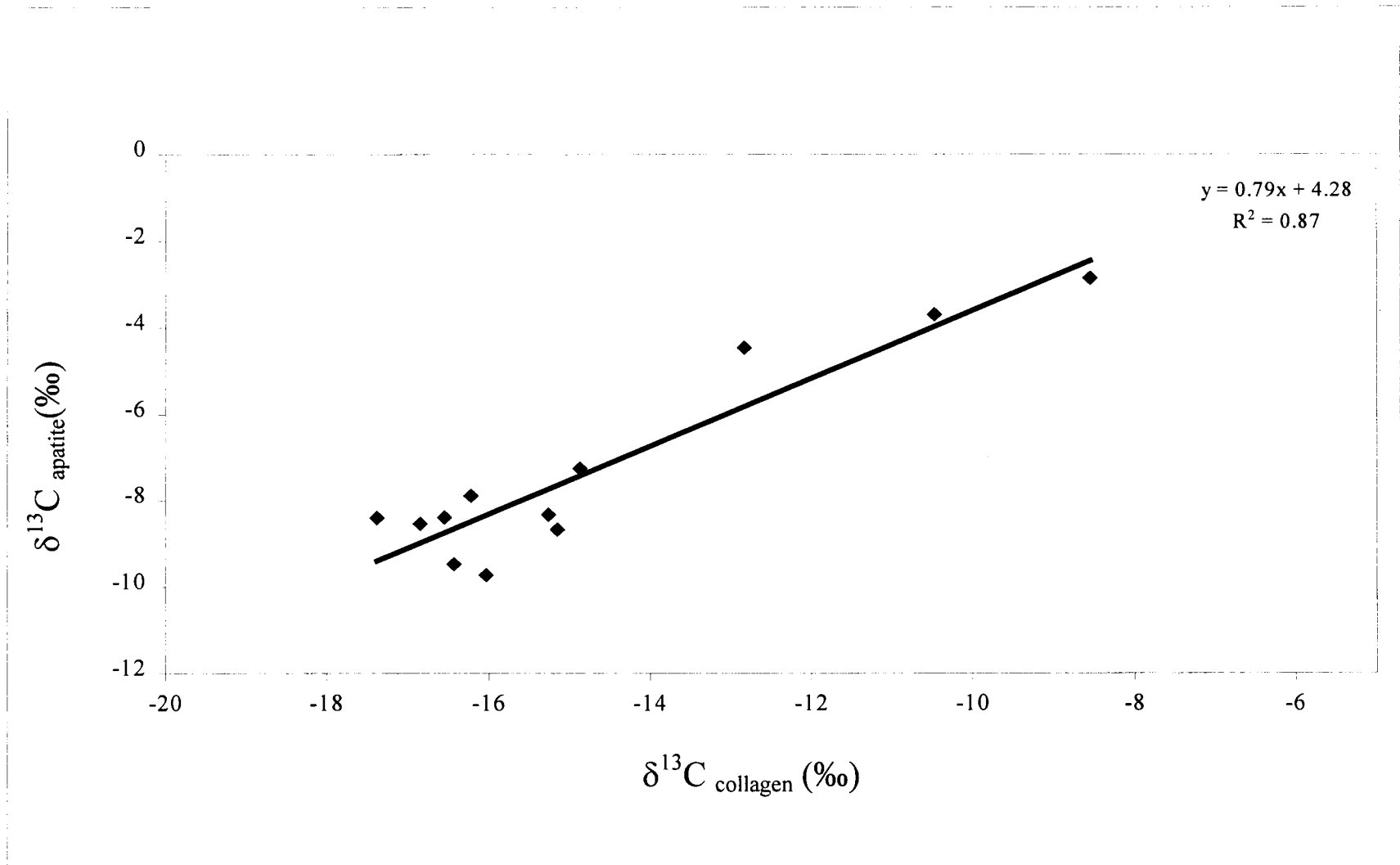


Figure 37: Plot of $\delta^{13}\text{C}_{\text{collagen}}$ versus $\delta^{13}\text{C}_{\text{apatite}}$ for cancellous bone

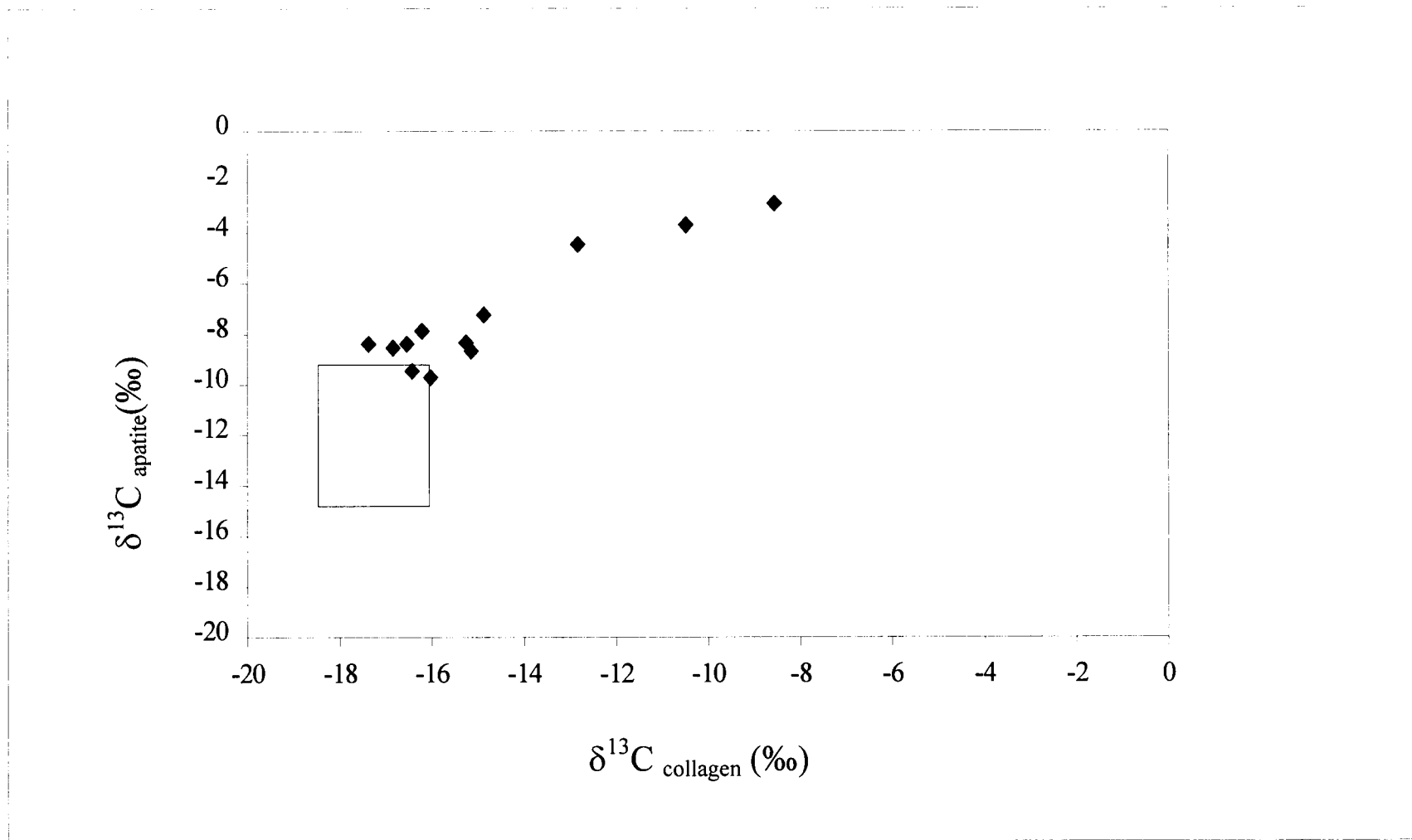


Figure 38: Plot of $\delta^{13}\text{C}_{\text{collagen}}$ versus $\delta^{13}\text{C}_{\text{apatite}}$ for cancellous bone. Rectangle indicates values predicted by the Krueger and Sullivan model (1984)

The most enriched $\delta^{13}\text{C}_{\text{apatite}}$ values of -2.9‰ and -3.7‰ are derived from C_4 based food. The diets of these two individuals did not change from those of their home environments (see discussion below). If these two outlying values are excluded, the $\delta^{13}\text{C}_{\text{apatite}}$ values for rib range from -7.3‰ to -9.7‰ .

Krueger and Sullivan (1983) illustrated the stable carbon isotope values of collagen and apatite in human bone for eight possible diets. One of their possible diets includes a combination of C_3 based and marine foods (Diet 7), the diet that was probably consumed in Cape Town in the eighteenth century. The values for Cobern Street do not cluster in the same range when plotted on a xy-graph (Figure 38). Unfortunately the raw data is not supplied in the article; however certain general comparisons can be made. The $\delta^{13}\text{C}$ values for the Cobern Street apatite are more enriched, they all cluster above 10‰ as opposed to the Krueger and Sullivan values, most of which cluster below 10‰ . The $\delta^{13}\text{C}$ - values for Cobern Street rib bone are slightly more enriched than those in the Krueger and Sullivan model.

The apatite-collagen spacings ($\Delta^{13}\text{C}_{\text{apatite-collagen}}$) in the Cobern Street skeletons vary from 3.6‰ to 11.4‰ with a mean of 7.2‰ . Values at the upper end of this range are very large, compared with previously reported apatite-collagen spacings. The largest value reported in the literature is 10.6‰ , for an individual from the Western Pacific (Ambrose *et al.* 1997). This study is the most detailed investigation of $\delta^{13}\text{C}_{\text{collagen}}$, $\delta^{13}\text{C}_{\text{apatite}}$ and $\delta^{15}\text{N}_{\text{collagen}}$ published to date, for coastal populations who used marine resources. As such, it is a useful study for comparison with the results reported here and is described in Chapter 5. Pacific people from Rota and Guam ate varying proportions of deep-water marine foods and terrestrial C_3 resources. The mean apatite-collagen spacings for Rota Island people was 6.5‰ . For these skeletons, "... $\Delta^{13}\text{C}_{\text{carb-coll}}$ decreases with increasing $\delta^{15}\text{N}$, which indicates the protein carbon in the diet was predominantly marine for individuals with high $\delta^{15}\text{N}$ values..." (Ambrose *et al.* 1997:356). This is not the case with the plot of $\Delta^{13}\text{C}_{\text{apatite-collagen}}$ and $\delta^{15}\text{N}_{\text{collagen}}$ values for Cobern Street (Figure 39).

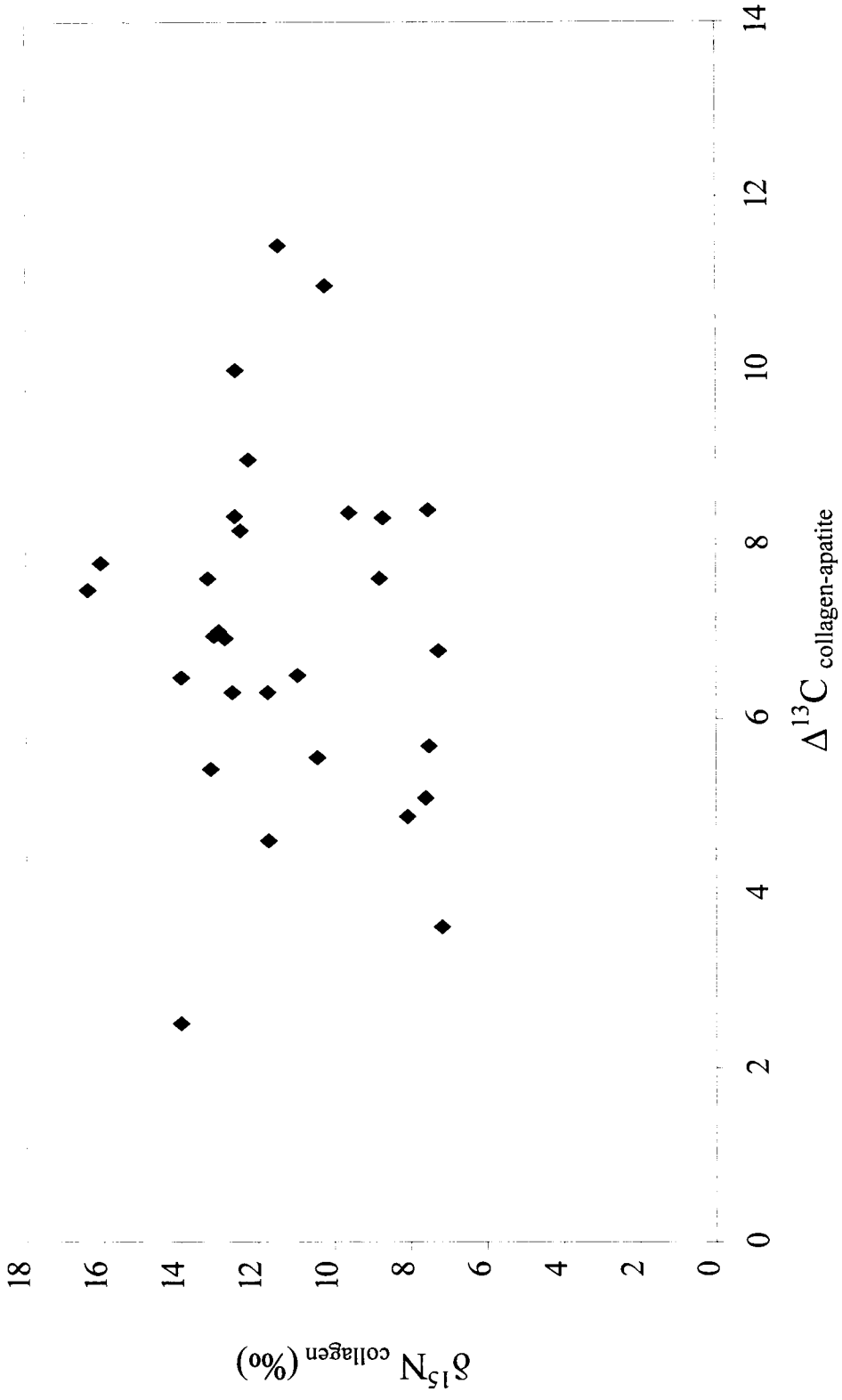


Figure 39: Plot of $\Delta^{13}\text{C}_{\text{collagen-apatite}}$ versus $\delta^{15}\text{N}_{\text{collagen}}$

According to the Ambrose model, derived from his feeding experiments using laboratory rats, mono-isotopic diets lead to $\Delta^{13}\text{C}_{\text{apatite-collagen}}$ of 4.4 ‰. If $\delta^{13}\text{C}$ of dietary protein is more negative than whole diet, one expects large apatite-collagen spacings. If $\delta^{13}\text{C}$ of protein is more positive than whole diet, the prevailing model predicts small apatite-collagen spacings (Ambrose & Norr 1993; Tieszen & Fagre 1993; Ambrose *et al.* 1997; Sealy 1997). This latter situation is what we expect at the Cape, for individuals who ate C_3 derived carbohydrates (eg. rice and wheat) with marine protein. The apatite-collagen spacings for tooth dentine at Cobern Street are 3.6 ‰ to 11.4 ‰, with a range of 7.8 ‰ and a mean of 6.7 ‰ (n=8). The apatite-collagen spacings for cancellous bone are to 5.7 ‰ to 8.9 ‰, a range of 3.2 ‰, and a mean value of 7.4 ‰ (n=13).

As discussed in the previous section, in some individuals dietary change could be seen in the nitrogen and carbon isotope values of bone collagen from different skeletal elements. Can these variations be seen in the apatite $\delta^{13}\text{C}$ measurements of the same tissues, and are there any patterns in the collagen-apatite spacings?

The results for each individual will be discussed below, under the same headings as those used for collagen.

Type B

Individuals with decorated teeth

Burial 20A's rib $\delta^{13}\text{C}_{\text{apatite}}$ value is -4.5 ‰, a signature that suggests a diet which included C_4 based food. The apatite-collagen spacing is large at 8.4 ‰. Assuming a diet-apatite spacing of 9.4 ‰ the $\delta^{13}\text{C}$ value of the whole diet was probably around -13.9 ‰ while that of the protein part of the diet was roughly -17.8 ‰ (if diet-collagen spacing is 5 ‰) (Table 22).

The carbon and nitrogen isotope values for collagen from Burial 20B reflect a considerable change in the protein components in her diet. This change is not because of an increase in marine resources ($\delta^{15}\text{N}$ remained constant at 7.5 ‰ for both tooth dentine and rib), but rather a change in terrestrial protein from a diet that included some C_3

resources to one based very strongly on C₄ plants. $\delta^{13}\text{C}$ collagen values for dentine were -12.2 , for cortical bone -9.2 and for the rib -8.6 ; a shift of 3.6 ‰. The apatite carbon values show a similar pattern of variation. The femur value is -3.8 ‰, while the rib is more enriched at -2.9 ‰. These apatite values indicate a smaller change in whole diet $\delta^{13}\text{C}$ of only 1.1 ‰ compared to the 3.6 ‰ change in dietary protein reflected in the collagen values.

Burial 20 C is a baby who appeared to be associated with 20A and 20B. Few studies on babies have measured apatite and the results are unexpected. The $\delta^{13}\text{C}_{\text{apatite}}$ value is -8.4 ‰ and $\delta^{13}\text{C}_{\text{collagen}}$ of -16.2 ‰. The apatite-collagen spacing is large, at 7.8 , which is unexpected if this individual's diet consisted mainly of protein-rich mother's milk.

Burial 40's diet was relatively consistent during life. The $\delta^{13}\text{C}_{\text{apatite}}$ value for its rib is -3.7 ‰. The apatite-collagen spacing is 6.8 ‰. This child ate C₄ based foods, probably with no marine resources, and maybe some protein from animal products.

Burial 50 began life eating C₄ based food, probably with no seafood. The $\delta^{13}\text{C}_{\text{apatite}}$ value for the premolar is -4.7 ‰. The apatite-collagen spacing is 5.1 ‰, less than the mean apatite-collagen spacing of 7.2 ‰. This smaller apatite-collagen spacing suggests that the protein and non-protein dietary resources were similar. The femur $\delta^{13}\text{C}_{\text{apatite}}$ value is -10.5 ‰, giving an intra-individual difference of 5.8 per mil. This is the largest fluctuation observed in the apatite values so far. This large shift correlates with a more depleted $\delta^{13}\text{C}_{\text{collagen}}$ value for the femur and a more positive $\delta^{15}\text{N}$ value. The apatite-collagen spacing for the femur is 5.4 . The combination of the introduction of C₃ plant-based foods and marine resources has caused a considerable depletion in ^{13}C in the whole diet value. The apatite-collagen spacing of 5.4 ‰ is fractionally larger than the spacing for the tooth. This is somewhat surprising, since C₃-derived carbohydrates and marine protein might be expected to result in small apatite-collagen spacings (Ambrose & Norr 1993; Lee-Thorp *et al.* 1989). The $\delta^{13}\text{C}_{\text{apatite}}$ value for rib is -9.7 ‰; this variation probably shouldn't be interpreted as anything more than normal. The apatite-collagen

spacing has increased to 6.3‰ perhaps the result of eating less protein or more plant food.

For Burial 60, the first molar has a $\delta^{13}\text{C}_{\text{apatite}}$ value of -4.4‰ . Diet during youth was based very strongly on C_4 food. The apatite-collagen spacing of 3.6‰ is the second smallest among the Cobern Street historic skeletons. The energy and protein components have similar carbon isotopic compositions. Cortical bone, in this case humerus, has a $\delta^{13}\text{C}_{\text{apatite}}$ value of -7.5‰ . This depleted value reflects the introduction of C_3 plants, in keeping with the shift in $\delta^{13}\text{C}_{\text{collagen}}$ from 8.0‰ for dentine to -13.8‰ for the humerus. The apatite-collagen spacing of 6.5‰ for the humerus indicates isotopic heterogeneity in adult diet. The $\delta^{13}\text{C}_{\text{apatite}}$ value for the rib is -8.3‰ , more depleted than the other apatite values for this individual and corresponding with the trend in collagen values. $\delta^{13}\text{C}_{\text{collagen}}$ for the rib is -15.3‰ . Once again, the large apatite-collagen spacing for the rib (7‰) does not square well with the apparent C_3 /marine nature of the diet this person ate in later life.

Individual	Body part	$\delta^{13}\text{C}$: (a) collagen (b) apatite	Enrichment	Diet: a)protein b)whole diet	Spacing
20A	rib	a)-12.8 b)-4.5	5 9.4	a) -17.8 b) -13.9	8.3
20B	rib	a)-8.6 b)-2.9	5 9.4	a) -13.6 b) -12.3	5.7
	3 rd molar	a)-12.2 b)-3.7	5 9.4	a) -17.2 b) -13.1	8.5
40	rib	a)-10.5 b)-3.7	5 9.4	a) -15.5 b) -13.1	6.8
50	vertebra	a)-16.0 b)-9.7	5 9.4	a) -21.0 b) -19.1	6.3
	femur	a)-15.9 b)-10.5	5 9.4	a) -20.9 b) -19.9	5.4
	premolar	a)-9.8 b)-4.7	5 9.4	a) -14.8 b) -14.1	5

Individual	Body part	$\delta^{13}\text{C}$: (a) collagen (b) apatite	Enrichment	Diet: a)protein b)whole diet	Spacing
60	rib	a)-15.3	5	a) -20.3	
		b)-8.3	9.4	b) -17.7	6.9
	Humerus	a)-14.0	5	a) -19.0	
		b)-7.5	9.4	b) -16.9	6.5
	1 st molar	a)-8.0	5	a) -13.0	
		b)-4.4	9.4	b) -13.8	3.6

Table 22: Whole diet and protein components calculated for individuals with decorated teeth.

Other Type B burials

The following burials have no distinctive features that differentiate them from the rest of the Type B burials.

The $\delta^{13}\text{C}_{\text{apatite}}$ value for rib of Burial 11 is -9.5‰ . If the diet-apatite spacing is 9.4‰ then the whole diet value was -18.9‰ , whereas the protein component of the diet would have been -21.4‰ ($\delta^{13}\text{C}_{\text{collagen}} = -16.4\text{‰}$; diet-collagen spacing of 5‰). The apatite-collagen spacing is large at 7‰ . The $\delta^{15}\text{N}$ nitrogen value (13.1‰) suggests access to marine resources likely to be rich in protein. This is hard to reconcile with the $\delta^{13}\text{C}$ value derived above for the protein component of the diet.

Four different skeletal elements from Burial 14 have been sampled for apatite measurement. $\delta^{13}\text{C}_{\text{apatite}}$ for tooth dentine is -11.6‰ . This depleted value corresponds with a depleted collagen $\delta^{13}\text{C}$ value (-19.2‰) and $\delta^{15}\text{N}$ of 8.8‰ . The $\delta^{13}\text{C}_{\text{apatite}}$ value for the femur is -9.1‰ , the $\delta^{13}\text{C}_{\text{collagen}}$ value is -14.7‰ and $\delta^{15}\text{N}_{\text{collagen}} = 10.4\text{‰}$. Thus all the isotope values are more enriched in the femur than in the tooth, by approximately 4.2‰ for $\delta^{13}\text{C}_{\text{collagen}}$ and just less than 2.2‰ for $\delta^{15}\text{N}_{\text{collagen}}$. The apatite-collagen spacing has decreased. $\delta^{13}\text{C}_{\text{apatite}}$ values for the vertebra (-9.1‰) and the rib (-8.5‰) become more enriched. The $\delta^{13}\text{C}_{\text{collagen}}$ value for the vertebra is -15.6‰ and for the rib -16.9‰ . $\delta^{15}\text{N}$ for rib is 8.7‰ . The apatite-collagen spacings are slightly smaller for the femur and the vertebra, at 5.6 and 6.5‰ respectively, than those for the tooth and the rib

(7.6 and 8.4 respectively). For this individual, smaller apatite-collagen spacings are associated with more positive $\delta^{13}\text{C}$ values.

For Burial 15, $\delta^{13}\text{C}_{\text{apatite}}$ for rib is -8.4‰ . The whole diet for the period before death would have been -17.8‰ , a C_3 based diet but probably with a component of marine protein that has enriched the signal ($\delta^{15}\text{N} = 12.4\text{‰}$). The apatite-collagen spacing of 8.2‰ is large.

The $\delta^{13}\text{C}_{\text{apatite}}$ value for the incisor of Burial 58 has a value of -7.3‰ . The $\delta^{13}\text{C}_{\text{apatite}}$ value for the femur, a lifetime average signature, is -8.3‰ . The whole diet becomes more depleted by one per mil, a small difference that could be normal variation within the different skeletal elements of this individual. The apatite-collagen spacings, however, are 4.6‰ for the incisor and 6.3‰ for the femur, which probably indicates a change in the isotopic composition of the different components within the diet. The $\delta^{15}\text{N}$ values are the same for both the rib and femur, at 11.7‰ .

For Burial 61, $\delta^{13}\text{C}_{\text{apatite}}$ for the rib is -8.7‰ and the apatite-collagen spacing is 6.5‰ . This is a relatively large spacing considering the $\delta^{15}\text{N}$ value is 14.0‰ , a fairly enriched value.

Individual	Body part	$\delta^{13}\text{C}$ (a)collagen (b) apatite	Enrichment	Diet a) protein b) whole diet	Spacing
59	rib	a)-17.4	5	a) -22.4	
		b)-8.4	9.4	b) -17.8	9
	femur	a)-18.2	5	a) -23.2	
		b)-7.2	9.4	b) -16.6	11
	incisor	a)-17.6	5	a) -22.5	
		b)-12.8	9.4	b) -22.2	4.8
64	rib	a)-16.2	5	a) -21.2	
		b)-7.9	9.4	b) -17.3	8.3
	femur	a)-16.8	5	a) -21.8	
		b)-6.8	9.4	b) -16.2	10
	1 st molar	a)-17.7	5	a) -22.7	
		b)-6.3	9.4	b) -15.7	11.4
65	rib	a)-14.9	5	a) -19.9	
		b)-7.3	9.4	b) -16.7	7.6

Table 23: Whole diet and protein components of diet calculated for individuals buried on their sides (Type C)

Type C

The incisor of Burial 59 has a $\delta^{13}\text{C}_{\text{apatite}}$ value of -12.8‰ , the most depleted apatite value measured. This person's diet during childhood was based mostly on C_3 foods. The protein component of the diet did not come from marine resources because the $\delta^{15}\text{N}_{\text{collagen}}$ value is only 8.1‰ . $\delta^{13}\text{C}_{\text{collagen}}$ is -17.6‰ , not as depleted as expected for a diet based solely on C_3 foods. It has been interpreted as including some C_4 foods. The apatite-collagen spacing is relatively small, 4.8‰ , so that the protein and whole diet $\delta^{13}\text{C}$ values are very similar. The $\delta^{13}\text{C}_{\text{apatite}}$ value for the femur is -7.2‰ , indicating a more enriched value for whole diet. The shift of 5.6‰ in the apatite values between tooth and femur are not mirrored in the collagen values. $\delta^{13}\text{C}_{\text{collagen}}$ for the femur is 0.9

‰ more negative than that for the tooth, a slight shift in the opposite direction to that seen in the apatite. $\delta^{15}\text{N}_{\text{collagen}}$ for the femur is 2.1 ‰ more positive than that for the tooth. This is surprising. If apatite carbon derives from whole diet, and collagen carbon and nitrogen derive from protein, it is hard to understand why a shift towards more enriched values in both $\delta^{13}\text{C}_{\text{apatite}}$ and $\delta^{15}\text{N}_{\text{collagen}}$ between tooth and femur should not be accompanied by a corresponding enrichment in $\delta^{13}\text{C}_{\text{collagen}}$.

If one compares the values for the rib of Burial 59 with those of the femur, the picture becomes even more complicated. $\delta^{15}\text{N}_{\text{collagen}}$ increases from 10.2 to 12.2 ‰ , but $\delta^{13}\text{C}_{\text{apatite}}$ decreases slightly from -7.2 to -8.4 ‰ . $\delta^{13}\text{C}_{\text{collagen}}$ increases slightly from -18.3 to -17.1 ‰ . Thus even within one individual, the patterns of intra-skeletal change seem to vary. The $\delta^{13}\text{C}_{\text{collagen}}$ values for tooth dentine have been interpreted as including C₃ and C₄ foods (see previous discussion). The $\delta^{13}\text{C}_{\text{collagen}}$ values remain relatively constant, which could be due to the introduction of marine food later in life, replacing the C₄ protein component.

The femur of Burial 59 has a large apatite-collagen spacing of 11 ‰ . The largest spacing recorded so far, in the published studies listed in Chapter 5, is 10.6 ‰ (Ambrose *et al.* 1997). Ambrose *et al.* (1997) notes that the largest spacing was the result of depleted collagen $\delta^{13}\text{C}$ (-18.3 ‰) and $\delta^{15}\text{N}$ (8.4 ‰) values in combination with enriched carbonate values (-7.7 ‰). He explains that prehistoric Western Pacific people ate significant amounts of protein from C₃ sources and consumed small amounts of reef or lagoon fish and shellfish. They must, however, have eaten some C₄ carbohydrates; he suggests sugar cane.

Burial 64's first molar $\delta^{13}\text{C}_{\text{apatite}}$ value is -6.3 ‰ which gives a whole diet $\delta^{13}\text{C}$ value of -15.7 ‰ . $\delta^{13}\text{C}_{\text{collagen}}$ is -17.7 ‰ , so the protein component of the diet had a $\delta^{13}\text{C}$ values of about -22.7 ‰ . Burial 64's diet probably included C₃ derived protein, but also an enriched carbohydrate component. The apatite-collagen spacing is the largest (11.4 ‰) recorded so far on human bone. The $\delta^{13}\text{C}_{\text{apatite}}$ femur value is marginally more depleted

at -6.8‰ , the $\delta^{13}\text{C}_{\text{collagen}}$ is about 1‰ more enriched as is the $\delta^{15}\text{N}$ value. The apatite-collagen spacing is smaller (10‰). The $\delta^{13}\text{C}_{\text{apatite}}$ value for the rib is -7.9‰ , more depleted than the earlier values

The $\delta^{13}\text{C}_{\text{apatite}}$ or whole diet became slightly more depleted during life, $\delta^{13}\text{C}_{\text{collagen}}$ and $\delta^{15}\text{N}_{\text{collagen}}$ became more enriched and spacings became smaller.

For Burial 65, $\delta^{13}\text{C}_{\text{apatite}}$ for rib is -7.3‰ , giving a whole diet value of -16.3‰ . From $\delta^{13}\text{C}_{\text{collagen}}$ of -14.9‰ , one can reconstruct $\delta^{13}\text{C}$ of the protein component of the diet to be -21.9‰ . The $\delta^{15}\text{N}_{\text{collagen}}$ for the rib is 13.3‰ . The apatite-collagen spacing is 7.6‰ .

LATER STONE AGE

Type A

For Burial 37A, there is a 1.9‰ difference between $\delta^{13}\text{C}_{\text{apatite}}$ values for the first molar (-9.7‰) and femur (-7.8‰). The femur has a more enriched $\delta^{13}\text{C}$ value, perhaps because of an increase in terrestrial protein, with enriched values. $\delta^{13}\text{C}_{\text{apatite}}$ values reflect whole diet so this enrichment could also be due to the introduction of fats and/or carbohydrates with more positive $\delta^{13}\text{C}$ values. The rib apatite value (-9.9‰) is two per mil more depleted than the femur and is similar to the value for the tooth.

The apatite-collagen spacings for the tooth (7.5‰) and femur (7.0‰) are large in comparison to values reported for previous studies on prehistoric skeletons found in the Western Cape (Lee-Thorp *et al.* 1989; Sealy 1997). Small spacings are said to occur when the $\delta^{13}\text{C}$ values for protein are enriched and the $\delta^{13}\text{C}$ values for fats and carbohydrates are depleted, in other words, when the dietary protein is less negative than whole diet (Ambrose *et al.* 1997). Large spacings are predicted when "...the value of dietary protein is more negative than that of the whole diet...". (Ambrose *et al.* 1997:351).

Sample	Body part	$\delta^{13}\text{C}$ a) collagen b) apatite	Enrichment	Diet: a) Protein b) whole diet	Spacing
37a	Rib	a)-12.4	+5	a)-17.4	
		b)-9.9	+9.4	b)-19.3	2.5
	Femur	a)-14.8	+5	a)-19.8	
		b)-7.8	+9.4	b)-17.2	7.0
37a	Tooth	a)-17.1	+5	a)-22.1	
		b)-9.7	+9.4	b)-19.1	7.4

Table 24: Whole diet and protein components calculated for Type A individuals

The large apatite-collagen spacing for the tooth therefore makes it unlikely that the elevated $\delta^{15}\text{N}$ value for the tooth (16.4 ‰) results from marine foods or from the intake of large quantities of animal protein. The alternative explanation—that it derives from an arid environment— is more consistent with the full set of isotope analyses. Thus it seems that this woman may have grown up in the northern Cape or in another arid part of South Africa, and moved to the Southwestern Cape subsequently.

The apatite-collagen spacing for this woman's rib is very small, at 2.5 ‰. Such small spacings have been reported previously in studies of prehistoric people of the southwestern Cape (Lee-Thorp *et al.* 1989; Sealy 1997). This small spacing suggests that her later diet included C_3 and marine foods, typical in the Western Cape. This spacing of 2.5 ‰ is the smallest in the Cobern Street sample.

CONCLUSION

$\delta^{13}\text{C}_{\text{collagen}}$, $\delta^{15}\text{N}_{\text{collagen}}$ and $\delta^{13}\text{C}_{\text{apatite}}$ have been measured on different skeletal elements from eight individuals in order to monitor possible change in isotopic ratios and hence dietary change. $\delta^{13}\text{C}_{\text{apatite}}$ values usually track the $\delta^{13}\text{C}_{\text{collagen}}$ values: if the $\delta^{13}\text{C}_{\text{collagen}}$ values become more depleted then so do the $\delta^{13}\text{C}_{\text{apatite}}$ values and vice versa. If one of the three ratios remains constant through the different skeletal elements, the $\delta^{13}\text{C}_{\text{apatite}}$

value tends to follow the enrichment or depletion of the variable that is changing. For example, in the case of Burial 20B, the $\delta^{15}\text{N}$ values remain constant at 7.5 ‰. The $\delta^{13}\text{C}_{\text{collagen}}$ become more enriched, as do the apatite values. For Burial 59, $\delta^{13}\text{C}_{\text{collagen}}$ do not show any change. The $\delta^{15}\text{N}$ values become more enriched, as do the apatite values. This pattern is consistent with the suggestion that $\delta^{13}\text{C}_{\text{apatite}}$ values tend to integrate the isotopic composition of the whole diet. The exception to this rule is Burial 14 who appears to have undergone a series of more complicated dietary changes.

From Table 21 it can be seen that there is some correlation between the sizes of the apatite-collagen spacings and $\delta^{13}\text{C}_{\text{collagen}}$ (or indeed, $\delta^{13}\text{C}_{\text{apatite}}$). The smallest spacings tend to occur with the most enriched $\delta^{13}\text{C}$ values. There is, however, no clear relationship between the size of the apatite-collagen spacings and $\delta^{15}\text{N}_{\text{collagen}}$, as reported by Ambrose *et al.* (1997). This may result from the complicated nature of diets eaten by people buried at Cobern Street. Thus there may be more than one dietary mix producing small collagen-apatite spacings.

STRONTIUM ISOTOPE MEASUREMENTS ($^{87}\text{Sr}/^{86}\text{Sr}$)

Strontium isotope measurements were obtained for four individuals, Burials 50, 59, 60 and 64 (Table 25 and Figure 41). In each of the four individuals, three measurements were made: on tooth dentine, femur and rib (Figure 41). This strategy was used for a number of reasons. The comparison of the four tooth results may help us to ascertain whether these people grew up in different areas. Any difference in the $^{87}\text{Sr}/^{86}\text{Sr}$ within each skeleton could represent a change in location during life (Figure 40).

Burial No	Skeletal element	$^{87}\text{Sr}/^{86}\text{Sr}$	Tooth-rib difference
50	Tooth dentine	0.709644	
	Femur	0.710504	
	Rib	0.710584	
			0.00094
59	Tooth dentine	0.710010	
	Femur	0.709105	
	Rib	0.708696	
			0.001314
60	Tooth dentine	0.715177	
	Femur	0.710540	
	Rib	0.710346	
			0.004831
64	Tooth dentine	0.709006	
	Femur	0.709995	
	rib	0.709905	
			0.000899

Table 25: $^{87}\text{Sr}/^{86}\text{Sr}$ results for all skeletons sampled

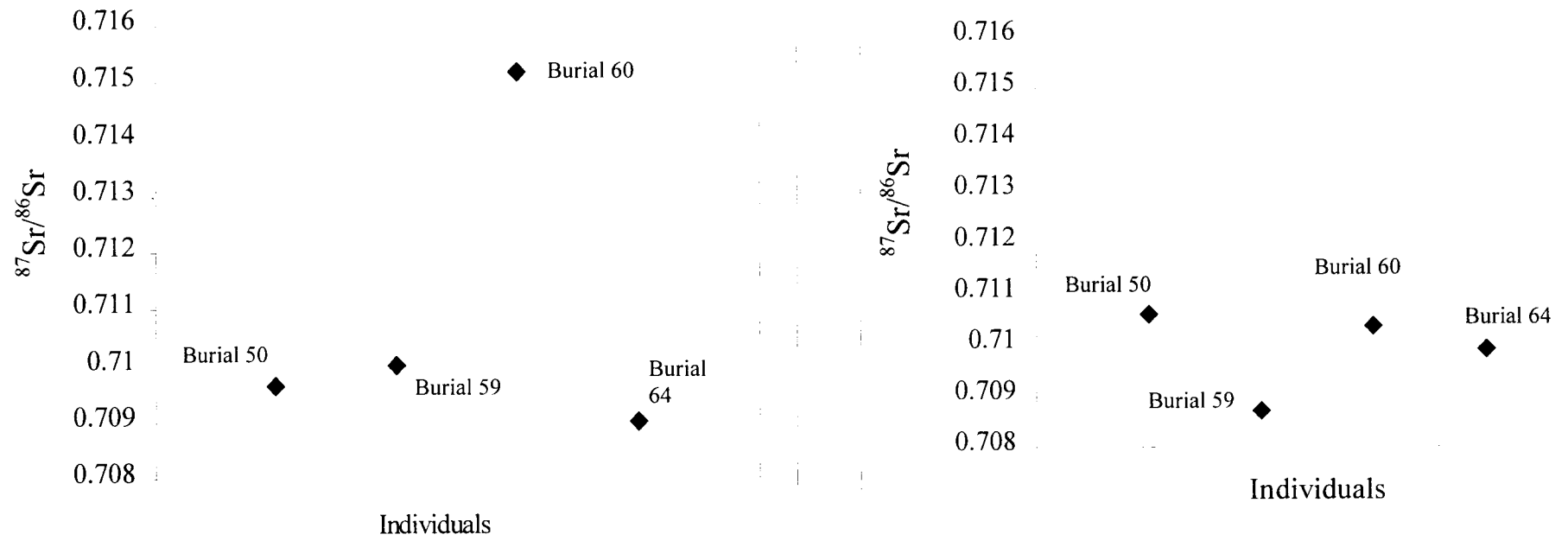


Figure 40: $^{87}\text{Sr}/^{86}\text{Sr}$ results for tooth dentine (left) and cancellous bone (right)

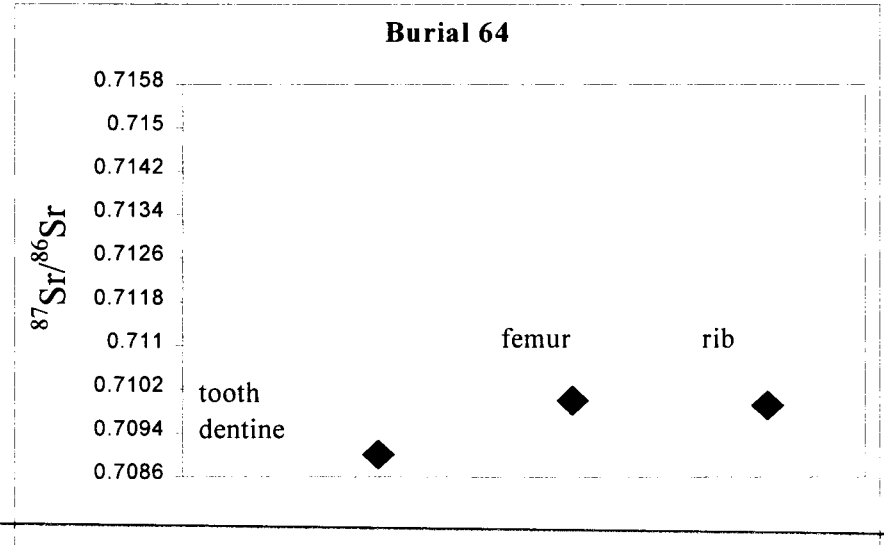
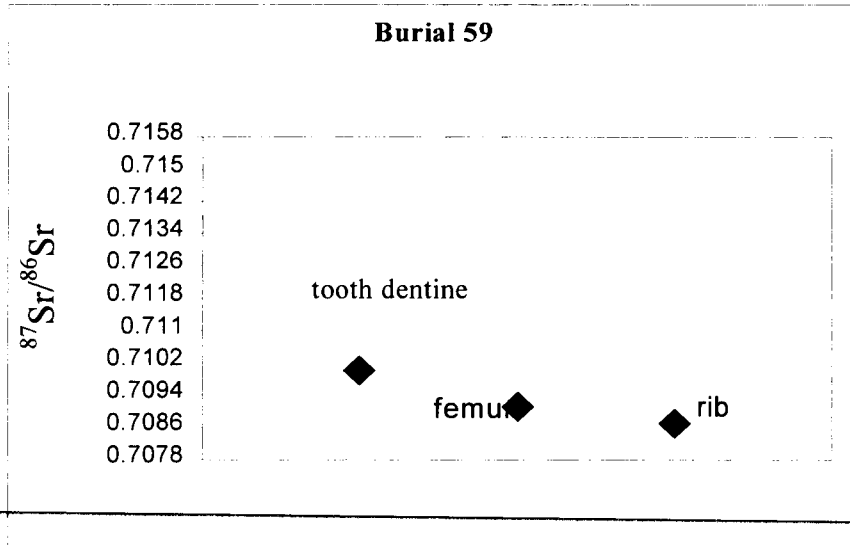
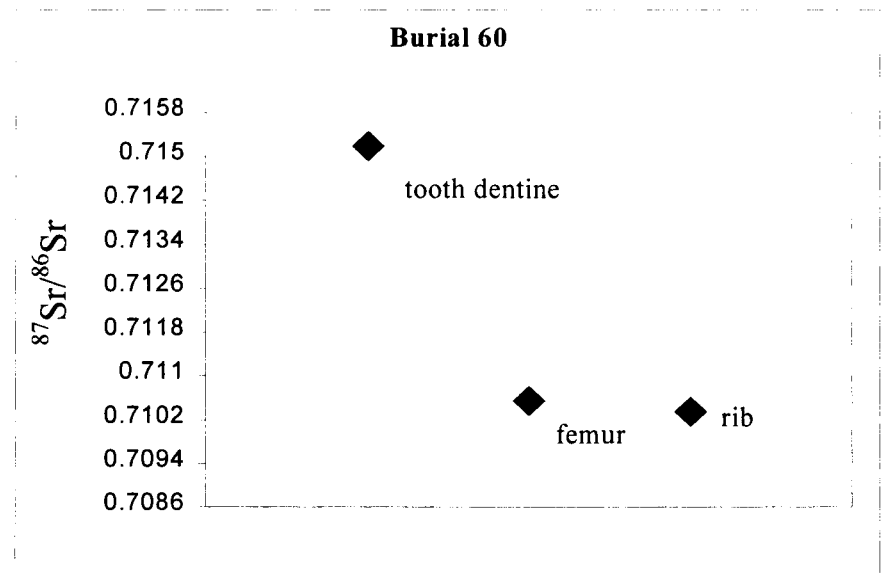
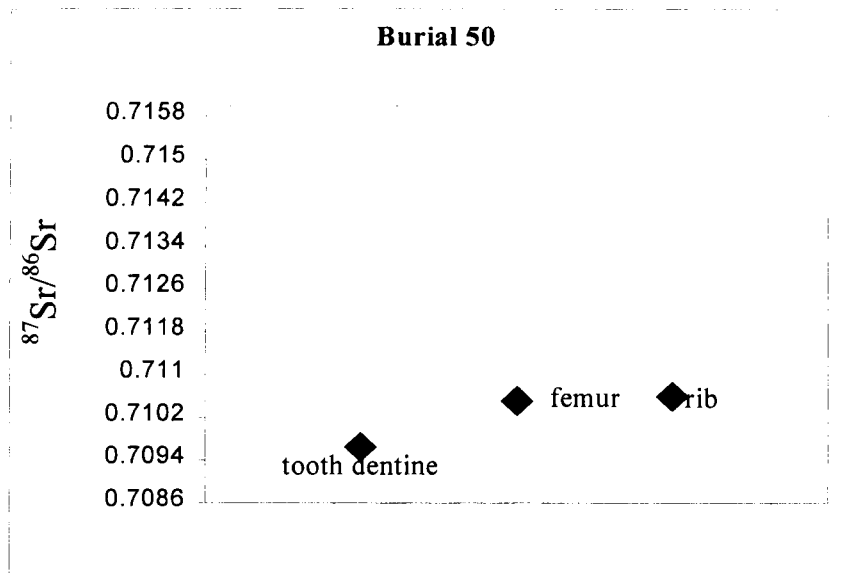


Figure 41: $^{87}\text{Sr}/^{86}\text{Sr}$ results for all four skeletons

$^{87}\text{Sr}/^{86}\text{Sr}$ values for tooth dentine range from 0.709006, which is probably a marine or coastal signature, to 0.715177. The range of 0.00617 is large in geochemical terms and suggests that these people came from different environments. $^{87}\text{Sr}/^{86}\text{Sr}$ values for rib bone range from 0.708696 to 0.710584, a difference of 0.001888. Although all four of these individuals were buried in the same informal burial ground, their strontium isotope signatures are not uniform.

Burial 50 and 60 will be discussed one after the other because both have decorated teeth. Burials 59 and 64 will be discussed together as they were both buried on their sides (Type C).

Burial 50 had decorated teeth (see previous chapters). $^{87}\text{Sr}/^{86}\text{Sr}$ values range from 0.709644 (tooth dentine) to 0.710504 (femur) to 0.710584 (rib). These results show a variation of only 0.00094. Values of 0.709 (or similar) are characteristic of coastal areas where the geological substrate consists of marine sands, as well as of some other rock types. It is therefore possible that this person came from a coastal environment but he may also have come from an inland area with a $^{87}\text{Sr}/^{86}\text{Sr}$ of 0.709. Stable carbon and nitrogen isotope measurements on the teeth do not indicate the consumption of seafood in early life, but the femur has a $\delta^{15}\text{N}$ value of 13.2 ‰ and the rib value is 12.6 ‰. Thus this person probably ate seafood in later life.

Burial 60 also had decorated teeth, a different pattern from #50. The strontium isotope value for tooth dentine is 0.715177, for the femur 0.710540, and the rib has a value of 0.710346. The range of values is 0.004831, a significant variation indicating a change in environment. Values as high as 0.715 occur in old geological formations, so the result for dentine indicates a childhood spent in an area with ancient rock types. It also indicates a terrestrial (non-marine) diet, confirmed by the $\delta^{15}\text{N}$ value for the dentine of only 7.5 ‰. The lower $^{87}\text{Sr}/^{86}\text{Sr}$ value for the femur and the rib could be the result of the introduction of seafoods with $^{87}\text{Sr}/^{86}\text{Sr}$ of 0.709 into the diet. $\delta^{15}\text{N}$ for the femur and rib are 10.9 and 12.8 ‰. Whatever the change that resulted in lowering of $^{87}\text{Sr}/^{86}\text{Sr}$ in the femur and rib,

it occurred many years before death, since it has registered so strongly in the femoral shaft.

The difference in $^{87}\text{Sr}/^{86}\text{Sr}$ between the two tooth dentine values of Burials 50 and 60 is 0.005533. Variation in the third place suggests that they came from different areas. $^{87}\text{Sr}/^{86}\text{Sr}$ for the tooth dentine of Burial 50 is similar to the values obtained for one of the shipwrecked slaves (SAM- AP 4788 discussed in Chapter 5). The shipwrecked slave embarked in Mozambique, and does not have decorated teeth. He or she was only 10-11 years at death, so may have been too young to have undergone the procedure, if it was carried out at puberty. Thus Burial 50 and SAM-AP 4788 may have come from the same region. The tooth dentine of Burial 60 has a value of 0.715177, a value not seen in any of the shipwrecked slaves.

Burial 59 was a side burial (see discussion in Chapters 2 and earlier in this Chapter). The values are as follows; tooth dentine: 0.710010, femur: 0.709105 and rib: 0.708696. The range is 0.001314, a variation that may be significant, although it is not as large as that seen in Burial 60 (see Chapter 5 for discussion on significance). The $\delta^{15}\text{N}$ values become more enriched by 4 per mil during this persons life. The $\delta^{15}\text{N}$ value for the tooth dentine of Burial 59 is 8.1‰, the femur is 10.2 and the rib is 12.2. This person started out eating very little, if any, seafood and increased his consumption later in life. The rib $^{87}\text{Sr}/^{86}\text{Sr}$ value of 0.708696 is lower than any other recorded in the Western Cape, however ratios between 0.708 and 0.710 were measured on loess and marine carbonates (Price *et al.* in press). $^{87}\text{Sr}/^{86}\text{Sr}$ values for the femur and rib are similar, suggesting that this person probably lived in environments with the same $^{87}\text{Sr}/^{86}\text{Sr}$ for most of adult life.

Burial 64 was also a side burial. $^{87}\text{Sr}/^{86}\text{Sr}$ for tooth dentine is 0.70900. The femur has a value of 0.709995 and the rib of 0.709905. The range is 0.000899. There is no significant variation in $^{87}\text{Sr}/^{86}\text{Sr}$ ratios. The values cluster around the marine strontium isotope average of 0.709. Burial 64's tooth dentine $\delta^{15}\text{N}$ value is 11.4‰, so this individual ate some seafood during youth. This value is consistent with $^{87}\text{Sr}/^{86}\text{Sr}$ value of 0.709. The $\delta^{15}\text{N}$ values show no significant variation (femur=12.5‰, rib=12.6‰).

Much like Burial 59, the values for the femur and rib are very similar and suggest a consistent lifestyle during adulthood.

The difference between the tooth values of 59 and 64, who were both buried on their sides, is 0.001004 suggesting that they may have come from different areas.

Where individuals have moved across geological boundaries, from regions with one $^{87}\text{Sr}/^{86}\text{Sr}$ value to another, this shows clearly in their bones. Many moves, however, do not cross boundaries, so strontium isotope measurements alone will not necessarily identify immigrants. Taken in combination with other isotopic indicators, however, $^{87}\text{Sr}/^{86}\text{Sr}$ determinations help to increase our chances of identifying changes of diet and place of residence of people in the past.

RESULTS OF BONE DENSITY FRACTIONATION

Ten of the 53 individuals sampled were chosen for further investigation of dietary changes during life by means of bone density fractionation, and subsequent isotopic analysis of the separate fractions. These skeletons were selected because the stable nitrogen and carbon isotope values of whole bone indicated significant changes in diet during life. It was hoped that these changes could be more closely monitored in the different density fractions. The exception to this criterion was Burial 11, who did not undergo any dietary change, and was included here in order to monitor the normal variation between fractions. The other individuals analysed were Burials 14, 20A, 20B, 21, 32, 49, 50, 52 and 60 (Appendix 2).

Unfortunately most of the bone samples could not be separated according to density, because they have been diagenetically altered. The bone, in many cases, had been almost entirely remodelled by bacterial change. Some intact areas remained. A valuable lesson was learnt and even though it became apparent after the first two samples were processed that these skeletons were not well preserved, the procedure was applied to 20 samples of

bone and the resulting fractions measured isotopically. Bell (1996) observed that histological preservation of skeletons buried in terrestrial graves was not as good as that of skeletons found in marine environments. Bell *et al.* (1999) also noted varying degrees of preservation in historic and prehistoric burials from the south-western Cape. In that study, bone samples from a terrestrial coffin burial (Vergelegen) were separated into fractions successfully. Three of the Cobern Street bone samples could be separated into different density fractions and these results will be discussed in detail below (Appendix 3).

Collagen

The rib cortex of Burial 11 was almost entirely bacterially remodelled, however, there were some intact osteons and a few unaltered trabeculae. It yielded seven density fractions, from less than 1.8 g/cm³ to more than 2.4 g/cm³. There were negligible amounts of bone less dense than 2.0g/cm³. Only 6% of the sample fell into the 2.1-2.2 g/cm³ fraction and 15% had a density of 2.2-2.3 g/cm³. The largest fraction, over 60% of the sample, had a density between 2.3-2.4 g/cm³. Just under 10 % was more dense than 2.4 g/cm³. This was probably bacterially remodelled bone. This density profile was not characteristic of fresh bone (Figure 42). There was a general shift to the higher-density end of the range, and much of the bone in the 2.3-2.4 g/cm³ fraction may have undergone some remodelling. $\delta^{13}\text{C}$ values were measured nonetheless. Sufficient bone was available for collagen to be extracted from five fractions, and measured isotopically. The $\delta^{13}\text{C}$ value for fraction 2.0-2.1 g/cm³ ($\delta^{13}\text{C}_{2.0-2.1}$) was -20.5‰ . The C/N ratio for this fraction fell outside of the accepted range of values for collagen (2.9- 3.6). The other fractions had ratios within this range. The four denser fractions had very similar $\delta^{13}\text{C}$ values, ranged from -17.0 to -18.4‰ , with an average of -17.4‰ . This was very similar to the value of -17‰ , obtained for bone that was powdered, but not density fractionated.

The $\delta^{15}\text{N}$ values for the fractions were on average slightly more positive than the whole bone values. The average $\delta^{15}\text{N}$ value for the four fractions was 13.5‰ . The $\delta^{15}\text{N}$ value for unfractionated powdered rib bone was 12.5‰ .

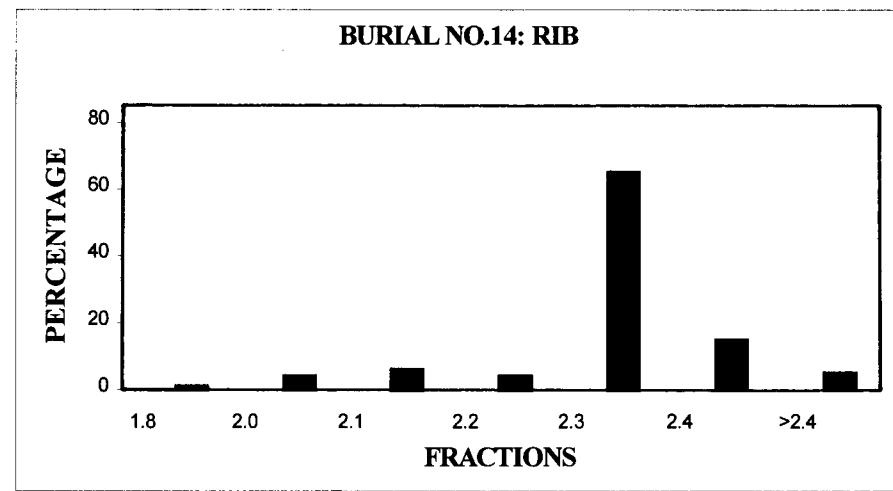
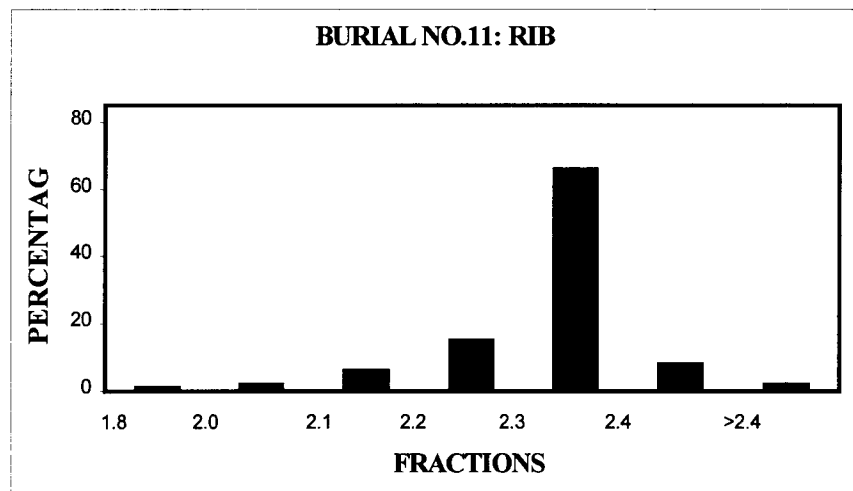
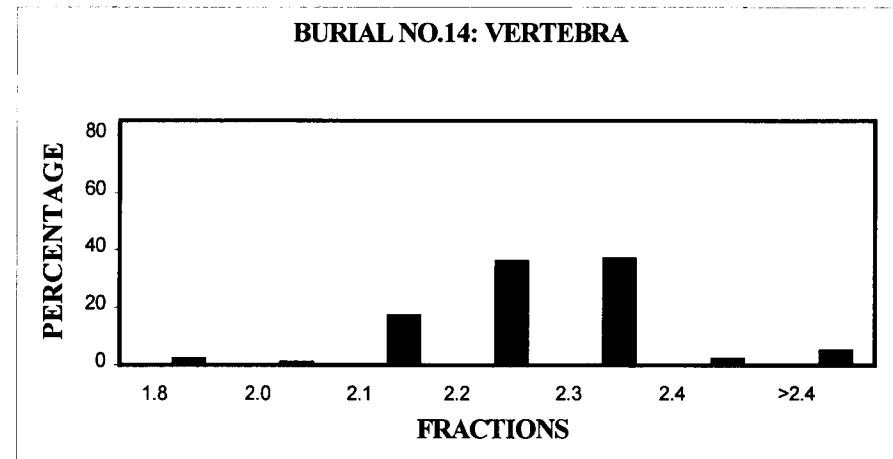
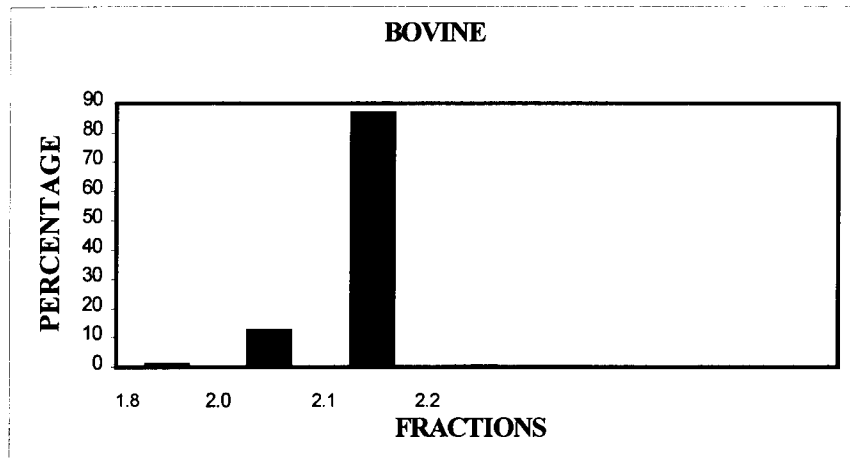


Figure 42: Bone density fractionation profiles

The femur of Burial 11 (the same individual as the rib discussed above) showed significant diagenetic alteration. All the bone was denser than 2.4 g/cm^3 . This material was measured in order to determine whether the isotopic values were affected by the diagenetic alteration. The C/N ratios of the collagen isolated were just outside of the accepted range, at 3.8. The isotopic signatures appear to be unaffected. The $\delta^{13}\text{C}$ value for the fraction more dense than 2.4 g/cm^3 was slightly more depleted (-17.4 ‰) than the whole powdered bone value of -17.1 ‰ . The $\delta^{13}\text{C}$ value for the fraction was more depleted than the value for the chunk (-16.4 ‰), which was the pattern for all the fractions. The $\delta^{15}\text{N}$ value for the material denser than 2.4 g/cm^3 was only 0.6 ‰ different from the whole bone value of 12.6 ‰ . The similarity between the isotopic values for very dense (bacterially remodeled) bone for the femur, and less dense fractions for the rib, may mean that bacterial remodeling does not necessarily result in a change in the isotopic values of the remodeled bone. The relationship between bacterial remodeling and isotope ratios is likely to be complex, and will form a subject for future research.

The rib of Burial 14 appeared to show post mortem microstructural change. Despite this poor histological preservation, fractions were obtained. Very little low-density bone was recovered, and this rib has a density profile similar to that from Burial 11 (Figure 42). Approximately 15% of the powdered bone was recovered from the 2 to 2.3 g/cm^3 brackets, 65% in the 2.3 to 2.4 g/cm^3 range and 15% was denser than 2.4 g/cm^3 . The $\delta^{13}\text{C}$ value for the lightest fraction $\delta^{13}\text{C}_{2.0-2.1}$ was -19.1 ‰ , $\delta^{13}\text{C}_{2.1-2.2}$ was -17.6 ‰ , $\delta^{13}\text{C}_{2.2-2.3}$ was -17.4 ‰ , $\delta^{13}\text{C}_{2.3-2.4}$ was -16.7 and $\delta^{13}\text{C}_{>2.4}$ was -16.9 . The lightest fraction had more negative $\delta^{13}\text{C}$ values than the other fractions (average = -17.1 ‰) and whole powdered bone value of -17.9 ‰ . However the C/N ratio of this lightest fraction was 4.6, which is outside the range of values for collagen. The $\delta^{13}\text{C}$ value is, therefore, suspect. The $\delta^{15}\text{N}_{2.1-2.4}$ average was 10.2 ‰ compared with the whole bone chunk value of 8.7 ‰ . ($\delta^{15}\text{N}$ was not obtained for powdered bone). This difference could be normal variation as the values are less than 2 ‰ different i.e. within the range of normal variation.

The vertebra for this individual was also processed, in order to compare the distribution of fractions for this bone with that of the rib. Unfortunately the histology was not available for this bone. The density profile looked more like that of fresh bone than the samples previously discussed (Figure 42). Density fractionation yielded small amounts of bone between 1.8 to 2.0 g/cm³ and 2.0 to 2.1 g/cm³. Approximately 17% fell into the 2.1 to 2.2 g/cm³, 36% in the 2.2 to 2.3 and almost 40% in the 2.3 to 2.4 g/cm³ bracket. $\delta^{13}\text{C}$ values for these three fractions were similar: $\delta^{13}\text{C}_{2.1-2.2}$ was -15.5‰ , $\delta^{13}\text{C}_{2.2\text{ to }2.3}$ was -15.3‰ and $\delta^{13}\text{C}_{2.3-2.4}$ was -16.2‰ .

The average $\delta^{13}\text{C}$ value for the three fractions was -15.7‰ comparable to the powdered whole bone value of -15.1‰ . $\delta^{15}\text{N}$ values for the three fractions were similar and averaged 10.3‰ , close to the powdered whole bone value of 9.5‰ .

$\delta^{13}\text{C}$ values for given fractions in different bones of the same individual should represent the same period of diet. In previous experimental work on density fractionation (Bell *et al.* 1999) the same density fractions for different bones of the same individual have been compared and the values have been similar. For Burial 14, however, $\delta^{13}\text{C}_{2.2-2.3}$ was -17.2‰ for the rib, but was -15.3‰ for the vertebra, a difference of almost 2‰ . This is a problem. More work will have to be done in this area to explain why this has happened.

Stable carbon and nitrogen values for whole bone ('chunks') for Burial 14 from tooth dentine, femur and rib have been interpreted as follows. During youth she had a diet that included C₃ based food with little or no seafood ($\delta^{13}\text{C}_{\text{dentine}} = -19.2\text{‰}$, $\delta^{15}\text{N}_{\text{dentine}} = 8.8\text{‰}$). Her lifetime average signature was more enriched (femur, $\delta^{13}\text{C} = -14.7\text{‰}$, $\delta^{15}\text{N} = 10.4\text{‰}$) and could be the result of an increase in marine food intake. The $\delta^{13}\text{C}$ value for her rib was -16.9‰ , more negative than that of the femur (-14.7‰). This depletion was possibly the result of an increase in C₃ plants and a decrease in seafood in the later part of her life. The fractions obtained represent the last 15-18 years of this person's life so the depleted values for tooth dentine will not register in the fractions. However, the lighter fractions should have more negative $\delta^{13}\text{C}$ values than the heavier fractions. This

may be the case, if the value for the lightest (2.0-2.1g/cm³) fraction is reliable, at -19.1 ‰.

The rib of Burial 20A showed profound bacterial remodeling with one central area intact. Most of the rib bone (96%) of Burial 20A was denser than 2.4g/cm³, however some bone was collected in the 2.4 fraction (4%). Unfortunately the C/N ratios for the 'collagen' isolated from these two fractions were out of range at 4, for the material really to be collagen.

The histological preservation of the femur for Burial 20A was similar to that of the rib, with very little intact bone. Approximately 2% of the powdered bone fell in the 2.3-2.4g/cm³ bracket, with 97% in the greater than 2.4 g/cm³ fraction. The C/N ratio for the 2.3-2.4 fraction was 3.4. The $\delta^{13}\text{C}$ value for this fraction was -15.8 ‰ and $\delta^{15}\text{N}$ was 8.7 ‰. The $\delta^{13}\text{C}$ value for whole powdered femur was -15.5 ‰ and the $\delta^{15}\text{N}$ value was 8.4 ‰. Surprisingly, since this material is bacterially altered, the C/N ratio for the greater than 2.4 g/cm³ fraction fell within the acceptable range (3.5). The $\delta^{13}\text{C}$ value for this fraction was -15.3 ‰ and $\delta^{15}\text{N}$ was 8.8 ‰.

Histological analysis was not available for the rib of 20B, however this bone did not separate into fractions. All the bone was denser than 2.4 g/cm³. Collagen extracted from this fraction has a C/N ratio of 3.6. The $\delta^{13}\text{C}$ was -12.0 ‰ and $\delta^{15}\text{N}$ was 7.3 ‰ very similar to values for whole powdered bone ($\delta^{13}\text{C} = -11.6$ and $\delta^{15}\text{N} = 6.7$). The values for the whole powdered bone are depleted in comparison to the value for the chunk of bone, as usual. The $\delta^{15}\text{N}$ value for whole powdered rib is 6.7 ‰ which is similar to the chunk value (7.5 ‰) and the fraction value (7.1 ‰). Burial 20B was a young girl aged 16 at death. The isotopic results have to be interpreted carefully because of her fast turnover of bone. The $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values for chunks of bone suggest she ate a diet that included C₄ based foods at her place of birth, but before she died (value for first premolar) she consumed more C₃ foods. She ate very little, if any, marine food. The tibia of this individual was entirely remodelled by bacteria with no obvious surviving bone.

The rib of Burial 21 was not analysed histologically; however its poor condition is obvious considering that all the powdered bone was denser than 2.4 g/cm^3 . The C/N ratio of the heavy fraction was unacceptable, at 3.9. However the isotope results pattern in a similar way to the results for powdered whole bone. The powdered whole bone values for the rib were $\delta^{13}\text{C} = -17.6 \text{ ‰}$; $\delta^{15}\text{N} = 12.4 \text{ ‰}$. The $\delta^{13}\text{C}_{>2.4}$ was -17.8 ‰ and $\delta^{15}\text{N}_{>2.4}$ was 13 ‰ . The cortex of the femur of Burial 21 was entirely remodelled by bacteria. The powdered whole bone $\delta^{13}\text{C}$ value was -16.5 ‰ and $\delta^{13}\text{C}_{>2.4}$ was -16.3 ‰ . Burial 21 was born outside the Cape, and she ate C_4 based foods during childhood. Later in life her C_3 plant intake increased sufficiently to manifest itself in her dietary signatures.

The rib of Burial 32 showed classic bacterial remodelling. Despite the fact that there did not appear to be any intact bone some bone in the $2.3\text{-}2.4 \text{ g/cm}^3$ was collected (6%). Collagen extracted from this fraction and the >2.4 fraction have acceptable C/N ratios. The isotope values for the powdered whole rib were $\delta^{13}\text{C} = -16.6 \text{ ‰}$ and $\delta^{15}\text{N} = 13.3 \text{ ‰}$. These values for the $2.3\text{-}2.4$ fraction were almost identical, at $\delta^{13}\text{C} = -16.9 \text{ ‰}$ and $\delta^{15}\text{N} = 13.2 \text{ ‰}$. The femur also showed bacterial change, however some areas of bone remained intact. All the bone was denser than 2.4 g/cm^3 . $\delta^{13}\text{C}_{>2.4}$ was -17.1 ‰ and $\delta^{15}\text{N}_{>2.4}$ was 12.0 ‰ . Burial 32 started out life eating mostly C_3 based foods and some seafood (from the tooth dentine values). The $\delta^{13}\text{C}$ values become more enriched in later life, possibly because of the addition of marine foods.

The femur of Burial 49 appeared on histological examination to have some intact bone, but it was all denser than 2.4 g/cm^3 . The collagen has a C/N ratio of 3.6. The $\delta^{13}\text{C}_{>2.4}$ was -16.7 ‰ , almost the same as the value for the whole powdered femoral bone (-16.0 ‰). The $\delta^{15}\text{N}_{>2.4}$ was 13.4 ‰ which is more enriched than the whole powdered bone at 11.5 ‰ .

The vertebra of Burial 50 showed profound alteration of the entire cortex, with only a few intact osteonal lamellae. The femur of Burial 50 has also been bacterially remodelled, but the mid cortical region was less affected, so that some intact bone was visible. A little

(2%) 2.3-2.4 g/cm³ fraction was obtained for the vertebra; however the C/N ratio of the collagen was 4.7. The $\delta^{13}\text{C}_{2.4}$ was -17.2 ‰ more negative than the whole powdered $\delta^{13}\text{C}$ value -16.8 ‰ but the range was within normal variation. The $\delta^{15}\text{N}$ values also resemble each other. $\delta^{15}\text{N}_{2.3-2.4}$ was 13.6 ‰ and $\delta^{15}\text{N}$ value for whole bone was 12.6 ‰.

The rib from Burial 52 appeared to have good microstructure, but no fractions were obtained. The >2.4 fractions for both skeletal elements were prepared for isotopic analysis but the collagen obtained was of a poor quality (C/N= 4.9) and the results are not worth discussing further.

Histological analysis of the rib of Burial 60 was not available. All the bone for this element was denser than 2.4 g/cm³. The C/N ratios for 'collagen' extracted from this material are out of range. The $\delta^{13}\text{C}$ value for whole powdered rib bone was -16.6 ‰ and $\delta^{13}\text{C}_{>2.4}$ was -17.6 ‰. The corresponding $\delta^{15}\text{N}$ values were 12.0 ‰ and 13.5 ‰ within the bounds of normal variation.

The cortex of the humerus had been affected by a dispersed bacterial attack so that some areas of bone was still intact. A small amount (2%) of the fractionated bone fell in the 2.3-2.4 g/cm³ bracket. The $\delta^{13}\text{C}$ value for the whole powdered humerus is -15.6 ‰. The $\delta^{13}\text{C}_{2.3-2.4}$ was -16.2 ‰ and $\delta^{13}\text{C}_{>2.4}$ was -18.8 ‰. This is more than 2 ‰ difference, but the reason for it is unclear. The $\delta^{15}\text{N}$ values for whole bone of the humerus were odd. The chunk of whole bone had a $\delta^{15}\text{N}$ value of 10.9 ‰ but the powdered bone has a $\delta^{15}\text{N}$ value of 7.8 ‰; a depleted value not unlike the value for dentine. The $\delta^{15}\text{N}_{2.3-2.4}$ was 10.3 ‰ and $\delta^{15}\text{N}_{>2.4}$ is 11.1 ‰. The $\delta^{15}\text{N}$ value for whole bone becomes more enriched during this person's life and this enrichment is mirrored in the $\delta^{15}\text{N}$ values for the fractions.

Burial 60, a 30-year-old woman had tooth decoration. She was probably brought to the Cape as a slave.

Apatite

Three density fractions from Burial 14 were prepared for analysis $\delta^{13}\text{C}$ in apatite. The $\delta^{13}\text{C}$ values mirror the values for apatite on whole bone. $\delta^{13}\text{C}_{\text{apatite}}$ value for whole powdered rib bone was -8.5‰ and $\delta^{13}\text{C}_{2.3-2.4}$ was -8.2‰ . $\delta^{13}\text{C}$ value for whole powdered femoral bone was -9.1‰ and $\delta^{13}\text{C}_{>2.4}$ was -8.6‰ . $\delta^{13}\text{C}_{\text{apatite}}$ for whole vertebra was -8.2‰ and the $\delta^{13}\text{C}_{2.3-2.4}$ was -7.9‰ . The difference between powder and fraction values for the rib is 0.3‰ , for the femur is 0.5‰ and for the vertebra is 0.3‰ .

In this project and the previous pilot study using the density fractionation technique, shifts in carbon values have been observed mirroring patterns in whole bone values.

These samples were processed regardless of the poor preservation apparent from the histological analysis. In some cases some bone was recovered despite considerable bacterial change. Where intact bone was visible some quality collagen was obtained with C/N ratios within the range. It has also been observed that although a rib from an individual may separate into fractions, the femur will not necessarily do likewise. Burials within the same ground may preserve differently. Burials 11 and 14 were buried closer to the surface than the other burials processed here, which may have influenced their state of preservation (Apollonio 1998).

This is a very new method and this exploratory study involved learning along the way. The Cobern Street set of samples has proved to be a difficult one for bone density fractionation, but some promising results were obtained. As a result of this work, we understand better the importance of good microstructural preservation in selecting samples for density fractionation. This study has also highlighted the interesting question of the apparent preservation of meaningful isotopic signals, even in bacterially remodeled bone.

CHAPTER 9

DISCUSSION

The people of eighteenth century Cape Town came from Europe, West and East Africa, Madagascar, southeast Asia and Indonesia. The Europeans had almost exclusive rights over burial in consecrated ground and only in 1804 was religious freedom granted at the Cape and all denominations were, gradually, allocated ground to bury their dead. During the eighteenth century those who did not have access to the walled burial grounds of Cape Town were buried in the area around Somerset Road. The poor Company employees-soldiers and sailors, free blacks and slaves did not have the financial means to buy burial plots. Even if they could afford the fee, it seems non-Europeans were discriminated against and could not be buried in the Dutch Reformed Cemetery. Thus unofficial burial grounds such as that in Cobern Street came into being.

Four different burial types have been identified at Cobern Street. These include Later Stone Age burials (Type A), individuals buried extended on their backs (Type B), on their sides (Type C) and bone scatters (Type D). Many of the burials were disturbed where older burials had been moved to make room for more recent interments. There does not appear to have been any control over how bodies were buried and this confirms the informal nature of this burial ground. If no burial fee was paid, there was no maintenance. Historical accounts refer to the burial grounds for slaves and free blacks as being untidy and unkempt.

The teeth of seven of the Cobern Street individuals have dental decorations, which have provided information on their possible origins. Four patterns of decoration have been classified and the groups in Africa who perform this custom have been identified. These people were probably brought to the Cape as slaves.

79.5% of the Type B burials were in coffins and 56% of all burials show some evidence of being interred in coffins. Coffin style was not always recorded in the field notes because many of the burials were badly disturbed. Seven coffins were well described because they had special features such as legs, handles, painted surfaces and one had iron brackets. Even though Cobern Street was an informal burial ground, coffin burial seems to have been standard practice.

A number of burials included artefacts: buttons, evidence of burial in a shroud, and personal items. These items provide valuable clues about the lives of these people. Some of these grave goods will be discussed below in conjunction with the information obtained from the isotopic analyses to reconstruct the life histories of some of the people buried at Cobern Street.

In this thesis, five archaeometric techniques of dietary tracing have been applied to the Cobern Street skeletons. Two of these methods (stable carbon and nitrogen isotope analyses of bone collagen) are well-established techniques. The third ($^{13}\text{C}/^{12}\text{C}$ measurements on bone apatite) has been the subject of much debate and the results presented here question some of the prevailing models on how to interpret these numbers. The fourth technique (strontium isotope measurements) has been used with caution in conjunction with the other techniques to provide additional information about the origins of these people. The fifth technique (bone density fractionation) is new and although there were problems with bone preservation at this particular site it shows potential. This is the largest range of isotopic approaches applied, to date, to any single set of skeletons.

The isotopic profiles answered the questions set out at the beginning of this thesis:

- 1) *What is the range of variation in diet among individuals buried at Cobern Street?*
There is considerable variation in diets eaten in early life, as recorded in the isotopic composition of teeth. This variation encompasses diets that included, almost exclusively C_4 based foods with no marine intake and diets with C_4 and marine food. C_4 plants grow in tropical environments. These individuals probably came to the

Cape from further north in Africa (see Chapter 3). Other individuals had diets based solely on C₃ based food with varying amounts of marine consumption. These individuals probably originated in temperate areas, for instance: Europe or the East. A few individuals ate C₃ and some C₄ plants and no marine food, and for dietary and other reasons are likely to be of Asiatic origin. There is less variation in diets eaten later in life, as recorded in the isotopic composition of the ribs. In general these diets included C₃ plants (rice, wheat) and some marine foods. This picture is consistent with information in historical documents about the foods eaten by poorer Capetonians in the eighteenth century.

2) *Is there a correlation between diet and burial style?*

Type A burials included four Later Stone Age individuals. If it were not for the burial style, this group would not have been differentiated from the rest of the skeletons from Cobern Street. Isotopic results for these four prehistoric individuals are within the range reported previously for LSA skeletons with the exception of 37A, who may have grown up in a more arid area than Cape Town. She may have come from the Northern Cape.

There is a large range of isotopic variation within the Type B group, indicating that this is a heterogeneous group. This emphasises a point made in earlier work on this site, that burial style does not necessarily indicate cultural affinity. The individuals with decorated teeth have been classified as Type B burials. They ate diets in early life based on C₄ foods. They all changed their diets to a greater or lesser extent during life with the exception of Burial 40, who was only 12 years at death, who only ate C₄ foods (page 152). Ten other individuals underwent a change of diet during their lives. Two had childhood diets like those individuals with decorated teeth and also grew up in a tropical environment. Six others had isotopic ratios for teeth that indicate the consumption of C₃ based foods in early life (pages 156, 161). Twenty-six individuals in the Type B group show no change during life in their isotopic ratios. These individuals probably lived in Cape Town all their lives (page 161). They ate C₃ based foods and some marine food. Initially it was thought that seafood formed a

very important part of their diets, however the analyses of apatite and the relationships between the carbon component of collagen and apatite appear to reveal more reliance on rice or wheat with only a little seafood.

Isotopic measurements of the five Type C burials indicate that they all came from temperate regions where they ate mostly C₃ based foods. Four also ate some marine food and two ate C₃ and C₄ foods (page 163). The burial style is Muslim and the isotope ratios suggest that these people came from one of the countries around the Indian Ocean.

3) *Did some of these individuals come to the Cape from elsewhere (i.e. were they immigrants, voluntary or otherwise)?*

Analyses of the results from the teeth, discussed in the answer to question 1, have highlighted the heterogeneity of this group. Isotopic values for the teeth of Burial 37A are very unusual in the context of Later Stone Age skeletons from the southwestern Cape, and she probably moved to the Cape from elsewhere. Some of the historic Cobern Street individuals came from tropical regions, probably East or West Africa. The $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of bone collagen from six individuals with dental decorations suggested heterogeneity within this group. These differences were also apparent in the bone apatite results for five individuals and $^{87}\text{Sr}/^{86}\text{Sr}$ on two individuals. All the individuals with decorated teeth were immigrants and all came from tropical areas. This probably means that tooth decoration was not practised among the slave community at the Cape, although it was an important part of the cultures from which many slaves came.

The isotopic results indicated that there might have been immigrants from Europe, or other temperate areas who were buried at Cobern Street. Their $\delta^{13}\text{C}$ for collagen and apatite are depleted and can be clearly differentiated from the enriched values for the individuals who come from tropical areas. The isotopic ratios for cortical bone and ribs for some individuals show considerable change, interpreted here as lifestyle change. In others there is no isotopically visible change which could mean that these people were life-long residents at the Cape.

4) *To compare the isotopic profiles of the Cobern Street skeletons with those of the Fort Knokke skeletons and the Vergelegen skeleton, thus expanding our database of isotopic results for historical skeletons from the Cape, especially skeletons likely to be the remains of slaves.*

The isotopic ratios of the individuals with decorated teeth have been compared to a previous study of shipwrecked slaves where dental decorations were present. All of these individuals had diets that included C₄ based foods during childhood. The shipwrecked slaves came from Mozambique. Some of the decorative patterns on the teeth of the Cobern Street skeletons are similar and they could also have come from the Makua, Yao and Maravi, the main groups exploited in Mozambique during the slave trade. The Vergelegen slave also had a diet based on tropical C₄ based foods. Strontium isotopes indicate that the Vergelegen slave came from a different area to the Cobern Street and shipwrecked slaves.

Some of the Cobern Street individuals came from temperate regions where C₃ plants were grown. Their isotopic signatures were compared to other individuals analysed at the Cape. The Oudepos skeleton, that from Fort and the coffin burials on Woodstock beach all had similar values during youth and they have been interpreted as being of European origin. A few of the individuals at Cobern Street have similar signatures, and may have come from Europe.

Future research

This project has highlighted various areas for future research. $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ in bone collagen have proved valuable in identifying people with different diets, who are likely to have come from different areas. These results are, on the whole unproblematic. $\delta^{13}\text{C}$ values for bone apatite, however, have proved difficult to interpret. This probably results, in part, from the wide range of diets eaten by people buried at Cobern Street, and the complexity introduced by the dietary changes many of them underwent during life. It is also possible that the apatite and collagen results from the Cobern Street skeletons may relate to one another in previously unrecognised ways, so that more detailed study may

increase our understanding of these dietary tracers. $^{87}\text{Sr}/^{86}\text{Sr}$ analyses of additional skeletons, especially of teeth, could help us to map the diverse origins of the foreign-born individuals buried at Cobern Street. Finally, this material has proved less than ideal for the bone density fractionation technique, but the approach certainly has potential for other archaeological studies of changing diets, especially at sites where only incomplete or co-mingled skeletons are available.

LIFE HISTORIES OF SELECTED INDIVIDUALS

The overall emphasis of this project was to find out as much about the underclass of Cape Town as possible. Of particular interest here are slave lifeways, because so little is known about this group and there are very few examples of excavations where grave goods have been found in association with slaves. The positive identification of at least six of these individuals as slaves or former slaves has been possible using the combination of evidence from the tooth decorations and the dietary reconstructions. Three others may also have been slaves; one had tooth decoration but was not sampled for isotopic analysis and 2 had isotopic signals expected for tropical environments. We know that these people arrived at the Cape as slaves. We do not know whether they were still slaves when they died, but before we enter this debate let us consider the evidence that has been accumulated during the course of this thesis. Dietary reconstructions for all these individuals have been discussed in detail in Chapter 8 (see Appendix 1). In discussion below the information from some of these reconstructions will be combined with that gleaned from the associated grave goods or, in some cases, the absence of grave goods. The integration of biological histories (dietary life histories) and cultural characteristics (artefacts) will hopefully reveal individual life histories of members of the underclass of early Cape Town.

Type A

The burial of 37A was associated with a Khoikhoi pot, and it is therefore assumed that this woman followed a pastoralist way of life. She was buried approximately 1200 years ago, 850 years before the Dutch set up a refreshment station in Table Bay. The isotopic signatures for her tooth are considerably different from those later in life. These have

been interpreted as being the result of moving from a dry environment where C₃ resources were available to the Western Cape where she relied to a greater extent on marine resources.

Type B: Individuals with decorated teeth

Three of these individuals were buried in coffins with unusual stylistic features. The coffin of Burial 50 was painted white on the outside. The tooth decoration on this middle-aged male was unique; it has not been recorded at any other site and has not been described in the ethnographic literature. Chips have been removed from the lateral or distal surfaces of the maxillary central incisors (unlike other skeletons at the Cape, where the chips are mesial). It is not like the patterns witnessed in Mozambique and this person may have come from another region; further north along the East Coast or maybe Angola where C₄ plants were eaten. Diets of West Africans may have included some C₃ plants such as bananas or yams and the childhood signatures of this person do not reflect any C₃ contribution to the diet. The apatite values highlighted the very distinct change in diet reflected in the $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ results. It was hoped that the strontium isotopes would reveal a distinctive home geology that could be differentiated from that of the other individuals in this and other studies. This was not the case. Bone density fractionation for this individual was unsuccessful.

Burial 49 was male and lived to between 30-35 years. He was buried in a coffin with a number of grave goods, a tinderbox, striker, flint, corroded fabric and clay pipe. He had sharpened maxillary incisors and bilateral pipe-wear. He began life eating tropical grains with no seafood but spent at least 10-15 years during his later life eating C₃ plants with some seafood.

The coffin of Burial 52 had green staining over large areas of the wood, implying either that there was copper staining, or that the coffin had been painted green on the inside. This woman was 25-35 years old at death. She was buried with an iron penknife, a pipe bowl that dates from 1725-1847, a gray flint and various metal and other buttons, many

of them military or livery buttons. She had sharpened maxillary incisors: a pattern recorded frequently in the literature, and shared by various groups in Africa.

Her dietary life history is particularly interesting. She began life eating C₄ based foods, so she lived in a tropical environment. The isotopic ratios for her femur, which represents a lifetime average, shows that she later increased her seafood intake significantly but her plant food intake remained C₄. Perhaps she moved from an inland to a coastal location. Before death she was eating less seafood, if any, and continued eating C₄ foods.

It seems that she did not live at the Cape for long enough to change her isotopic signatures as a result of the introduction of wheat and rice. (It was hoped that bone density fractionation would reveal more information on her diet shortly before death, but the bone of this individual was badly preserved and it did not separate into fractions.) Her fancy coffin is unusual, however the staining is interpreted. The large quantity of grave goods suggests a certain amount of stature and/or respect from her peers or the officials who may have buried her.

Burials 49 and 52 both had striking implements with them. These would have been used for smoking pipes and lighting fires for cooking. Fire making and wood collecting often formed part of a slave's day to day tasks and they would have had to keep these implements handy. In contemporary accounts we read that many colonists were afraid of the damage that slaves could do with these basic artefacts. Slaves had the power to start fires and there are cases during the eighteenth century of this occurring as a sign of resistance.

The coffin of Burial 60 had large quantities of iron on it, in L-shaped brackets. She had sharpened maxillary incisors and was about 30 years of age at death. Her diet changed dramatically from one based on terrestrial C₄ plants to one that included C₃ based foods and some marine resources later in life. Apatite results confirmed this strong reliance on C₄ plants during youth. The apatite-collagen spacing was small, probably because the

energy and protein foods had similar carbon isotopic composition. Later in life the spacing increased reflecting the isotopic heterogeneity of diet in adulthood. Strontium isotopes clearly reflect a move from one environment to another. Few fractions were recovered from bone density fractionation and unfortunately it was not possible to witness these changes in diet in the different fractions.

Burial 20 contained two adults and a child. There was evidence of a coffin, but no grave goods. Both 20A and 20B had their maxillary incisors chipped to form an inverted 'V' shape. Burial 20A, a male, was 25-30 years at death. Isotopic analysis showed that he grew up in a tropical environment. His diet also included some C₃ plants, probably introduced after his enslavement. Burial 20B only lived for 16 years. She ate C₄ based foods. Like 20A, she was probably born in a tropical region. However she did not eat as much C₃ food as 20B. These two individuals have different dietary life histories despite being buried in the same burial shaft. They may have died shortly after arriving in Cape Town or even on board the vessel in which they were travelling. The child, approximately 1 ½ - 2 years old, appeared to be associated with Burial 20A. Despite detailed analysis it is not clear whether they were related (mother and child), or whether this baby was born in Cape Town and happened to be buried in this grave.

Burial 40 had no coffin and no grave goods. This individual was only 12 years old at death. His signatures remained C₄ derived throughout his brief life. There is no isotopically detectable change, despite the fact that at this young age bone turns over rapidly. Food on board slave ships was often C₃ based, however there are instances of C₄ foods being supplied (see Chapter 3 and Chapter 8)

It seems relatively certain that the latter three individuals were still in bondage at death, since they seem not to have lived at the Cape for long enough to have been manumitted. Burials 50 and 60 may still have been in bondage but had access to some form of income that enabled them to purchase special coffins. The same could be true of Burials 49 and 52 but the possibility exists that they could have been "free blacks" who were earning money and who requested family, friends or peers to bury them with an assortment of

items. We also know, however, that there were very few African free blacks living in Cape Town at the end of the eighteenth century (2.5% of 240).

Type B: Individuals without decorated teeth

Burial 21 was a female of about 25-35 years at death. She was buried with two red snapped cane glass beads with grey and black stripes. She began life in a tropical coastal region and during her life she increased her intake of C₃ foods. She may have been brought to the Cape as a slave, in fact she may still have been one at death.

Burial 54 was buried with pipe stem and a bone knife handle. He began life in a temperate environment, eating C₃ foods and maybe a little seafood. Burial 61 was buried with a silver needle case and a snuffbox, with "MHK 1764" engraved on it. She was a young woman, about 20 years old at death. Her isotopic ratios remain fairly constant during life, within the bounds of normal variation. She ate more seafood than the average for people who seem to have lived in Cape Town all their lives. Perhaps her family was part of the fishing community. Free blacks carried out a number of activities similar to those of the poorer free burghers. The majority of free blacks were said to have been fishermen. (In 1820 there were 92 Dutch or German and 65 free black fishermen). It is not clear whether the initials on the snuffbox were those of the deceased or whether it was acquired as a gift or by other means. Certainly this person was buried after 1764.

CONCLUSION

The techniques of analysis outlined in this project have expanded our knowledge of the underclass of eighteenth century Cape Town. The search for slave sites and reconstructing slave lifeways has been an explicit goal of historical archaeologists at the University of Cape Town for more than a decade. Excavations at Vergelegen and at the Castle have identified slave dwellings or possible dwellings, but disappointingly few artefacts were recovered. As far as we have been able to tell, other archaeological traces of slavery seem mostly to have been obliterated by urban development in Cape Town, and rebuilding of rural farmsteads. Thus material evidence of Cape slave culture has been virtually non-existent and sites representing slave lifeways absent from the

archaeological record. In addition the lack of documentary evidence has created the impression that slaves at the Cape had no culture. These slaves originating from widely disparate regions of the VOC world remained locked in servitude, culturally dislocated from their countries of origin. The effects of this cultural dislocation can be seen in the presence of tooth decoration only in individuals who were foreign-born. The practice was not continued at the Cape. The work presented here suggests that whether foreign or local born, free or unfree, the underclass were united in death by a number of practices:

-Burial in a common burial ground

-The freedom to retain exotic burial practices such as Islam and

-The freedom to declare an identity in associated grave goods, with a mixture of items that emanate from both the land of their oppression (clay pipes, flints, clothes) and possibly that of their origin (beads).

These cultural aspects represent the material expression of an identity assumed by foreigners in eighteenth century Cape Town. These individuals buried at Cobern Street with their associated grave goods represent the first clearly documented expression of "Slave culture at the Cape".

The poor and those in bondage buried their dead in the open wastes behind the new Waterfront towards Green Point. The picture created by the literature of a mass burial ground where slaves were buried and old horses shot and left to rot brings home the unsanitary conditions of eighteenth century Cape Town. The Cobern Street skeletons manifest the harsh reality of child mortality, short hard lives and of slaves dying in transit before reaching their destinations. An African slave woman with sharpened incisors had a military jacket buried with her. An African man with decorated teeth had a clay pipe perpetually grasped between his teeth. And a young woman who died in her early twenties was buried with treasured possessions, however they were acquired. We have not been able to find the names of these people and they remain anonymous. However we do have valuable clues as to the nature of their existence, as part of the lower strata of colonial Cape Town.

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APPENDIX 1: SUMMARY OF BURIALS

Teeth

Ossicle

458.1	6192-3	4						
458.2	6194	9						
459.1	6195-6	6						
459.2	6197	7						
459.3	6198-9	.8						
460	6200-1,6460	3	-16.4	11.8				
461	6202-3	5						
498	6204-5,6957	10	-16.6	13.3				
499	6206-7	11						
500	6208-9,6491,6498	12	-17.1	11.2			-18.6	13.2
501	6210-1,6958	13	-16.3	12.4				
502	6212-3,6461	14	-19.2	8.8	-11.6			
504	6214-5,6462	15	-17.4	10.9				
508	6216-7,6959	18	-13.9	11.8				
509	6218	19						
510	6219-20,6463-4	20A	-13.8	9.8				
511	6221-2,6465-6	20B	-12.2	7.5	-3.8			
512	6223-4,6467,6493	20C	-16.2	16.1	-8.4		-16.6	15.1
514	6225-6,6468	21	-11.3	12.3				
515	6227-8	22						
516	6229-30,6960	23	-15.3	12				
517	6231,6961	24	-16.8	12.6				
518	6232-3,6962	25	-17.1	10.6				
521	6234-5,6469	27B	-16.4	10.3				
522	6236-7	28						
526	6238-9,6470	32	-18.0	11.4				
528	6240-1,6471	34	-19.8	10.3				
531	6242-3,6472	37A	-17.1	16.4	-9.7			
532	6244-5	37B						
535	6246-7,6473	40	-9.9	6.1				
536	6248-9,6963	41	-15.3	12.1				
539	6250-1,6474	42A	-14.6	13.6				
540	6252-3	42B						
541	6254-5	43						
542	6256-7,6475	44	-13.4	14.3				
543	6258-9,6476	45	-16.7	13.1				
544	6260-1,6477	46	-17.7	11.3				
545	6262-3,6964	47	-15.3	12.1				
546	6264-5	48						
547	6266-7,6478,6494	49	-10.3	8.1			-12.5	8.6
548	6268-9,6479	50	1504 -9.8	7.6	-4.7	0.709644		
549	6270-1	51						
550	6272-3,6480	52	-12.0	7.2				
551	6274-5	53						
552	6276-7,6965	54	-18.6	9.9				
554	6278-9	56						
555	6280-1,6481	57	-18.4	11.8				
556	6282-3,6482	58	-11.9	11.7	-7.3			
557	6284-5,6483	59	1105 -17.6	8.1	-12.8	0.710010		
558	6286-7,6484,6495	60	1540 -8.0	7.2	-4.4	0.715177		
559	6288-9,6485	61	-15.5	14.6				
562	6290-1,6496	64	1995 -17.7	11.4	-6.3	0.709006	-17.7	11.7
563	6292-3,6486,6497	65	-15.6	10.8				

* All Type B burials in coffins unless otherwise stat

† Repeat

APPENDIX 2: RESULTS OF BONE DENSITY FRACTIONATION

Lab No	Burial No	Sex	Age	Skeletal-part	Histology	Fraction	$\delta^{13}\text{C}$ collagen (‰)	SD(number)	$\delta^{15}\text{N}$ collagen (‰)	SD(number)	$\delta^{13}\text{C}$ apatite (‰)	% of total bone	Collagen yield	C/N ratios		
6206	11	F	<40	Rib	BR*, SI†	Chunk	-16.4		13.1							
						Powder	-17.0		12.5							
						2.0-2.1	-20.5		12.2			2	12	5.5		
						2.1-2.2	-17.3	0.11 (n=3)	13.5	0.03 (n=3)	6	21	3.3			
						2.2-2.3	-17.1	0.15(n=5)	13.8	0.14(n=5)	15	13	3.1			
						2.3-2.4	-17.0	0.07(n=3)	13.4	0.16(n=3)	66	6	3.1			
+2.4	-18.4	0.09(n=3)	13.4	0.25(n=3)	8	16	3.6									
6207	11			Femur	BR, SI	Chunk	-16.4		13.7							
						Powder	-17.1		12.6							
						>2.4	-17.4		13.3			7	3.8			
6212	14	F	45-55	Rib	BR	Chunk	-16.9		8.7							
						Powder	-17.9				-8.5					
						2.0-2.1	-19.1	0.09(n=3)	9.8	0.27(n=3)	4	15	4.6			
						2.1-2.2	-17.6	n=1	10.6	n=1	6	11	3.5			
						2.2-2.3	-17.4	0.15(n=3)	10.5	0.12(n=3)	4	18	3.6			
						2.3-2.4	-16.7	0.04(n=3)	10.0	0.1(n=3)	65	15	3.5			
+2.4	-16.9	n=1	10.0	n=1	15		3.6									
6213	14			Femur	BR	Chunk	-14.7		10.4							
						Powder					-9.1					
						>2.4	-18.5	0.16(n=3)	10.4	n=1	-8.6	21	4.1			

Lab No	Burial No	Sex	Age	Skeletal part	Histology	Fraction	$\delta^{13}\text{C}$ collagen (‰)	SD(number)	$\delta^{15}\text{N}$ collagen (‰)	SD(number)	$\delta^{13}\text{C}$ apatite (‰)	% of total bone	Collagen yield	C/N ratios	
	14			Vertebra		Chunk	-15.6		9.5						
					Powder		-15.1		9.5			-8.2			
					2.1-2.2		-15.5	0.02(n=3)	10.2	0.35(n=3)			17	22	3.4
					2.2-2.3		-15.3	0.12(n=2)	10.5	0.11(n=2)			36	9	3.0
					2.3-2.4		-16.2	0.05(n=3)	10.2	0.16(n=3)		-7.9	37	18	3.4
					Teeth		Chunk	-19.2		8.8					
6219	20A	M	25-30	Rib	BR	Chunk	-12.8		9.6						
					Powder		-16.2		7.5						
					2.3-2.4		-16.6	0.24(n=2)	9.1	0.28(n=2)			4	11	4
					>2.4		-15.5	n=1	9.3	n=1			96	8	4
6220	20A			Femur	BR	Chunk	-15.1		7.1						
					SI	Powder	-15.5		8.4						
					2.3-2.4		-15.8		8.7				2	21	3.4
					>2.4		-15.3	0.16(n=2)					97	17	3.5
				Teeth		Chunk	-13.8		9.8						
6221	20B	F	16	Rib		Chunk	-8.6		7.5						
					Powder		-11.6		6.7						
					>2.4		-12.0		7.3				20		3.6
6222				Tibia	BR	Chunk	-9.2		7.1						
					Powder		-12.2								

Lab No	Burial No	Sex	Age	Skeletal part	Histology	Fraction	$\delta^{13}\text{C}$ collagen (‰)	SD(number)	$\delta^{15}\text{N}$ collagen (‰)	SD(number)	$\delta^{13}\text{C}$ apatite (‰)	% of total bone	Collagen yield	C/N ratios	
6225	21	F	25-35	Rib		Chunk	-16.0		12.3						
						Powder	-17.6		12.4						
						>2.4	-17.8	0.01(n=2)	13.0	0.19(n=2)		7	3.9		
6226	21			Femur	BR, SI	Chunk	-14.1		10.7						
						Powder	-16.5								
						>2.4	-16.3	n=1	12.1	n=1		20	3.5		
6238	32	M	50-60	Rib	BR,SI	Chunk	-15.9		14.1						
						powder	-16.6		13.3						
						<=2.4	-16.9	0.36(n=3)	13.2	0.21(n=3)		6	22	3.5	
						>2.4	-17.5	0.00(n=2)	13.2	n=1		94	13	3.5	
6239				Femur	BR,SI	Chunk	-16.8		12.4						
						Powder	-17.0		11.6						
						>2.4	-17.1		12.0			18	3.6		
6266	49	M	30-35	Femur	BR	Chunk	-15.1		12.6						
						Powder	-16.0		11.5						
						>2.4	-16.7	n=1	13.4	n=1		19	3.6		

Lab No	Burial No	Sex	Age	Skeletal part	Histology	Fraction	$\delta^{13}\text{C}$ collagen (‰)	SD(number)	$\delta^{15}\text{N}$ collagen (‰)	SD(number)	$\delta^{13}\text{C}$ apatite (‰)	% of total bone	Collagen yield	C/N ratios	
6268	50	M	35-50	Vertebra	BR	Chunk	-16.0		12.6						
						SI	-16.8		12.6						
						2.3-2.4	-17.2		13.6		2	11	4.1		
						>2.4	-17.8				98	18	4.8		
6269				Femur	BR	Chunk	-15.9		13.2						
					SI	Powder	-17.4		12.1						
6272	52	F	25-35	Rib	BR,SI	Chunk	-10.1		9.0						
6273				Femur	BR	Chunk	-13.9		7.5						
6286	60	F	30	Rib		Chunk	-15.3		12.8						
						Powder	-16.6		12.0						
						>2.4	-17.6		13.5			8	4.8		
6287				Humerus	BR	Chunk	-13.8		10.9						
					SI	Powder	-15.6		7.8						
						2.3-2.4	-16.2	n=1	10.3	n=1	2	3	3.8		
						>2.4	-18.8	n=1	11.1	n=1	98	9	4.9		
						Teeth			-8.0		7.2				

Histological analysis performed by Lynne Bell. *BR: Bacterially remodelled †SI: Some intact bone visible