STUDY OF THE TERTIARY HOMINOINDS AND THEIR PALAEOENVIRONMENTS IN EAST AFRICA · VOL. I

REPORT OF FIELD SURVEY IN KIRIMUN, KENYA, 1980

EDITED BY
HIDEMI ISHIDA
AND
SHIRO ISHIDA

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CONTRIBUTORS FOR VOLUME 1

Hidemi ISHIDA, D.Sc., Associate Professor, Department of Biological Anthropology, Faculty of Human Sciences, Osaka University, Suita, Osaka, 565 Japan.

Shiro ISHIDA, D.Sc., Associate Professor, Department of Geology and Mineralogy, Faculty of Science, Kyoto University, Kyoto, 606 Japan.

Masayuki TORII, M.Sc., Instructor, Department of Geology and Mineralogy, Faculty of Science, Kyoto University, Kyoto, 606 Japan.

Takaaki MATSUDA, M.Sc., Instructor, Department of Geology, Himeji Institute of Technology, Himeji, Hyogo, 671-22 Japan.

Yoshinari KAWAMURA, M.Sc., Instructor, Department of Geology, Faculty of Education, Aichi University of Education, Kariya, Aichi, 448 Japan.

Kiyotaka KIZUMI, M.Sc., Research Assistant, Department of Anthropology, Faculty of Science, University of Tokyo, Tokyo, 113 Japan.

Hideo NAKAYA, M.Sc., Research Assistant, Department of Geology and Mineralogy, Hokkaido University, Sapporo, 060 Japan.

Martin PICKFORD, Ph.D., Geologist and Palaeontologist, National Museums of Kenya, Nairobi, (P.O.Bos 40658 Nairobi), Kenya.

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Preface

An overseas scientific survey on the Miocene hominoids and their palaeoenvironments was carried out mainly in the Kirimun district, Kenya by a project team organized at Osaka University from June to October, 1980. This volume reports the result of our first field survey including excavation in the Kirimun South Site.

Many reports of the field surveys on Tertiary hominoids and palaeoenvironments in Africa have been published so far by African, European and American Scientists. This is the first report on the same theme by Japanese scientists. New and detailed information of geology and palaeontology of the Miocene around Kirimun area will be provided in this report, although no new materials of the Miocene hominoids have been collected and excavated in the first season. We would like to continue this project and make a contribution to evolutionary anthropology of East Africa.

Acknowledgements

This project has been supported by the Japanese Ministry of Education, science, and Culture with its Grant-in-Aid for Overseas Scientific Survey, which has enabled us not only to conduct field survey but also to publish this volume. We are very grateful to the Ministry.

We should like to express our gratitude to the Kenyan National Council of Science and Technology and the Office of the President of the Kenyan Government including Mr. E. K. Ruchiami for having granted us research permits. We are also grateful to administrators of the Samburu District where we had worked, including Mr. S. Z. Ambuka, D.C. and Mr. Wanga, for heir advice and cooperation.

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We are indebted to Osaka University, which took up the Official responsibility of supervising our project. We also thanks Miss H. Fujikawa of Kyoto University, Miss T. Ohta of Osaka University for their secretarial services. Finally, each of us thanks our respective University for having permitted us leave of absence.

The contributors

I Outline of the survey in 1980

Outline of the survey in 1980

In modern evolutionary anthropology, one of the major objectives is to clarify the mechanism of origin and evolution of hominids, that is, the mechanism of hominization. The hullmark of hominids is habitual terrestrial bipedality. Therefore, the study of origin of bipedality will provide a basis for the elucidation of the mechanism of hominization. To make clear the process of the appearance of the locomotor mode and adaptation, we need postcranial evidences of early hominids and other hominoids related to them and also detailed informations

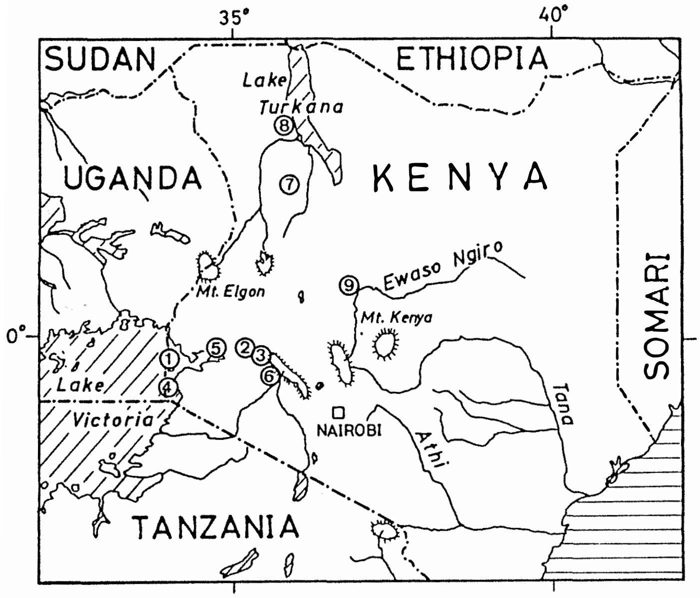

Fig. 1 Map showing Kenya, its surroundings and fossil localities:

1 Rusinga, 2 Songor, 3 Koru, 4 Mfwangano,

5 Maboko, 6 Fort Ternan, 7 Loperot,

8 Losidok and Muruorot, 9 Kirimun

on the palaeoenvironments in which they lived. Therefore, main aims of our field surveys have been to find new materials of Ramapithecine and their close relatives and to conduct geological and palaeontological surveys on the middle Miocene period.

It is beyond dispute that East Africa, especially Kenya, is a prominent place for the studies mentioned above because of the abundant fossil materials and many studies done so far on the subjects. This is the reason why we have conducted field surveys in Kenya. Since A. T. Hopwood (1933) described the first ape specimens, more than a half thousand specimens of hominoids have been found from different Miocene deposits in Kenya, including Rusinga Island, Songor, Koru, Mfwangano Island, Maboko and Fort Ternan (Andrews 1978, Cooke 1978, Simons and Pilbeam 1978). and also many palaeontologists and geologists, inculding L. S. B. Leakey, have explored Miocene hominoids so far in Kenya. He was one of the pioneers of the work. He found *Kenyapithecus (Ramapithecus) wickeri* in the deposit of the Fort Ternan (1962). At present, *Ramapithecus* specimens found in Africa come from two sites in Kenya, Fort Ternan and Maboko. Recently, the phylogenetic status of *Ramapithecus* as the earliest member of hominids has slightly become ambiguous, but it is likely to be at least broadly ancestral to late Cenozoic hominids (Simons and Pilbeam 1978).

In 1979, H. Ishida discussed the area where the Osaka University expedition team conducts the first field survey in Kenya with Mr. R. Leakey, Director, Chief Exective of the National Museum of Kenya. Based on this discussion, the expedition team planed to carry out the survey in the Maralal region. After examination of the region, the team chose the Kirimun district as the main area of the survey. And the east slope of the Rift Valley from west of Maralal to west of Baragoi was chosen as the secondary survey area.

Kirimun (0°48'13"N,36°52'17"E) is a small village which is situated in the west of the central part of Kenya, about 110km north of Nairobi and 45km south east by south of Maralal, which is the center of the administrative district of Samburu. Many Miocene sediments are exposed within a radius of 6km of Kirimun. There are three main routes from Nairobi to Kirimun (Fig. 2). One of them is a west route through Gilgil, Nyahururu, Rumuruchi (C 77) and Palagalagi. The second is an east route going up north through Thika and Nanyuki (A 2), and near Dondol. The last one is a north route, which takes the west route until Rumuruchi (C 77), and used road C 77 till Kishima and finally takes a branch road going down south-east and leading to Kirimun. The best route seems to be the north one. But in the north of Rumuruchi and Nanyuki, every road is not paved. Therefore, pebbles and rocks on the road cause troubles to cars.

Baragoi is situated about 110km north of Kirimun and 80km north of Maralal on the way from Maralal to the Lake Turkana. Sediments preliminarily invesgated are at 30km west of Baragoi. Roads around Baragoi are not paved and the surfaces are badly undulated. To reach the sediments exposed on the slope of the Rift Valley, we should drive on dried river beds.

Kirimun area is in the east margin of plateau phonolite in the east of the Rift Valley. The upper surface of the plateau becomes a plain 1,700 to 2,000m in altitude. The east margin has a steepy cliff, from foot of which a basement peneplain extends eastwards. On the peneplain, there are some hills capped with phonolite. The River Uaso Nyiro goes up to north along the east margin of the plateau and turns east at the east of Kirimun, cutting the valley 300m in depth. The River Kirimun which comes from Kirimun spring runs down to the east through gorge of phonolite and meets the River Uaso Nyiro. The sites surveyed and excavated were exposed Miocene sediments which underlie the phonolite.

The sites preliminarily surveyed in the Baragoi area are located in the east slope of the Rift Valley. Between Maralal and Baragoi, the western plateau

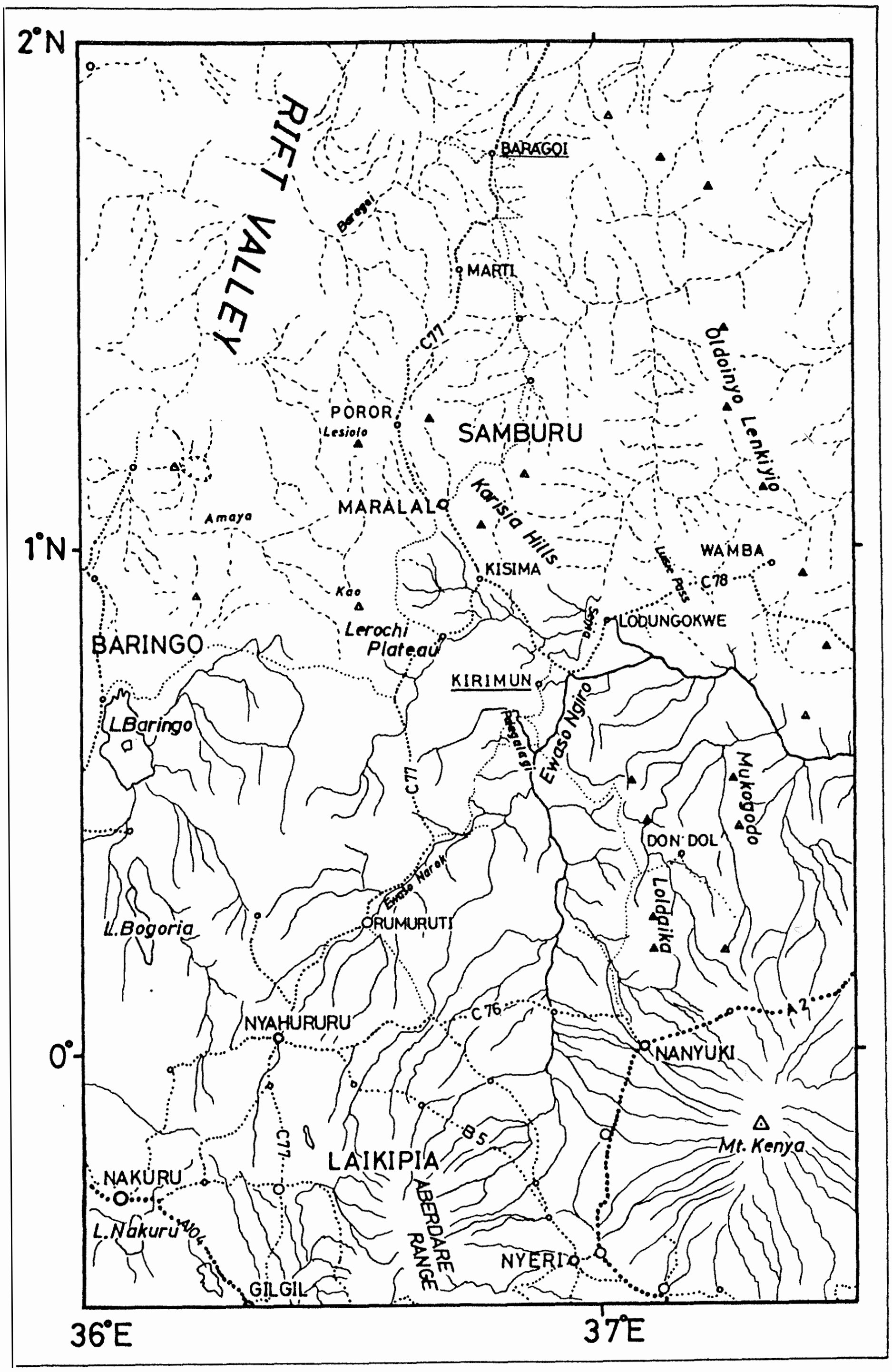

Fig. 2 Map showing region from Gilgil to Baragoi.

phonolite abuds on the eastern mountains consisting of basalt. The west slope of the plateau becomes gradually lower towards the Rift Valley dipping westwards. The Rift Valley extends southwards from Lake Turkana to Suguta Valley. The east slope of the Rift Valley between the Suguta Valley and the Lake Baringo will be surveyed in next season, 1982. The sediments horizontally underlie phonolite in the eastern part of the slope, but they come out as an upper horizon in west part of the slope.

All members of the expedition team conducted general surveys on the Miocene sedimentary rocks exposed along the boundary between the basements and plateau phonolite in the Kirimun destrict. The major areas of the sedimentary rocks exposed are Seya, Kirimun and Palagalagi areas as shown in Fig. 4-6. Excavations were carried out at the Kirimun South in Kirimun area, where we found many fossil specimens from the surface (Fig. 10). Seven sites (A-G) were dug in the area for collecting fossil specimens. From muddy sandstone of the site C, many fossils occurred. Small fossil specimens were also collected by washing and sieving the sandstone. In Baragoi area, we did surface collecting. The fossil specimens obtained by the field surveys in Kirimun and Baragoi areas amount to 4808 in number Geological surveys were also conducted including rock sampling for K-Ar dating, Fission-track dating and palaeomagnetism. Fission-track age of the phonolite welded tuff underlain by the Kirimun formation was determined as about i5 Ma. The fauna of Kirimun is not similar to the fauna of the Fort Ternan but to those of Rusinga and Songor. Therefore, it can be said that the Kirimun Formation and Fauna correspond to the Early Miocene as Pickford (1981) has suggested.

This field surveys have been conducted by all the members of the project team. However, analyses of the specimens and samples were made by two separate working groups. Therefore, Chapter 1 was written by H. Ishida, Chapter 2 by S. Ishida, M. Torii and T. Matsuda, and Chapter 3 by Y. Kawamura, K. Koizumi, H. Ishida and H. Nakaya. H. Nakaya was not a project member in the first season, 1980. But he has assisted Y. Kawamura and others and he will be a member of the expedition team in the second season, 1982. He belongs to Hokkaido University, Faculty of Science at present.

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II Geology of the Kirimun district

II GEOLOGY OF THE KIRIMUN DISTRICT

1. Introduction

A geological survey of the Kirimun district was made to reveal a detailed succession of Miocene strata which yield abundant fossils including hominoids. In this chapter preliminary results of the geological survey with results of radiometric age datings and a paleomagnetic study are presented. A short note on a reconnaissance in the Baragoi area is also reported.

The Kirimun district is situated on the eastern flank of the Kenya rift valley, eighty kilometres north of Nanyuki (Fig. 2). The eastern half of the Kirimun district is underlain by metamorphic rocks. These rocks, which form the basement of the area, are the Precambrian gneiss of the Mozanbique Metamorphic Belt of the Pan African Orogeny (Cohen and Swelling, 1966). The metamorphic rocks in this area are exposed below 1650 metres in altitude and/or in the mountain area above 2000 metres such as in the Karisia Hills, Oldoinyo Lenkiyio (Matthews Range), and Lodaika-Mukogodo Hills. They consist of biotite gneiss, garnet-biotite gneiss, and garnet feldsparthic gneiss with subordinate amount of ultrabasic rocks and quartzite. They generally strike NS to N15°E, and dip 90° to 45°W.

In contrast with the eastern half, western area is underlain by the Miocene plateau phonolite with sub- and/or intra-volcanic sediments emplaced at the time of early stage volcanism of the Kenya rift valley as shown in Fig. 3 (Shackleton, 1946; Baker et al., 1971; King, 1978; Shackleton, 1978).

Shackleton (1946) summarized the geologic history in his excellent paper, and he divided the Miocene strata into five formations; namely, sub-volcanic sediments, Samburu Basalt Series, Rumuruti Phonolites, Losiolo Phonolites, and Thomson's Falls Phonolites/Mt. Kenya Volcanic Suite, in ascending order. He also described some mammal fossils, such as <u>Deinotherium</u> and <u>Mastodon</u>, collected from Miocene sedimentary rocks.

In 1949, Louis Leaky visited the Kirimun district. He found a fossil of a canine of hominoids from the subvolcanic sedimentary rock, and identified it

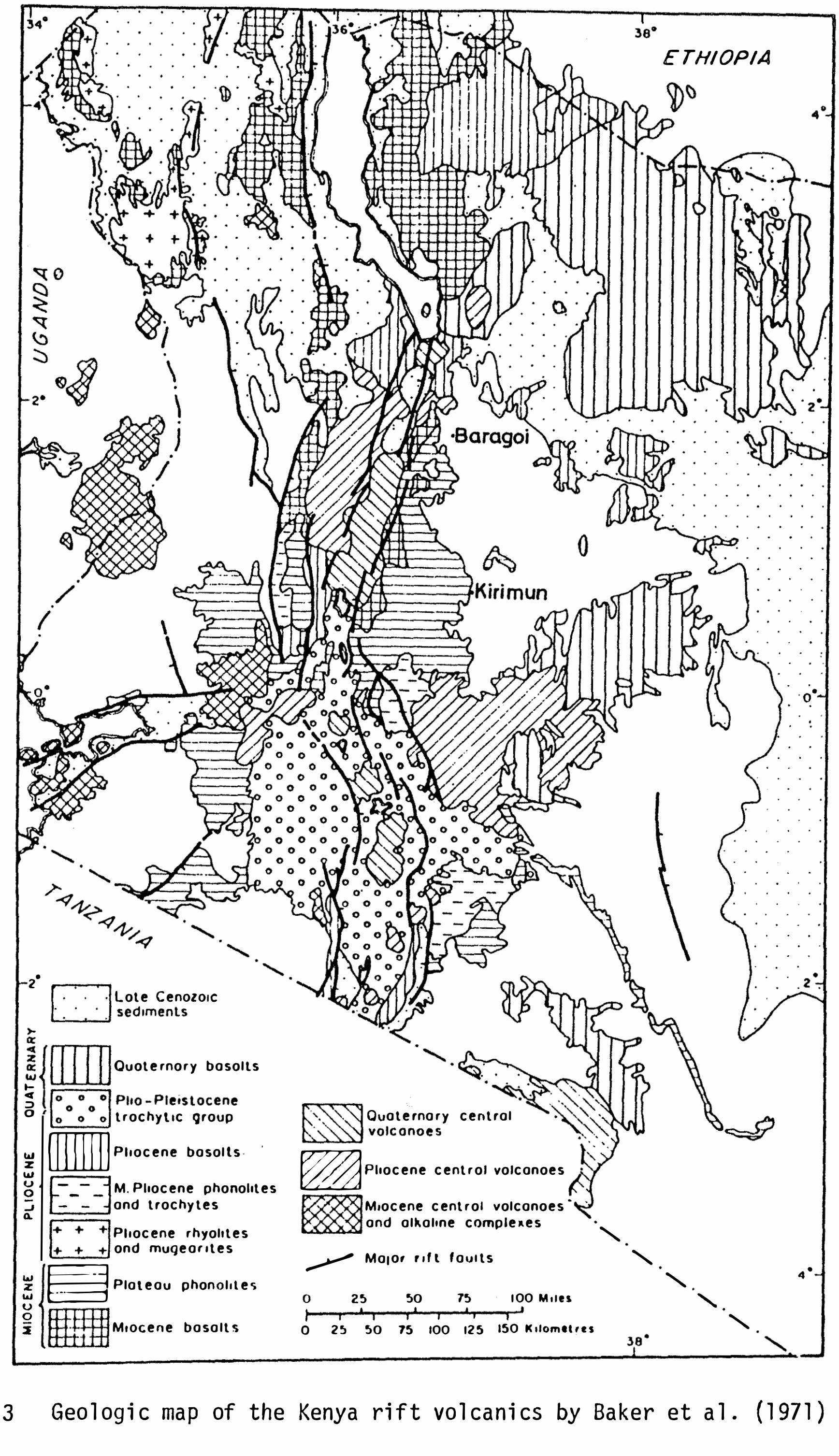


Fig. 3 Geologic map of the Kenya rift volcanics by Baker et al. (1971)

as Proconsul major (the details were written down on his fieldnote which was preserved in TILLMIAP).

There is a fair chance for finding out the other hominoids fossils from this area, which may enable us to clarify their palaeontological situation and palaeoenvironments. Thus the main purpose of this study was to make precise stratigraphy of the Miocene formations, and details of the results are presented in the following sections.

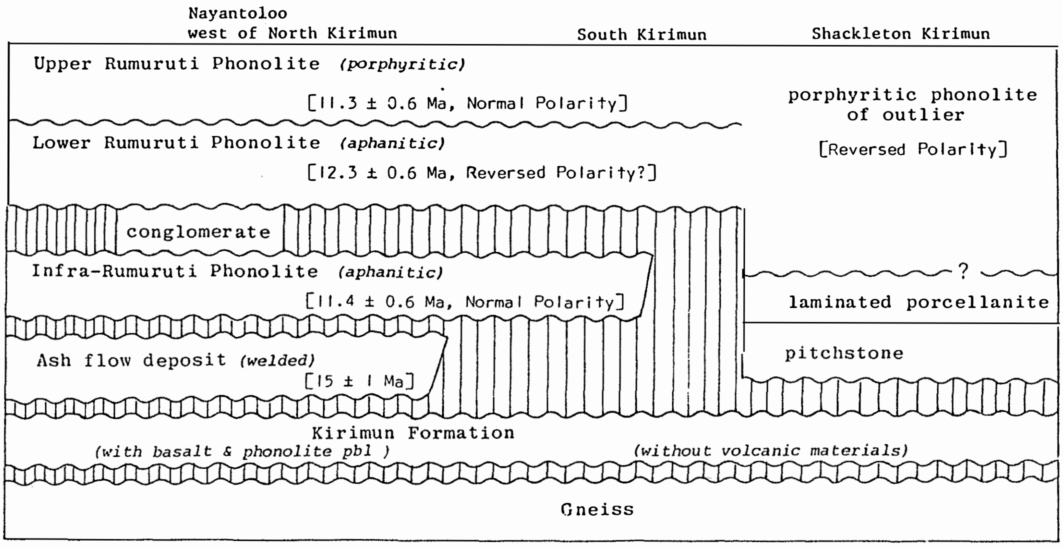


Fig. 4 Stratigraphy for Kirimun area.

2. Miocene Stratigraphy

Miocene sedimentary rocks in the Kirimun district are distributed from the Seya River to Palagalagi, and sporadically exposed along the boundary between the basements and plateau phonolite. The sediments unconformably overlying the basements, are composed mainly of conglomerate, sandstone, and mudstone, and are overlain by phonolite lavas and ash flow deposits. Moreover, a thin conglomerate bed is intercalated by the phonolite lavas in the Kirimun area. These sedimentary rocks are called the Kirimun Formation in this report (Fig. 4-6). The exposed area of the Kirimun Formation is divided into three areas, and subdivided into eleven parts as follows:

(i) Seya area
- a. Garuma
- b. Nkoteyia

(ii) Kirimun area
- a. North Kirimun
- b. Nayantoloo valley
- c. South Kirimun
- d. Kirimun River
- e. Shackleton Kirimun and 5 km SSE Kirimun

(iii) Palagalagi area
- a. GR 6371
- b. GR 6271
- c. Mbagathi North and Mbagathi South
- d. Shackleton Palagalagi

(i) Seya area

In the Seya area, sedimentary rocks crop out in two parts, in a valley in Garuma, and the other at Nkoteiya, along the road to Wamba. Between the two parts phnolite lavas cover the sedimenttary rocks.

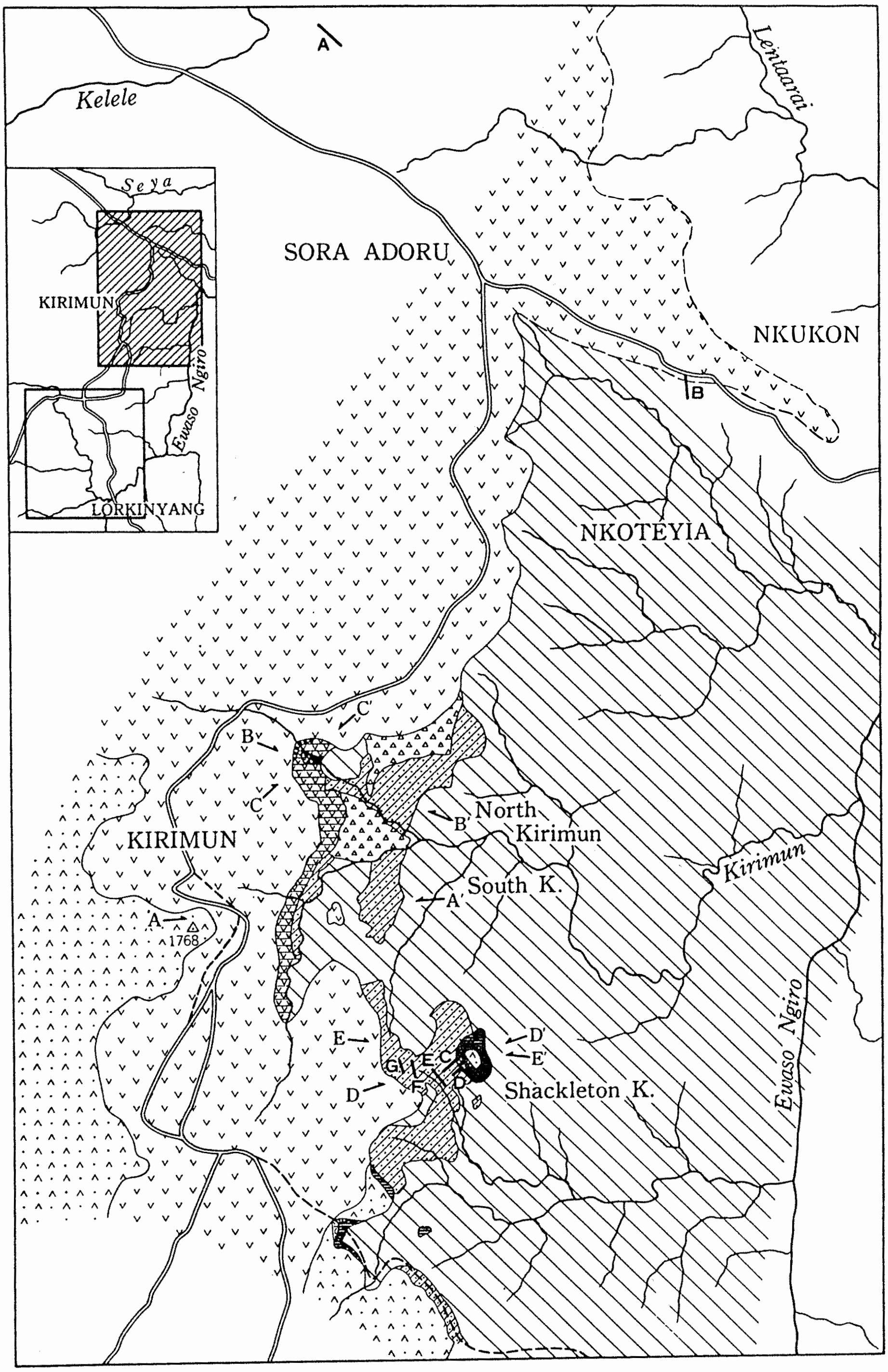
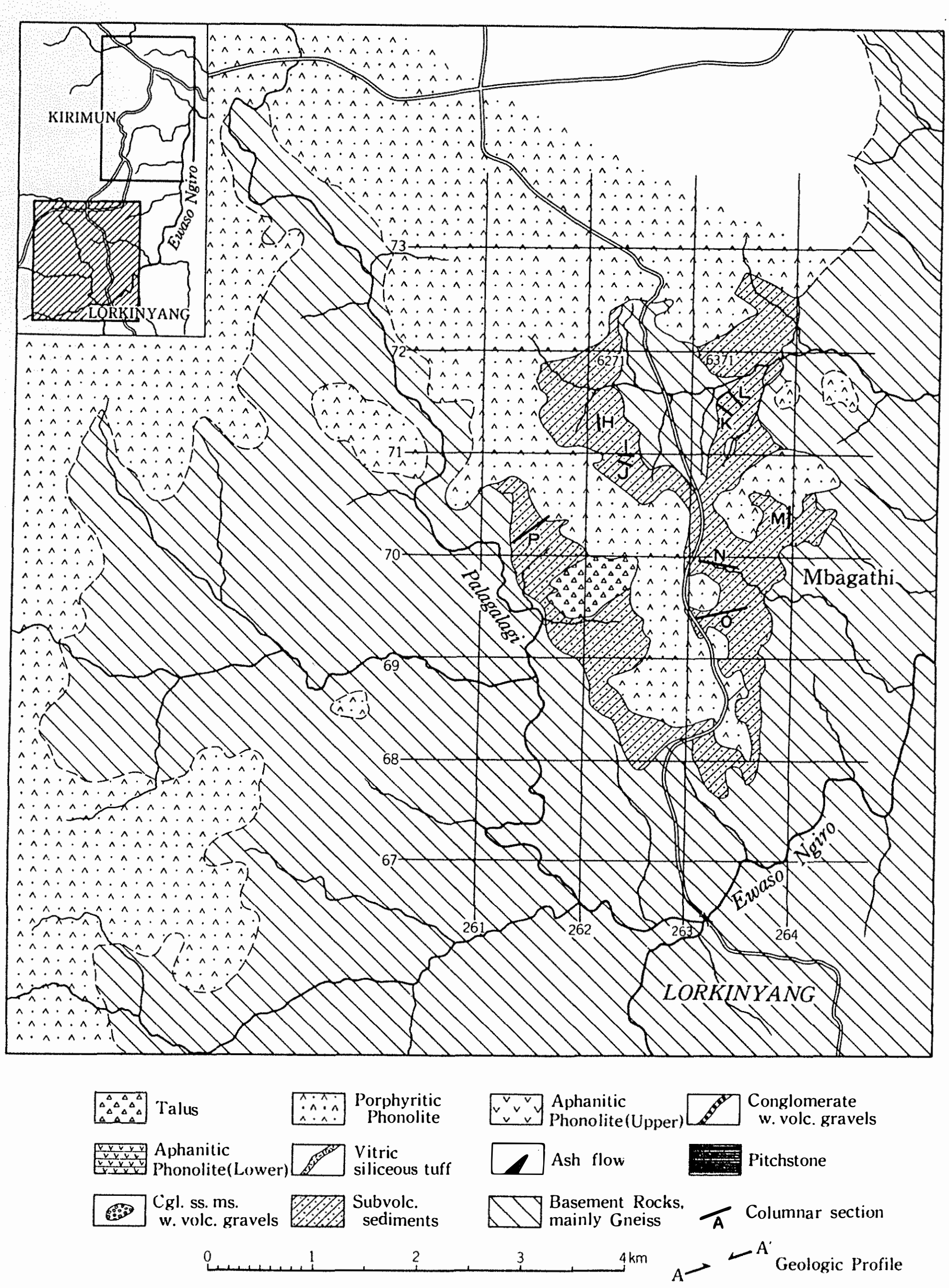


Fig. 5 Geologic map of Kirimun district a Kirimun area



b Palagalagi area

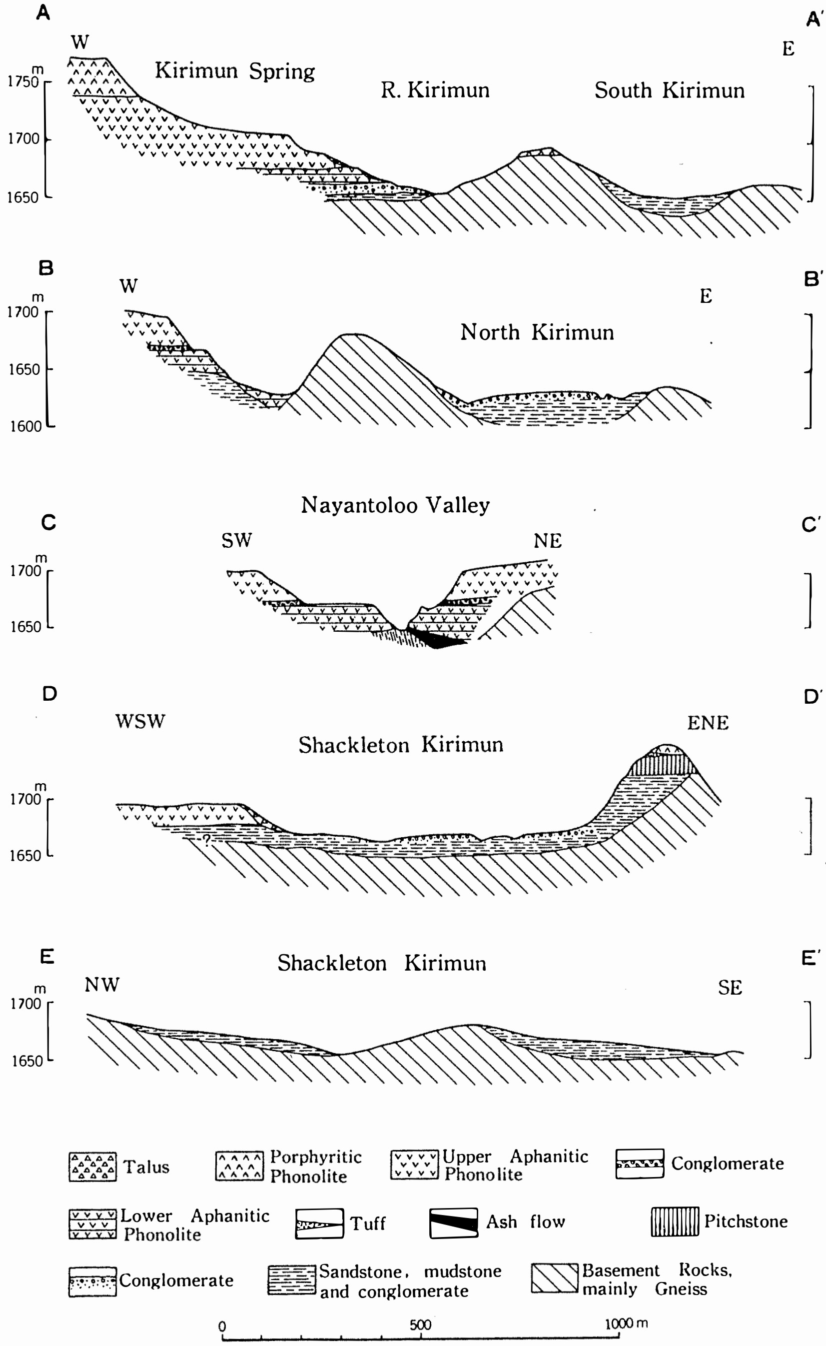


Fig. 6 Geologic cross sections across Kirimun area. Locations of line A-A', B-B', C-C', D-D', and E-E' are indicated in Fig. 5-a.

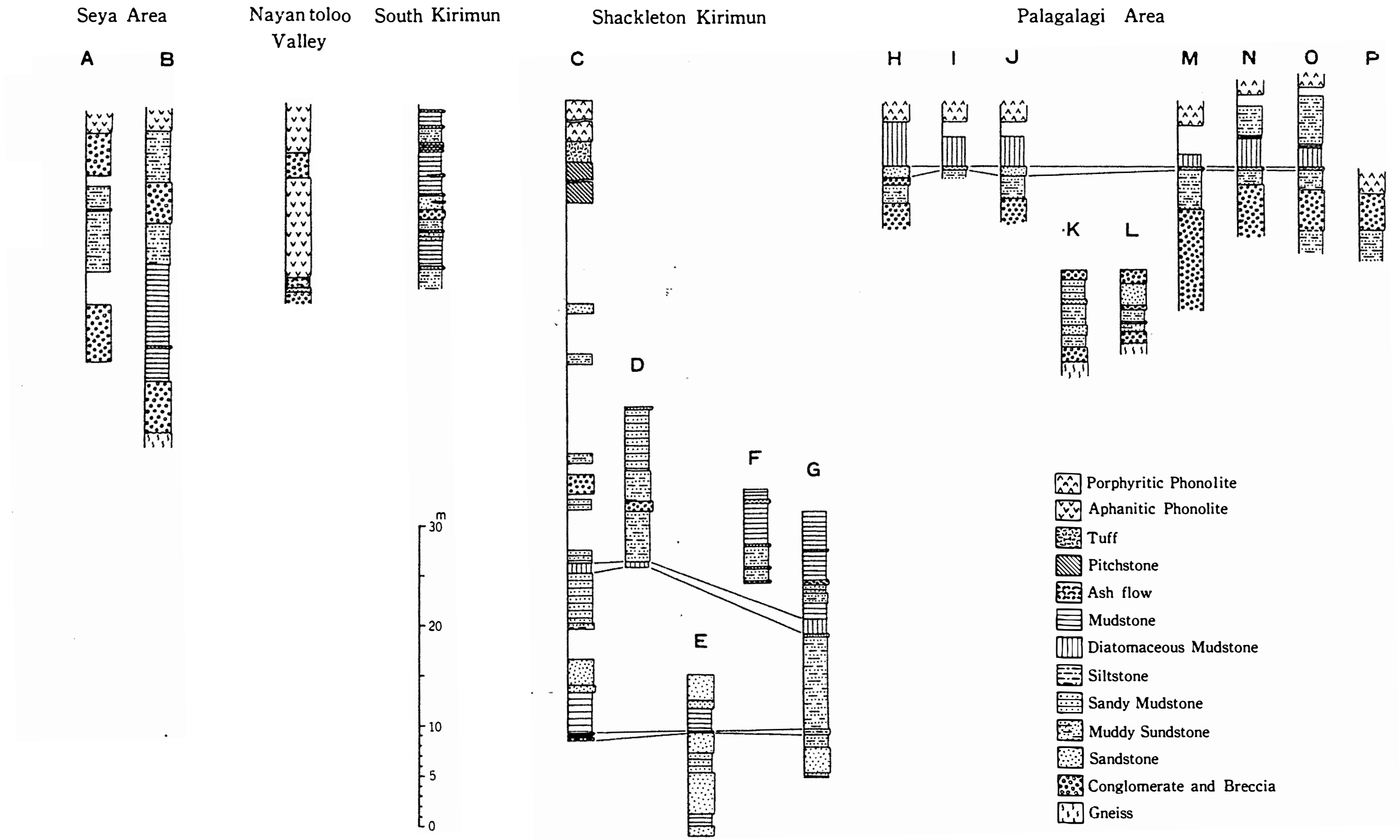


Fig. 7 Geologic columns of Tertiary rocks in Kirimun district. Location of each column is indicated in Fig. 5-a, b.

a. Garuma

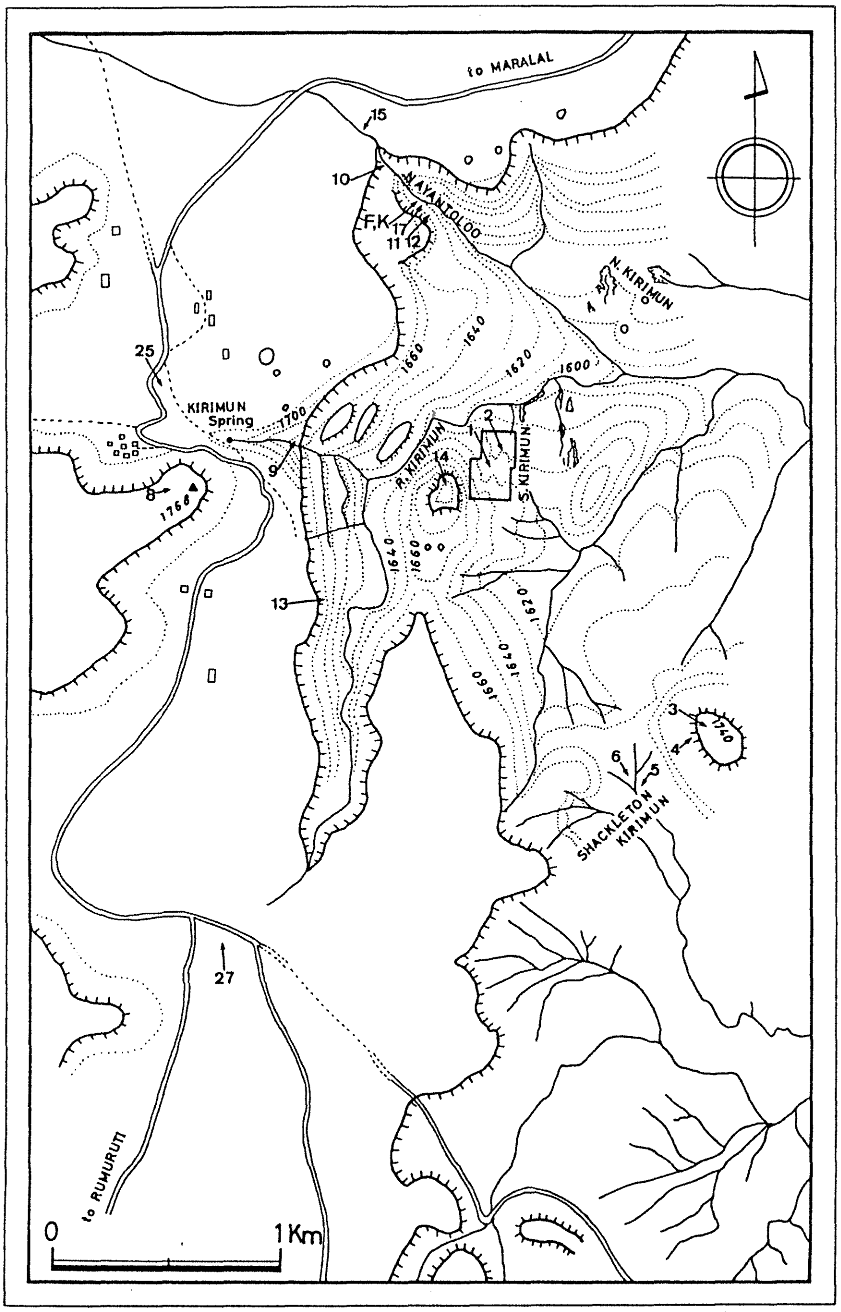
The sedimentary rocks in Garuma are mainly composed of conglomerate which intercalates mudstone and sandstone at the upper part (A in Fig. 7). Phonolite lava horizontally overlies them. It is composed of a upper porphyritic layer containing phenocrysts of orthoclase and nepheline, 3 to 10 mm in diameter, and of a lower aphanitic layer. On a cliff north of the valley of the Seya River, these layers can be seen to be intergradational with a range of 50 cm. Accordingly, they are considered to be made up of one flow unit of a composite lava. This lava is observed to extend eastward as a spur about thirty kilometres to the Luisie Pass.

b. Nkoteyia

The geologic column at Nkoteyia is shown by B in Fig. 7. The sedimentary rocks rest on the basement rocks, and in ascending order are composed of conglomerate (5 m thick), mudstone (12 m), muddy sandstone (5 m), conglomerate (4.5 m), and muddy sandstone (5.5 m). A hard mudstone bed, 30 cm thick, and a hard calcareous ball bed, 40 cm thick, exist at horizons of 2 m and 3 m above the base of the mudstone. The aphanitic phonolilite (the Lower Rumuruti Phonolite) lies on them.

From Garuma, we collected the teeth and bone fragments of mammal fossils. From Nkoteyia, twenty eight pieces of fossil crocodile, chelonia and fish were collected.

Fig. 8 (opposit) Map around the Kirimun area. Numbers on contour line indicate altitude in metre. F and K on small arrow show sampling locality for fission-track dating (KE-8091101), and K-Ar dating (KE-8090902), respectively. Numbers on small arrows show sampling localities for palaeomagnetic study as listed in Table 4.



to MARALAL
15
10
NAYANTOLOO
F.K
17
11 12
N. KIRIMUN
1640
1660
1620
1600
25
KIRIMUN
Spring
1700
1
2
R. KIRIMUN
S. KIRIMUN
14
9
8
1766
13
1640
1660
1620
1640
1660
3
1740
4
6
5
SHACKLETON
KIRIMUN
27
to RUMURUTI
0
1 Km

(ii) Kirimun area

a. North Kirimun

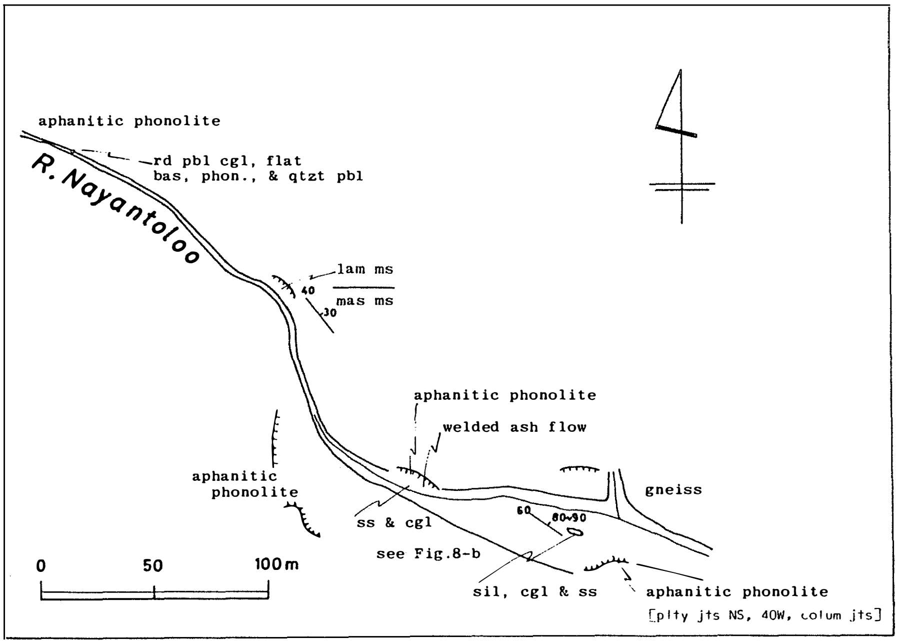
North Kirimun is consists of the southern slope of the north-side of the Nayantoloo River, a tributary of the Kirimun river. The sediments occupy the depression of a basement about 500 m wide east to west, and crop out at two gullies developing in the margin of talus. One occurs along a small gully, about a hundred metres long, in the eastern part of North Kirimun. In the gully ill-sorted, fine-grained sandstone, 2 m thick, is horizontally overlain by granule conglomerate, 2 m thick. The other occurs a hundred and fifty metres west of the first along a small, narrow gully about a hundred metres long, south to north. There, ill-sorted, fine-grained sandstone, 2.5 m thick, is covered by laminated mudstone, more than 30 cm thick. Most of the fossils from North Kirimun are obtained from this outcrop. The eastern border of North Kirimun is a ridge of basement rocks running north-northwest.

About three hundreds metres northwest of North Kirimun, a conglomerate layer containing only pebbles and cobbles of gneiss and quartzite without volcanic rocks is exposed. It is presumably part of the upper horizon rather than of North Kirimun.

From North Kirimun, 28 fragments of fossil bones of the mammals were collected. These were identified to be Gomphoteriidae and Rhinocerotidae.

b. Nayantoloo valley

The sediments along the upper stream of the Nayantoloo River are separated from North Kirimun by basement rocks projected southwards in the northern slope (Fig.8). The route map of the ravine is shown in Fig.9, and the columner section is shown in Fig. 7. The Miocene rocks consist of conglomerate and aphanitic phonolite lava in ascending order. The lowest conglomerate is composed of round pebbles of basalt and phonolite containing quartzite pebbles and quartzose sandstone. They strike N50° to 75°W and dip 60° to 80°N. The welded ash flow deposits dip gently north and abut on the conglomerate. The aphanitic phonolite lava unconformably overlies the conglomerate and the ash flow deposits.



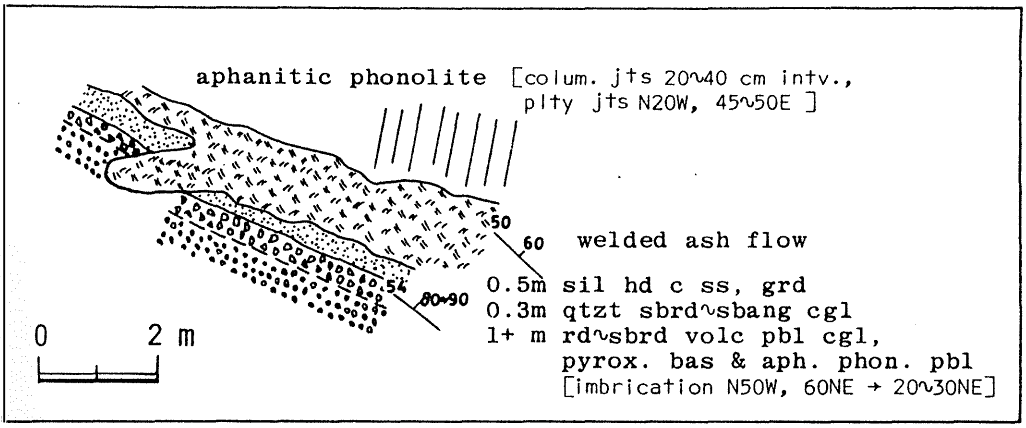


Fig. 9-a Route map along the valley of Nayantoloo (above).
-b Sketch of the outcrop in the valley of Nayantoloo (below).
Abbreviations are followed to the list of Mitchel and Maher (1957).

About a hundred metres NNW, massive mudstone and laminated mudstone are exposed below the aphanitic phonolite lava, dipping to the northeast. They are considered to be of the successive strata of the conglomerate mentioned above. Upstream about a hundred metres northwest from this outcrop, the horizontal bed of conglomerate crops out in the bottom of the valley. The conglomerate is composed of rounded pebbles of basalt and phonolite containing quartzite pebbles. It is considered to be interbedded into two aphanitic phonolite lavas. The lower aphanitic phonolite is tentatively called the Infra-Rumuruti Phonolite in this report.

It cannot be concluded that the lowest sediments containing basalt and phonolite pebbly conglomerate are younger than the subvolcanic sediments of North Kirimun. Alternatively, it can be considered that they were simultaneously deposited in the different water-systems which were separated by the barrier of basement rocks.

c. South Kirimun

The sediments of the South Kirimun crop out in a gentle slope on the south-side of the Kirimun River in a east to west direction (Fig.8). They are nearly flat between the west phonolite outlier and the east hilly ridge of the basements trending north-northeast. The outlier is situated 1 km east of Kirimun spring. The ridge ranges northwards with the east ridge of the North Kirimun. Detailed geological observation and fossil collection were performed in South Kirimun. Seven sites were excavated for fossil collection and four sites for geologic observation.

The sedimentary rocks in South Kirimun abut on the east, west and south, and the basal part of it is covered by alluvium on the north. They are subvolcanic sediments and are composed of sandstone and mudstone containing conglomerate beds, and are 13 m in thickness. They are generally ill-sorted, and contain quartz breccias and calcareous coatings. The formation is interbedded with three laminated mudstone beds at its upper, middle and lower horizons. They contain intercalated diatomaceous seams and yield fossil fishes. Toward the southwest, the mudstone thin out and coarse materials become dominant. The top of the formation consists of hard sandy pebble breccias.

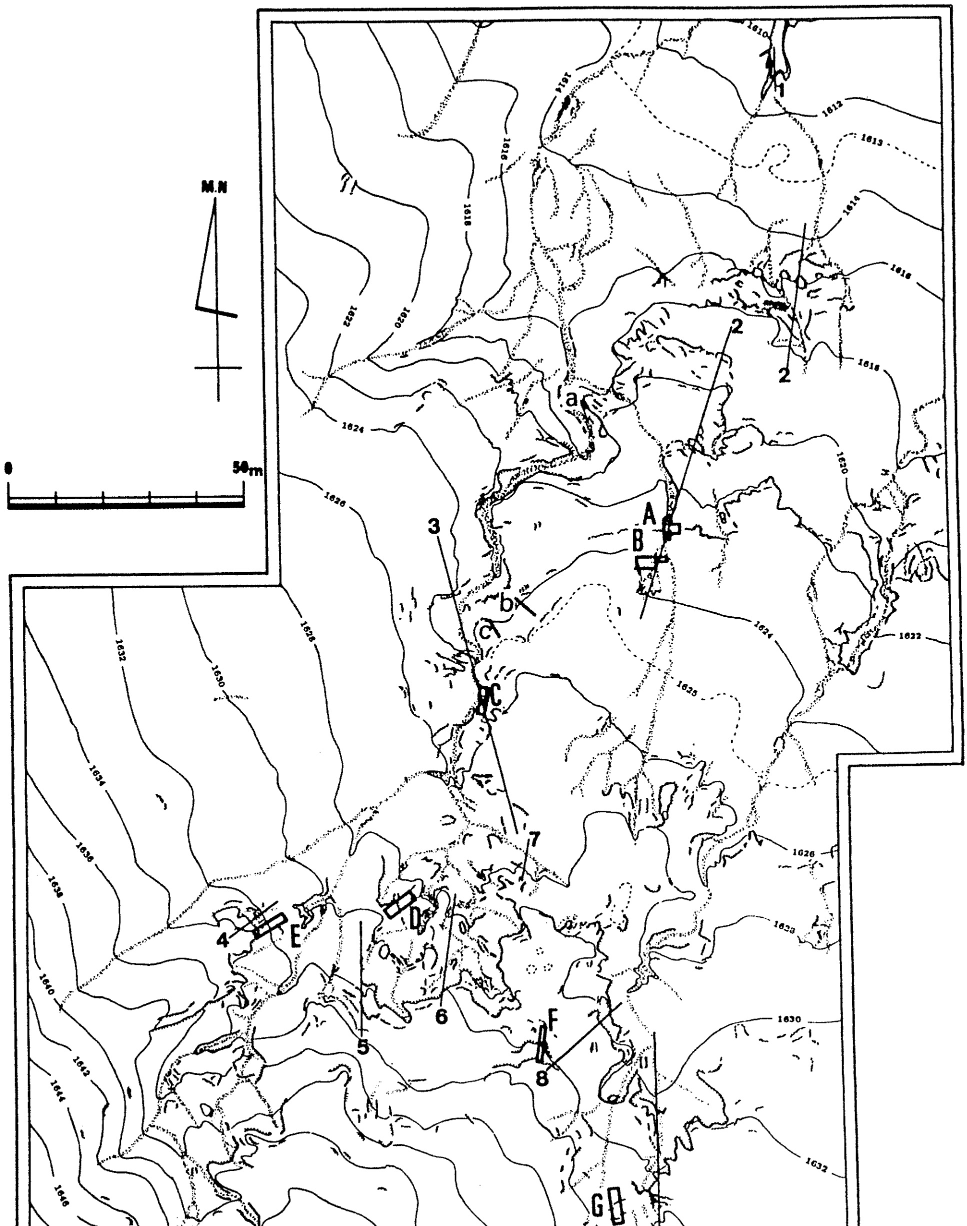
In the northern and central part two layers of light reddish-coloured, fine-grained, hard tuff are exposed which contain apatite and zircon.

Fifty five pieces of fossil were obtained by surface collection. They are Deinotheriidae, Gomphotheridae, ?Giraffidae, Crocodylidae and Chelonia. Fossil Gastropods were also taken by surface collection (see Appendix).

The calcareous coatings of tree trunks, pointing N50°E, were discovered in the upper part of the South Kirimun. The outer mold of trunk is impressed on their inner surface.

On the course of survey, the excavations were carried out at eleven sites as shown in Fig. 10 in order to find out fossils and to make more precise geological observations. Seven sites A to G were for fossils and from sites a to d were for geological observations. Details of each excavation sites are described in the following paragraphs. Their ground plans, sketches of walls and columns are shown in Figures 12-19.

Fig. 10 (next page) Large-scale map of South Kirimun by land surveying in 1980. Original map was drown on a scale of 1 to 500. Area covered by this map is indicated in Fig. 8. A to G show excavation sites for fossils. a to d show location of trenches for geological survey. 1 to 9 show locations of sections of Fig. 11.


M.N
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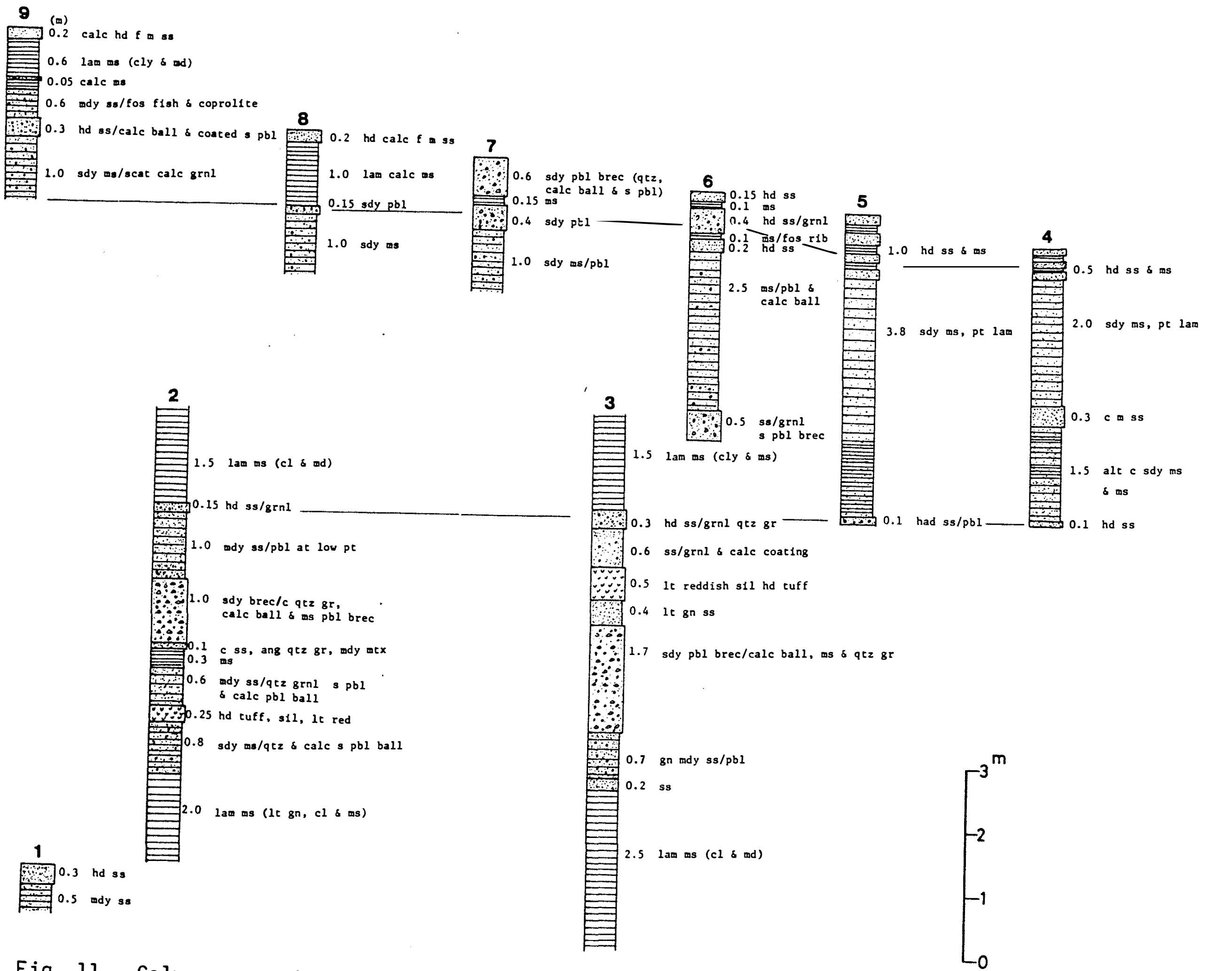


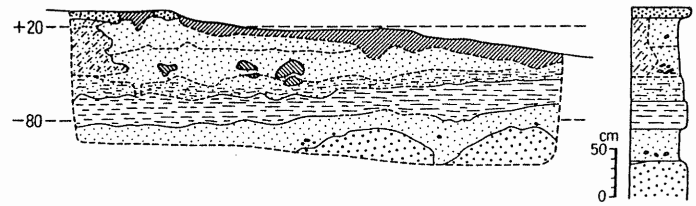
Fig. 11 Columnar sections of Kirimun Formation in South Kirimun. Abbreviations are followed to the list of Mitchel and Maher (1957).

1) Site A Some fragments of fossil bone of crocodile were found at this site. They occurred from the lower part of greenish grey muddy sandstone, 60 to 80 cm thick. At the end of this excavated work, the lower jaw of presumed genus Ethecondon was found at the center of the bottom of the trench. The tip of jaw was faced to S50°W. It was buried again to excavate carefully for the next time. The succession of the sediments which was observed at the western wall of the excavated site A are as follows in descending order.

cm	
8 - 14	hard light grey very coarse-grained sandstone with granule gravels
60 - 68	upper part: brown to greenish grey coase- to medium-grained gravels lower part: greenish grey muddy sandstone southern part: hard light grey medium- to coarse-grained sandstone
10 - 24	greenish grey muddy sandstone
18 - 38	yellowish sandy mudstone with rarely coprolite
18 - 50	greenish grey muddy coarse- to medium-grained sandstone with pinkish fine tuff breccias
1	white mudstone
40	light grey coarse- to medium-grained sandstone, hard

2) Site B The fragments of crocodile bones were found to be scattered on the surface of this site. The geologic succession is presented below in descending order.

cm	
3	white very fine-grained sandstone, hard
14 - 23	greenish grey laminated mudstone
17 - 29	greenish grey mudstone with crocodile bones
22 - 31	greenish grey sandy mudstone and muddy sandstone with coprolite, interbedded laminated mudstone containing fish fossils in the upper part
9 - 12	hard light grey sandstone.



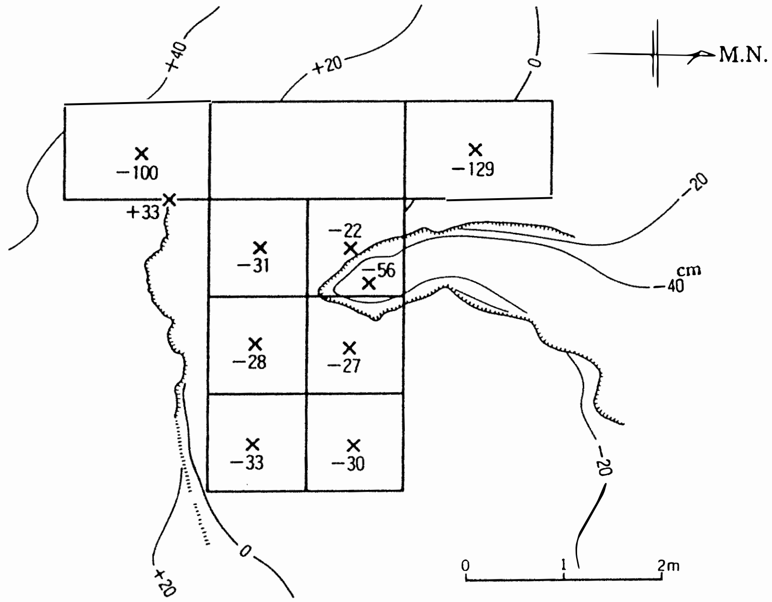


Fig. 12 Plan, sketch of wall and column of excavation at Site A.

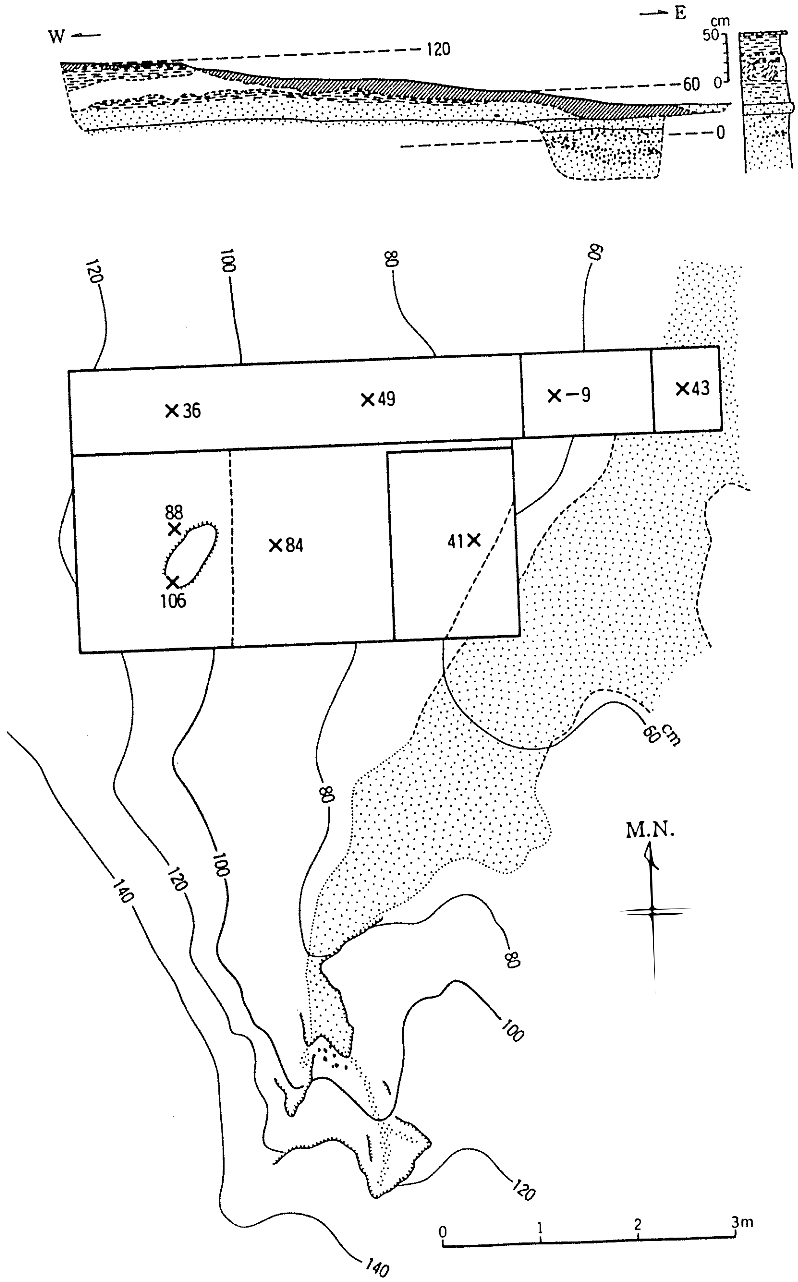


Fig. 13 Plan, sketch of wall and column of excavation at Site B.

57	light grey coarse- to fine-grained sandstone, hard

3) Site C At site C, following rocks crop out in descending order. A rhinoceros fossil was found in the sandstone beneath tuff.

cm	
25	light grey coarse-grained sandstone with granules and pebbles
30 - 45	pinkish hard fine-grained tuff
40	light grey ill-sorted medium- to coarse-grained muddy sandstone, with coprolite and light pink soft mudstone pebbles

The lowest muddy sandstone yielded many fossils. Their disposal are shown in Figure 15. In addition, abundant small fossils were also collected by washing and sieving the sandstone. Obtained fossils from this site are listed below.

Class Mammalia

Order Rodentia

Paraphiomys cf. pigotti Andrews

P. sp.

?Megapedetes sp.

Afrocricetodon sp.

Order Carnivora

Carnivora, fam., gen. et sp. indet.

Order Proboscidea

Deinotheriidae, gen. et sp. indet.

Order Hyracoidea

?Procaviidae, gen. et sp. indet.

Order Preissodactyla

Brachypotherium heinzelini Hooijer

Order Artiodactyla

Sanitherium sp.

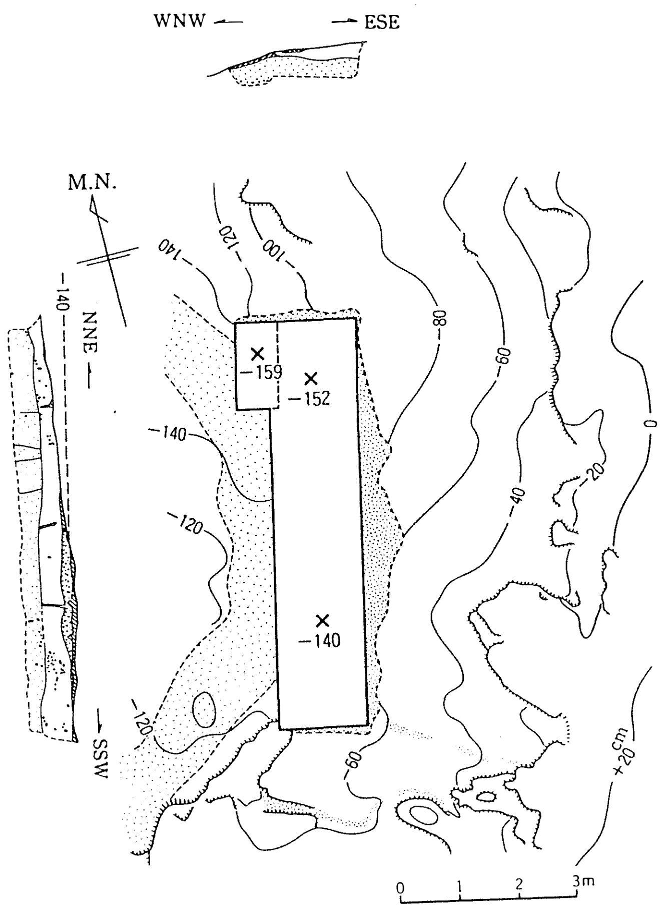
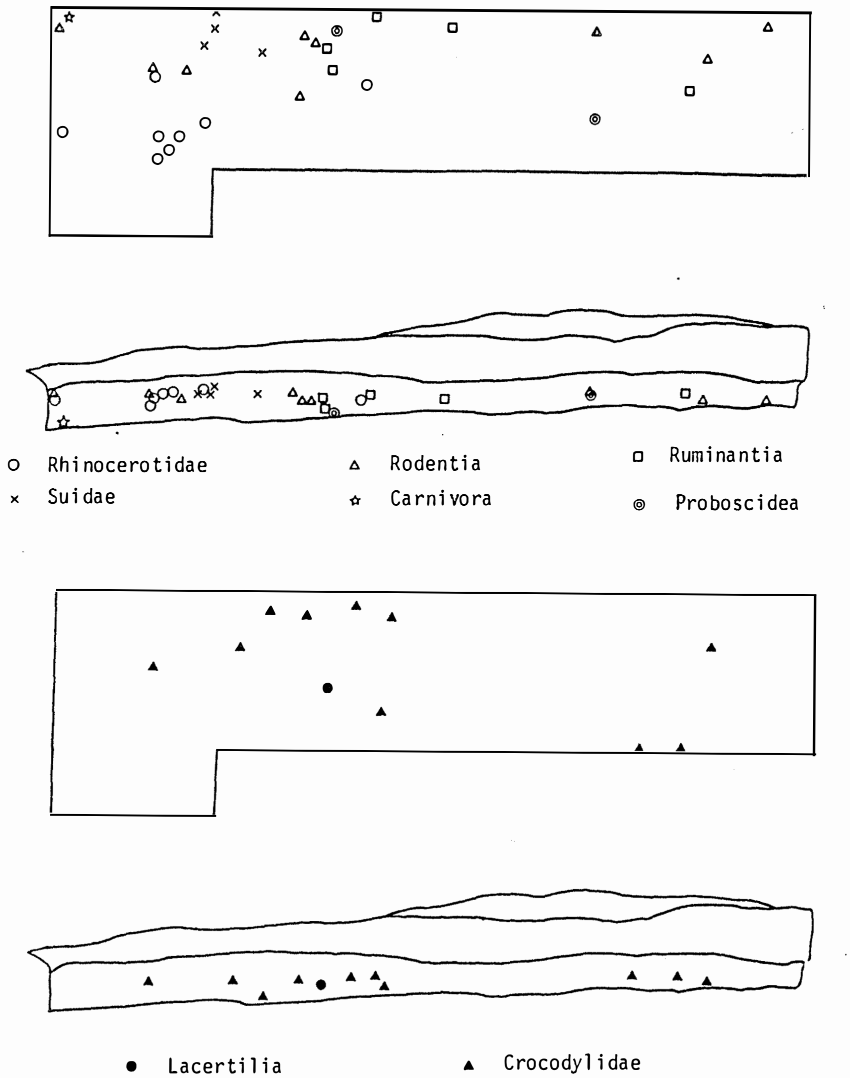


Fig. 14 Plan and sketches of wall of excavation at Site C.



ig. 15 Disposition of fossil bones in the Site C of South Kirimun. (a) mammal, (b) reptile. Each upper figure is horizontal projection and each lower figure is vertical projection.

?Giraffidae, gen. et sp. indet

Dorcatherium cf. pigotti Whitworth

D. sp.

Class Reptilia

Order Crocodilia

Crocodylidae, gen. et sp. indet.

Order Chelonia

Chelonia, not Trionychidae

Order Squamata

Ohidia, fam., gen. et sp. indet.

Lacertilia, fam., gen. et sp. indet.

Class Amphibia

Order Anura

Anura, fam., gen. et sp. indet.

Class Pisces

Pisces, order, fam., gen. et sp. indet.

Class Gastropoda

Gastropoda, order, fam., gen. et sp. indet.

4) Site D At site D, sandstone were exposed and did not yield any fossil. Geologic succession is as follows in descending order.

cm	
100	ill-sorted muddy sandstone
20	well-sorted medium- to fine-grained sandstone
50	light grey and white medium- to coarse-grained sandstone
80	ill-sorted coarse- to medium-grained sandstone with granules and pebbles.

5) Site E A fossil bone of rib was found to be exposed on the wall of this locality, and geologic succession in descending order is as follows.

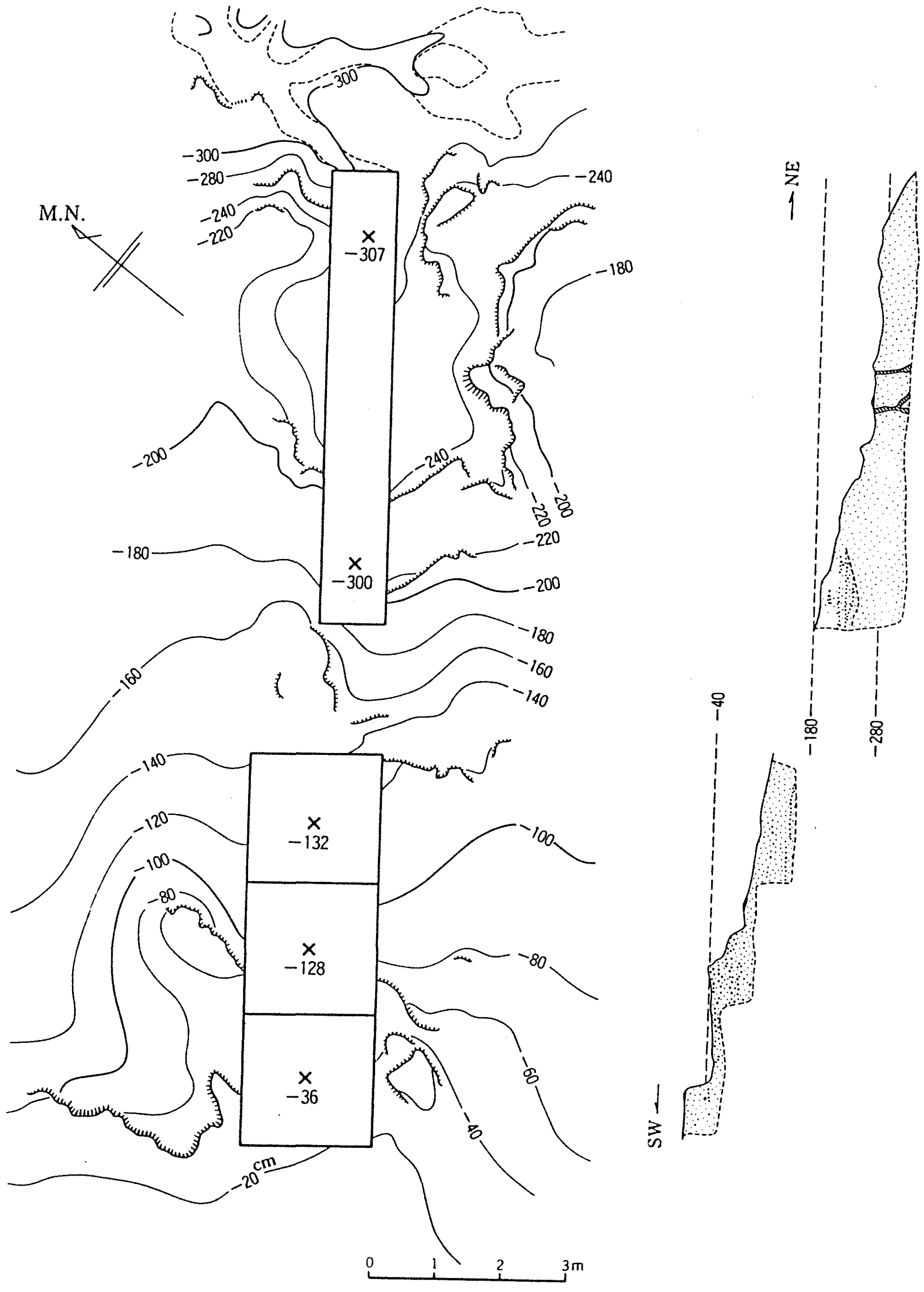


Fig. 16 Plan and sketch of wall of excavation at Site D.

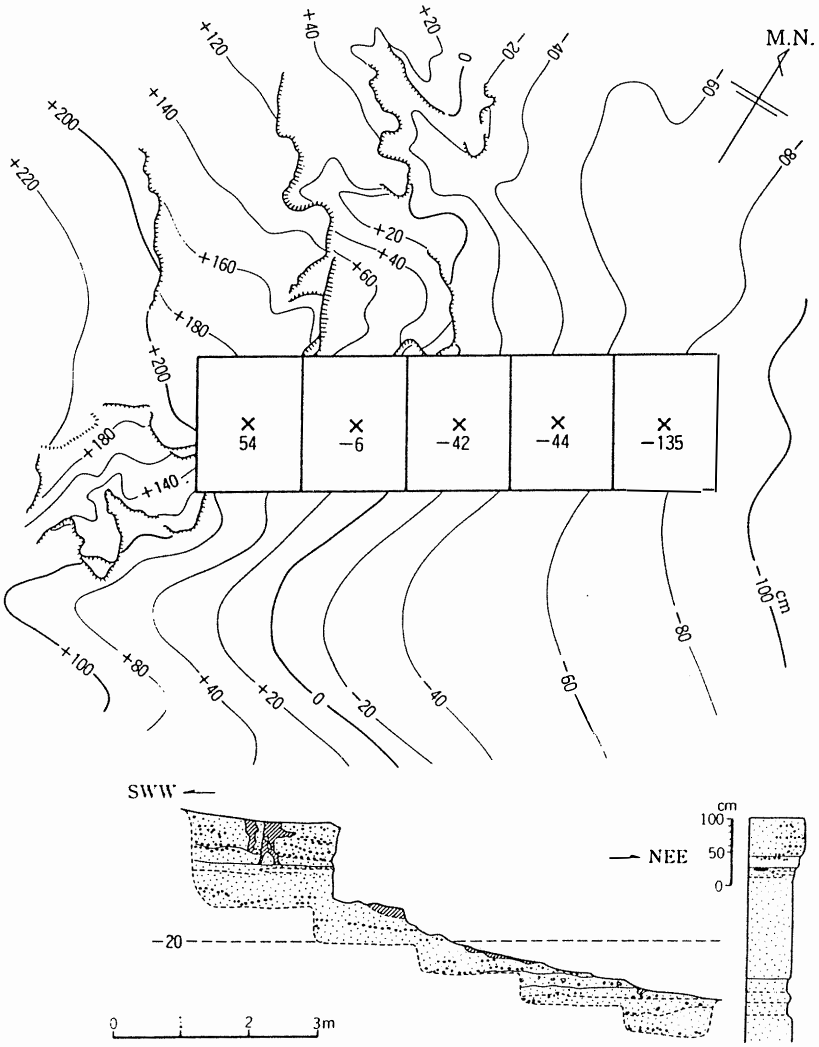


Fig. 17 Plan, sketch of wall and column of excavation at Site E.

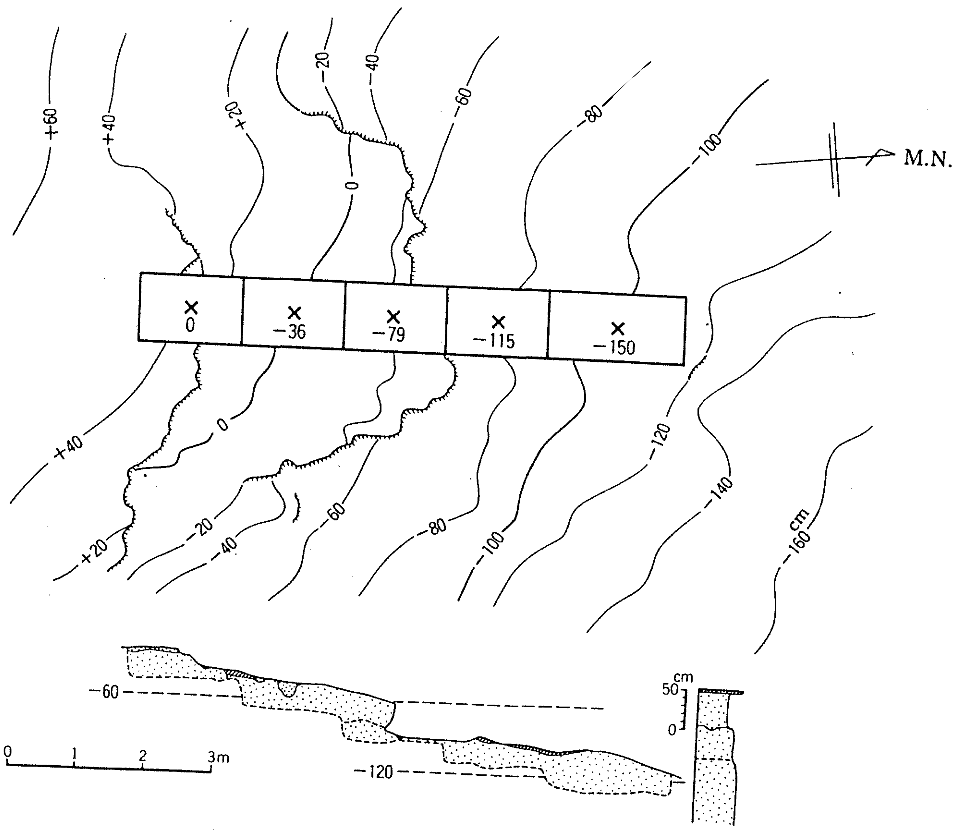


Fig. 18 Plan, sketch of wall and column of excavation at Site F.

cm	
56	hard coarse-grained sandstone with granules and pebbles in SSW part
8 - 24	hard medium- to fine-grained sandstone, well-sorted
13 - 16	coarse- to medium-grained sandstone with biotite, fossil bone of rib occurred from the upper part
152	medium- to fine-grained sandstone with pebbles and granules
14 - 24	well-sorted medium-grained sandstone with coprolites
10 - 16	medium- to coarse-grained sandstone
12 - 24	coarse-grained sandstone, and very coarse-grained sandstone in the basal part
44	medium-grained sandstone with pebbles and granules

6) Site F Geologic succession of this site is listed below in descending order.

cm	
4	hard coarse- to medium-grained sandstone.
43 - 62	well-sorted coarse-grained sandstone
63 - 32	hard massive ill-sorted medium- to coarse-grained muddy sandstone with pebbles and granules

7) Site G This site is excavated to observe the upper part of sedimentary rocks in South Kirimun.

cm	
22 - 34	laminated sandstone and mudstone
6 - 3	coarse- to medium-grained sandstone with well-preserved fossil fishes
5 - 2	light yellow well-sorted very fine-grained sandstone
4 - 11	coarse- to medium-grained sandstone with fossil fishes
5 - 0	light yellow well-sorted very fine-grained sandstone (diatomite?)
58 - 46	light greenish grey coarse- to medium-grained sandstone with fossil fishes
5	well-sorted hard medium-grained sandstone

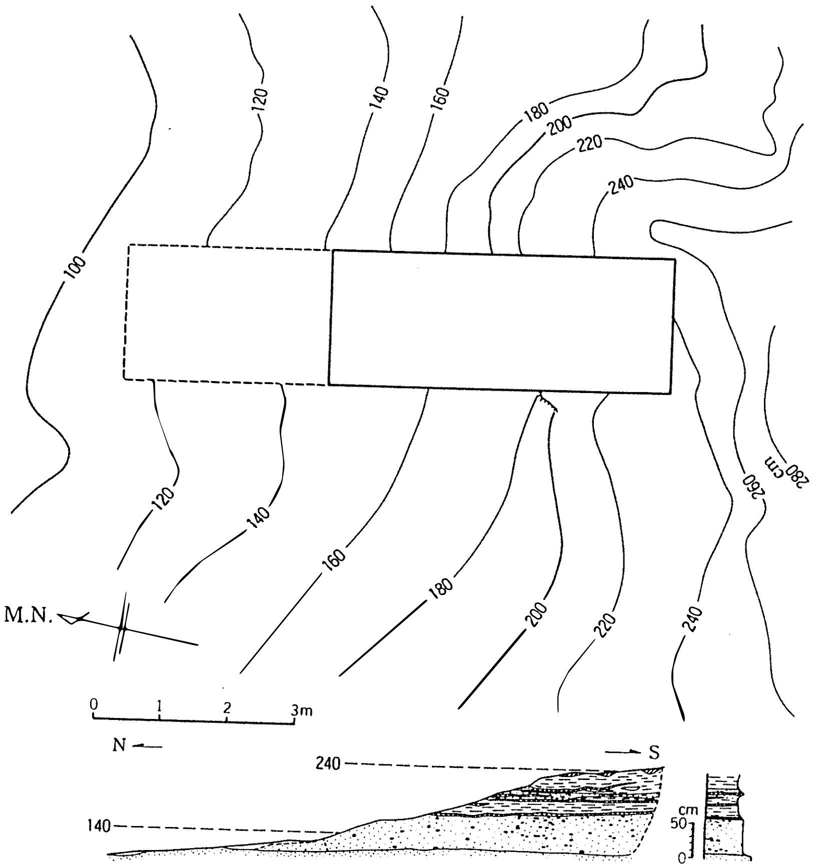


Fig. 19 Plan, sketch of wall and column of excavation at Site G.

The geologic trench a was made on the right cliff of wadi at the northern part of South Kirimun, where laminated mudstone was exposed. The trench b and c were excavated to trace the fine-grained tuff which was exposed in Site C as illustrated in Fig. 20. The tuff thinned out and is blocked towards southeast at the trench c. In the trench b, it was not found in muddy sandstone.

The trench d was made at the top of hill consisting of South Kirimun. However, muddy soil more than 1 m thick was only observed in this trench.

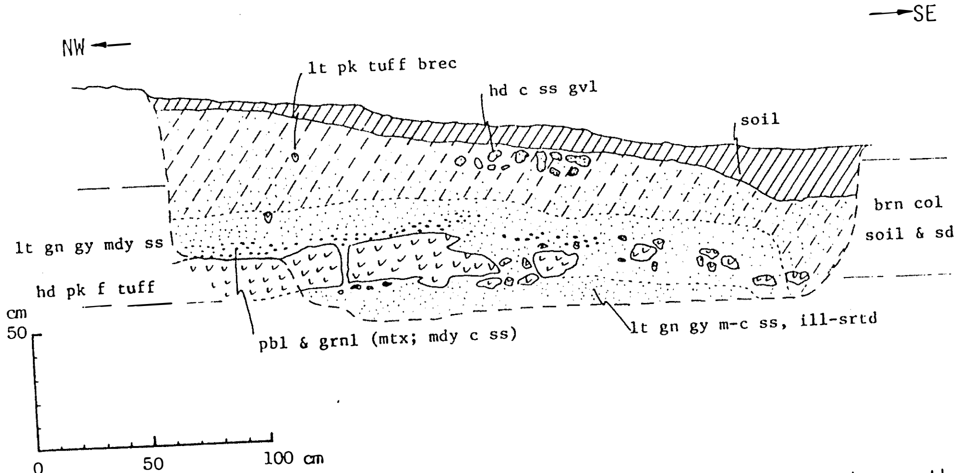


Fig. 20 Thinning out of the tuff is observable from sketch of the south facing wall of the trench c.

d. Kirimun River

Subvolcanic sediments composed mainly of sandstone and conglomerate with subordinate mudstone also crop out along the valley of the Kirimun River between Kirimun spring and the phonolite outlier, west of South Kirimun.

Two flat planes are observed in the Kirimun area. The higher one is the upper surface of the Upper Rumuruti Phonolite and the lower one of the Lower Rumuruti Phonolite. Between the two, a steep cliff is developed. The Kirimun village is on the Lower Rumuruti Phonolite. The surface of the Upper Rumuruti Phonolite is about 60 m above the level of village. The boundary of the two lavas is situated at the lower level of the cliff.

e. Shackleton Kirimun

Sedimentary rocks in the vicinity of Shackleton Kirimun are widely distributed as shown in Fig. 5-a. In the central part many outcrops are observed. Shackleton (1946) reported the occurrence of Deinotherium hobleyi and Mastodon sp. from this site. The sedimentary rocks are exposed in a small area in the northwestern and southern parts since they are widely covered by talus deposit from phonolite cliffs. The Lower Rumuruti Phonolite is widely distributed to the west of the sedimentary rocks and rests on them. To the north, south and east, the basement rocks are distributed in topographically lower areas. There is a small hill on the east of Shackleton Kirimun. The top of it is flat and is about 20 m higher than the upper surface of the Lower Rumuruti Phonolite. It is composed of pitchstone, laminated porcellanite and prophyritic phonolite lava (the Upper Rumuruti Phonolite ?) in ascending order, which lie on the sedimentary rocks. A small height of the basement rocks, west of Shackleton Kirimun, is covered directly by the Lower Rumuruti Phonolite.

Main outcrops in Shackleton Kirimun are exposed in a valley, 400 m wide, on the southeast side of a gentle ridge running in a southwest direction from the eastern hill. A narrow spur (the central ridge) in the central part of the valley divides the valley into the eastern gouge and western gouge.

The sedimentary rocks in the valley strike N30° to 50°E, and dip 8° to 10°SE. In the southwest of the western gouge, the sedimentary rocks abut on the basement rocks and strike N30° to 70°W, and dip 10° to 20°NE.

he geologic columns of the sedimentary rocks in the valley are shown by C to G in Fig. 7. C and D are observed from the bottom of the eastern gouge to the western slope of the east hill. E is on the central ridge, and F and G are in the western gouge. Two marker beds, hard sandstone of the lower horizon and diatomaceous mudstone of the middle horizon, are well traced from the western to eastern gouges.

The total thickness of the sedimentary rocks is about 50 m. The fossils are obtained from the horizons just above and below the diatomaceous mudstone bed.

Three hundred metres north of the valley, sandstone and conglomerate are exposed. Five hundred metres northwest, they rest on laminated siltstone, 1.5 m thick. Five hundred metres south-southwest, sandstone and conglomerate, 5-6 m thick are exposed, and covered by pitchstone and porphyritic phonolite (the Upper Rumuruti Phonolite). One and half kilometres further south, a thin conglomerate bed unconformably lies on the basement rocks and is overlain by the porphyritic phonolite (the Upper Rumuruti Phonolite). These sedimentary rocks yielded no fossil.

In this area, we collected fragmental fossils of Gomphoteriidae, Crocodylidae, Chelonia and Pisces.

(iii) Palagalagi area

In the Palagalagi area, the phonolite plateau is widely distributed northwards and westwards, and a narrow belt of phonolite, extending to the southeast, occupies the central part of this area. The cliffs of the phonolite are about 30 m high, along the plateau. The east and south areas are underlain by the basement rocks and are topographically lower. The sedimenatary rocks are exposed in four places separated by the phonolite and the basement rocks (Fig. 5-b). They are GR6371, GR6271, Mbagathi (North and South), and Shackleton Palagalagi.

a. GR 6371

The extension of sedimentary rocks in this place is bounded on the north and south by porphyritic phonolite lava (the Upper Rumuruti Phonolite). In the west they are eroded to the level of the basement rocks. The geologic columns in this area are shown by K and L in Fig. 7. The sedimentary rocks, 19 m thick, unconformably cover the basement rocks, and are composed of breccia, muddy sandstone, coarse-grained sandstone containing small amount of granules, muddy sandstone, coarse- to medium-grained sandstone or conglomerate, sandy mudstone of fine-grained sandstone, and conglomerate in ascending order. They are piled horizontally.

From this area, 1192 pieces of fossil were collected. A half of them is mammal.

They are Gomphotheriidae, Deinotheriidae, Rhinocerotidae, ?Giraffidae, Crocodylidae, Pelomedusidae, Testudinidae, Tronychidae and Pisces. Since they were collected from the surface, their horizons are not obvious.

b. GR 6271

GR6271 is bounded by the porphyritic phonolite lava, and by the basement rocks exposed in the southwest. The sedimentary rocks crop out mainly in four gullies. They unconformably cover the basement rocks and consist of conglomerate, mudstone, hard sandstone, laminated mudstone(diatomite?), in ascending order. Their total thickness is about 10 m as shown in Fig. 7 (columns H, I and J). No fossil was obtained from this place. It is topographically higher than the GR6371, and the sedimentary rocks in both are horizontally piled. Consequently, the sedimentary rocks of GR6271 are presumably higher than those of the GR6371.

c. Mbagathi North and Mbagathi South

The sedimentary rocks are exposed for 2 km north to south, and 1 km wide in EW direction. They are covered by porphyritic phonolite lava on the west and north, and the basement rocks are widely exposed to the east. A small outlier of the porphyritic phonolite exists in central part of this area and divids it into two parts, that is Mbagathi North and Mbagathi South.

In Mbagathi North, the sedimentary rocks rest on the basement rocks, and are composed, in ascending order of conglomerate, muddy sandstone, hard sandstone, laminated mudstone, white hard mudstone and mudstone. They are horizontal and 13 m thick (Fig. 7, column M). Fossils from this site are obtained mostly from the horizon of muddy sandstone and above it.

In Mbagathi South, the sedimentary rocks are composed of muddy sandstone, conglomerate, muddy sandstone, hard sandstone, laminated mudstone, white hard mudstone and muddy sandstone in ascending order. They are flat, and are 15 m thick (Fig. 7, columns N and O). The laminated mudstone and muddy sandstone of the upper horizon yield plenty of fossils of crocodile and chelonia. Ripple marks are developed on the hard sandstone.

d. Shackleton Palagalagi

The sedimentary rocks in the Shackleton Palagalagi are mainly of conglomerate, 35 m thick, which overlies a thin muddy sandstone bed, 3 m thick (Fig. 7, column P). They are overlain by porphyritic phonolite in the north and west, and abut on the basement rocks at the west.

From this area, twenty five pieces of fossil were collected. They belong to Probosidea, Rhinocerotidae, Crocodylidae, Trionychidae, Chelonia and Pisces.

As shown in Fig. 7, the sedimentary rocks of these four places can be correlated with each other. In GR6371 and Shackleton Palagalagi, the lower part of the sedimentary rocks is observed, and in GR6271 the upper part are exposed. In the Mbagathi North and Mbagathi South, whole succession of the sedimentary rocks is observable.

Wilkinson (1976) was reported _Listriodon skatilubas_ and _L. akatidogus_ from Mbagathi. We collected 1116 pieces of fossil. They are Rhinocerotidae, Ruminantia, Crocodylidae, _Penusios_ sp., Trionychidae, Lacertilia, Pisces and Gastropoda.

3. Radiometric Age Determination

K-Ar and fission-track age determinations on the Miocene volcanic rocks in the Kirimun district were carried out to estimate the age of the vertebrate fossils. Two whole rock K-Ar ages were already reported for the phonolite lavas by Baker et al. (1971). They mentioned the sampling horizons to be the Upper Rumuruti Phonolite and the Lower Rumuruti Phonolite which correspond to the upper and lower flow of the Shackleton's Rumuruti Phonolite, respectively. The K-Ar age of the former is 11.3 ± 0.3 Ma, and that of the latter is 12.3 ± 0.6 Ma after recalculation by adopting the newly established decay constant and isotope abundance (Steiger and Jäger, 1977).

Two samples, KE-8091101 (phonolite welded tuff) and KE-8090902 (Infra-Rumuruti Phonolite), were collected from the horizon which stratigraphically are closer to the fossil bearing beds than Baker's sampling horizon. Both samples were collected in the valley of the River Nayantoloo as shown in the Fig. 8.

(i) KE-8091101 (fission-track method)

The sample was obtained from the phonolite welded tuff which was considered the lowest member of the Miocene volcanic rocks in the studied area. It is characterized by an eutaxitic texture which means high temperature deposition and subsequent welding. It also includes little amount of lithic fragments. The fission-track age determination was performed on zircon separates from the sample.

The fission-track age, T years, can be represented by the following equation (Price and Walker, 1963).

$$T = \frac{1}{\lambda} \ln\left(1 + \frac{\lambda}{\lambda_f} \frac{\rho_s \phi \sigma}{\rho_i \eta}\right) \text{ --------------(1)}$$

where ρ_s is the fossil fission-track density (cm^{-2}), ρ_i is the induced fission-track density (cm^{-2}), λ is the total decay constant for ^{238}U, λ_f is fission decay constant for ^{238}U (7.03×10^{-17} yr^{-1}), σ is the thermal neutron cross section for fission of ^{235}U (cm^2), ϕ is the thermal neutron dose (cm^{-2}), and η is the isotope ratio $^{235}U/^{238}U$. If T is smaller than 10^9yr., the equation (1) can be written as follows.

$$T = 5.96 \times 10^{-8} \phi \frac{\rho_s}{\rho_i} \text{ ---------------(2)}$$

Both the fossil and induced fission-track densities are counted on the same external surface of the same grain. The procedure of the age determination was performed following the method of Nishimura and Yokoyama(1973) and Yokoyama et al.(1980). A thermal neutron was irradiated in the KUR-1 reactor of Kyoto University.

The result of the age determination on 16 grains are shown in Table 1, and the age histogram of each grain is shown in Fig. 21. The age of each grain ranges between 13 to 19 Ma. From the frequency pattern, it is considered to all grains are the essential material of this tuff. Although some grains are slightly rounded and it is considered to be accidental, their ages agree with that of non-rounded

Table 1 Fission-track ages of individual zircon grains from the welded tuff (KE-8091101).

Grain no.	Spontaneous fission-track N_s	ρ_s (cm^{-2})	Induced fission-track N_i	ρ_i (cm^{-2})	fission-track age T (Ma)
1	37	9.87×10^5	166	4.43×10^6	13.3
2	109	4.89	403	1.81	16.1
3	72	16.4	233	5.32	18.4
4	11	3.61	42	1.38	15.6
5	16	3.05	71	1.35	13.5
6	28	4.31	112	1.72	14.9
7	45	9.47	171	3.60	15.7
8	42	9.55	184	4.18	13.6
9	57	12.3	175	3.77	19.4
10	42	3.39	188	1.52	13.3
11	26	2.63	113	1.14	13.7
12	29	8.92	129	3.97	13.4
13	19	5.85	85	2.62	13.3
14	38	4.65	164	2.00	13.9
15	79	10.4	306	4.04	15.3
16	59	7.26	227	2.79	15.5
Total	709	6.35×10^5	2769	2.48×10^6	

$\lambda_f = 7.03 \times 10^{-17} yr^{-1}$. $\Phi = 1.00 \times 10^{15} cm^2$.

Fission-track age calculated from total number of tracks counted: 15 ± 1 (σ) Ma.

Mean fission-track age of grains: 15 ± 2 (σ) Ma.

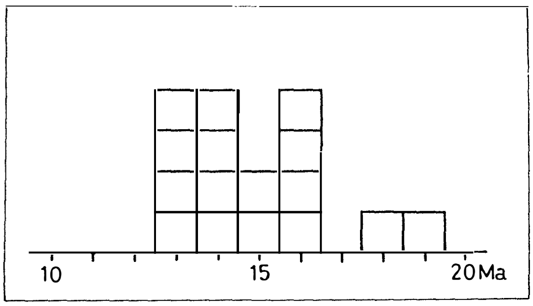


Fig. 21 Distribution of fission-track ages on individual grains of zircon crystals from the welded tuff (KE-8091101). Calculated age is 15 + 1 Ma.

grains. This fact suggests that the fossil tracks of the rounded grains, namely older in age, were anealed out at the time of welding. Consequently, all ages of grains are considered to show the age of the eruption of this welded tuff. The total numbers of spontaneous and induced tracks counted are 706 and 2769, respectively. The fission-track age of this sample is calculated at 15 ± 1 Ma.

(ii) KE-8090902 (K-Ar mehtod)

The sample was obtained from the Infra-Rumuruti Phonolite. It is composed of aphanitic phonolite. The minerals of the groundmass are aegirine-augite, aegirine, alkali amphibole, small laths of orthoclase, nepheline, analcite, and opaque minerals. A small amount of secondary carbonate mineral occurs in the groundmass. Therefore, this sample might be slightly altered.

Whole-rock K-Ar age determination of this sample was carried out by the Teledyne Isotopes (New Jersey, U.S.A.). The detail of the result are listed in Table 2. The age obtained was 11.4 ± 0.6 Ma.

Table 2 K-Ar age of whole-rock sample from the Infra-Rumuruti Phonolite (KE-8090902).

scc Ar^{40Rad}/ gr $\times 10^{-5}$	% Ar^{40Rad}	% K	Isotopic Age
0.194	66.2	4.37	11.4 ± 0.6 Ma
0.194	71.3	4.38	

$\lambda_\beta = 4.962 \times 10^{-10} yr^{-1}$, $\lambda_\varepsilon = 0.581 \times 10^{-10} yr^{-1}$

$^{40}K = 1.167 \times 10^{-4}$ atom/atom on natural K

The K-Ar age of the Infra-Rumuruti Phonolite is very close to the ages of the Upper and Lower Rumuruti Phonolite cited in the paper of Baker et al.(1971) as mentioned before. There is no significant difference among these age data. Therefore, these phonolite lavas possibly erupted in quite short intervals around 12 Ma.

The fission-track age of the welded tuff was determined to be 15 $\pm$ 1 Ma. The welded tuff is considered to be the lowest member of the Miocene volcanic rocks in this area. The Kirimun Formation yielding fossils is thought to be covered by the welded tuff. Thus, the fossil beds are older than 15 Ma, and are presumably of the Early to Middle Miocene Period.

4. Palaeomagnetic Study

Samples for a palaeomagnetic study were collected from thirty sites around Kirimun. The locality and geologic setting of each site are shown in Fig. 8 and Table 3. At least six block samples were collected from each site, after orientation with a specially designed clino-compass. From each block sample, several cylindrical specimens were drilled in the laboratory at Kyoto University.

The direction and intensity of natural remanent magnetization (NRM) were measured with a spinner magnetometer (Schonstedt SSM-1A). In this study, the palaeomagnetic procedure was to first measure NRMs before any demagnetization treatments. The next step was to demagnetize two or three pilot specimens from each site by alternating field demagnetization (AFD) in small increments up to 1400 Oe peak field (in the maximum case). From the results of the pilot study, an optimum field value was selected for the partial AFD. The other pilot specimens were subjected to a progressive thermal demagnetization (ThD) up to 600°C. The initial susceptibility value (X) was also measured following each step of progressive ThD by using a magnetic susceptibility meter (Bison model 3101). These measurements were done to detect a change in the magnetic property of the specimen. Additional measurements for the change of strong-field magnetization with increasing temperature were performed for each site by using an automatic thermomagnetic

Table 3 List of sampling locality, rock type, and geologic formation of each site.

SITE	LOCALITY	ROCK TYPE	FORMATION
1	Sotuh Kirimun	tuff	Kirimun Formation
2	Sotuh Kirimun	tuff	Kirimun Formation
3	Shackleton Kirimun	porphyritic phonolite	Upper Rumuruti Phonolite
4	Shackleton Kirimun	pitchstone	
5	Shackleton Kirimun	siltstone	Kirimun Formation
6	Shackleton Kirimun	siltstone	Kirimun Formation
7	south of Shackleton Kirimun	porphyritic phonolite	Upper Rumuruti Phonolite
8	west of Kirimun spring	porphyritic phonolite	Upper Rumuruti Phonolite
9	Kirimun spring	aphanitic phonolite	Lower Rumuruti Phonolite
10	Nayantoloo gorge	aphanitic phonolite	Lower Rumuruti Phonolite
11	Nayantoloo gorge	aphanitic phonolite	Infra-Rumuruti Phonolite
12	Nayantoloo gorge	aphanitic phonolite	Infra-Rumuruti Phonolite
13	Kirimun spring	aphanitic phonolite	Lower Rumuruti Phonolite
14	South Kirimun	aphanitic phonolite	Lower Rumuruti Phonolite
15	Nayantoloo gorge	aphanitic phonolite	Lower Rumuruti Phonolite
16	Garma	porphyritic phonolite (composit)	(Seya)
17	Nayantoloo gorge	aphanitic phonolite	Infra-Rumuruti Phonolite
18	Luisie Pass	aphanitic phonolite (composit)	
19	Luisie Pass	porphyritic phonolite (composit)	
20	Palagalagi	porphyritic phonolite	Upper Rumuruti Phonolite (?)
21	Ewasa Narok	porphyritic phonolite	Upper Rumuruti Phonolite (?)
22	Palagalagi	porphyritic phonolite	Upper Rumuruti Phonolite (?)
23	Nkoteyia	aphanitic phonolite	Lower Rumuruti Phonolite
24	Nkoteyia	aphanitic phonolite	Lower Rumuruti Phonolite
25	Kirimun spring	aphanitic phonolite	Lower Rumuruti Phonolite
26	Garma	aphanitic/porphyritic phonolite (composit)	(Seya)
27	south of Kirimun spring	aphanitic phonolite	Lower Rumuruti Phonolite
28	west of Kirimun spring	porphyritic phonolite	Upper Rumuruti Phonolite
29	west of Kirimun spring	porphyritic phonolite	Upper Rumuruti Phonolite
30	west of Kirimun spring	porphyritic phonolite	Upper Rumuruti Phonolite

balance. A strong-field magnetization curve and microscopic observation under reflecting light were used to provide magnetominealogical data of the specimen as discussed below.

The intensity of NRM of the phonolite lavas ranges from 10^{-2} to 10^{-4}emu/gr, which shows rather wide variation. On the other hand, sediments of the Kirimun Formation were very weak in intensity; the intensity of the tuff was 10^{-6}emu/gr and the siltstone was 10^{-7}emu/gr. The magnetization of the siltstone was practically unmeasurable after partial demagnetization.

The NRM direction from the majority of the sites showed unreasonable scatter before the demagnetization. Most specimens showed a rapid decrease in intensity to AFD. A representative value of median destructive field (MDF) was less than 50 Oe, and only one hundredth of the initial intensity remained after the demagnetization of 400 Oe. The direction of NRMs, however, showed a significant clustering after appropriate partial AFD for about sixty percent of the sites.

The thermal method of demagnetization was not effective for removing secondary components of remanence; by this it is meant that the direction of the pilot specimens did not converges during thermal treatment. An increase of inhomogeneity within a specimen and a sudden jump of χ value were usually observed with the rising of temperature. In addition, thermal demagnetization was complicated by a number of specimens of the phonolite lavas shattering at the temperature of about 300°C. This explosive nature of the rocks has been already reported by Patel and Gacii (1972) for the Kapiti Phonolite of Miocene age from the southern part of Kenya. Thus thermal method was not employed in this study for the partial demagnetization of the sites. In the following paragraphs, two typical results of experiments are presented in detail.

Fig. 22 shows the result from Site 30, which was situated on the surface of the lava plateau of the Upper Rumuruti Phonolite at the west of Kirimun spring. This site showed the most successful results of all the sites. As shown in the diagram of the progressive AFD (Fig. 22-c), the pilot specimen has a very stable remanent direction and a relatively high MDF value (ca. 200 Oe). NRM directions

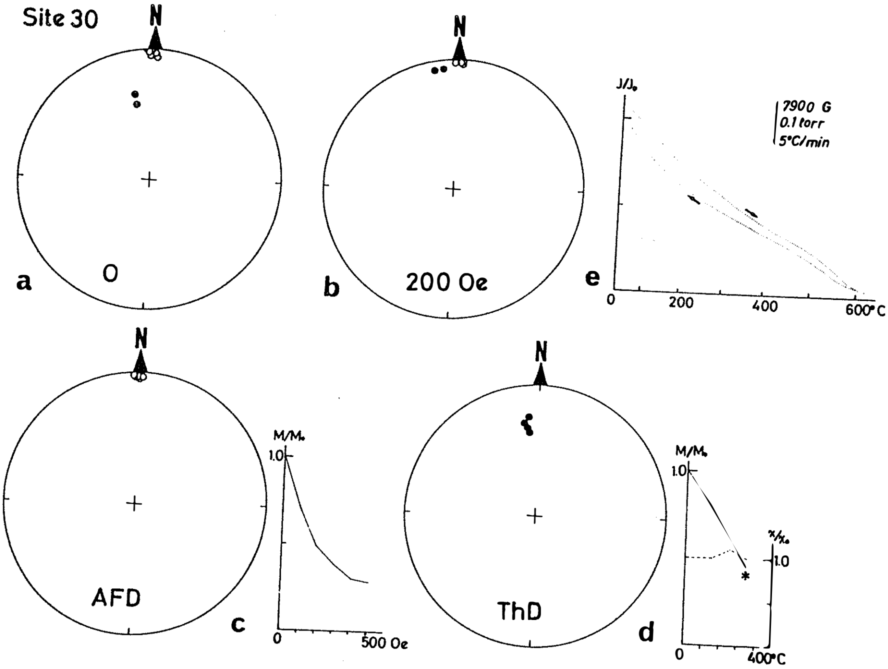


Fig. 22 Typical results of successful site. (a) NRM directions before demagnetization. (b) NRM directions after partial AFD of 200 Oe. (c) Change of direction and intensity of pilot specimen by progressive AFD up to 500 Oe. (d) Change of direction, intensity (solid line), and initial susceptibility (dashed line) by progressive ThD up to 350°C. (e) Strong-field magnetization curve of heating and cooling process.

after AFD of 200 Oe make a tight cluster of normal polarity. The stability of the remanent direction is also shown from the result of ThD on pilot specimen (Fig. 22-d). The change of X value by stepwise heating did not show any remarkable change, however X value were not obtained above 350°C because of shattering. The cooling curve of thermomagnetic analysis approximately retrace the heating curve, and indicates a single Curie temperature (Tc) which is identical with that of magnetite (Fig. 22-e). When a polished surface of the specimen was examined under a reflecting microscope. microphenocrysts of magnetite with ilmenite lamellae were visible. These facts suggest in situ high temperature oxidation, which may explain the reason of the high stability of the NRM. The reversibility of the strong-field magnetization curve was only observed for the samples from the upper surface of the Upper Rumuruti Phonolite (Site 28, 29 and 30). This result may possibly be explained by in situ oxidation at the time of the emplacement of the lava flow. It is interpreted that the rocks of this type represent the primary thermal remanence.

Fig. 23 shows the other type of magnetic behavior which characterize the rest of the sites. All nine sites, from which we could not get significant clustering of the NRM directions, showed similar magnetic properties to this second type of behavior. The result of progressive AFD (Fig. 23-c) indicates a very low MDF value (ca. 50 Oe), and all make a random flip of direction with progressive demagnetization. It seems very difficult to reach a stable end point of the directional change before getting a spurious magnetization caused by AFD it self. ThD is not effective in removing a secondary component, and an abrupt increase of χ value occurs at temperatures higher than 250°C (Fig. 23-d). The strong-field magnetization curve of the heating process shows that the Tc is about 300°C, and then there appears a characteristic hump in the curve around 400°C (Fig. 23-e). The cooling curve is quite unlike with the heating curve, recovering almost twice the intensity of magnetization than that of the initial value. There may be two reason to explain such an irreversibility between the heating and cooling curves: 1) oxidation of titanomagnetite into Ti-poor titanomagnetite and ilmenite by the heating during the experiment.. 2) thermal change of titanomaghemite into magnetite and Ti-rich phase. The thermomagnetic balance system employed for this study could not make a high vacuum, (greater than 0.1 torr). Thus, it is difficult to decide the reason of the above-mentioned irreversibility definitely. By microscopic observation, most of the opaque minerals were possibly pseudobrookite. Only small

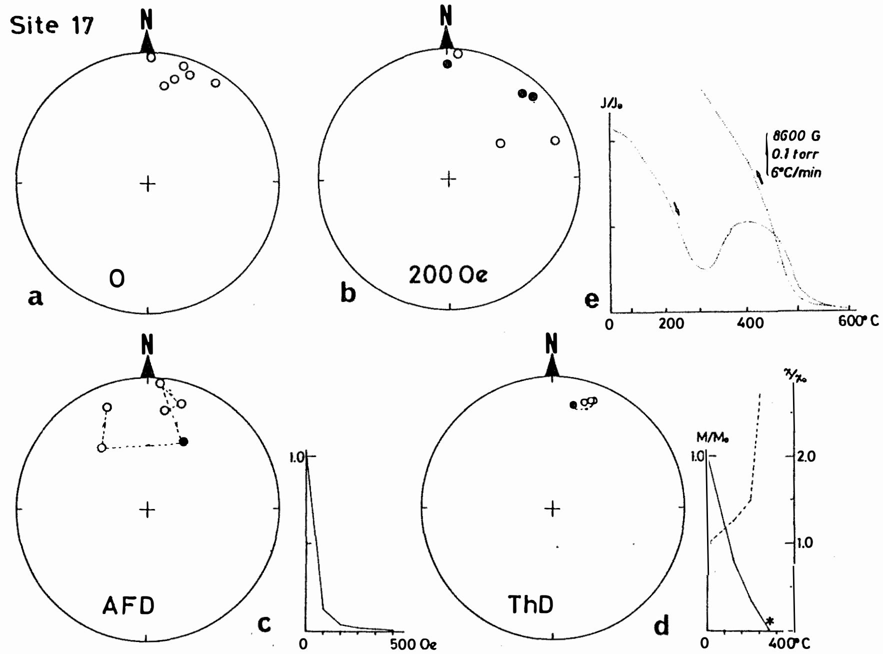


Fig. 23 Typical results of unstable site. See Fig. 22 for explanation. Abrupt change of χ value by progressive ThD, and irreversibility between heating and cooling curve of thermomagnetic analysis are notable.

amount of magnetite was visible which had no ilmenite lamellae and no distinct maghemitization. Therefore, we conclude the reason of the above-mentioned irreversibility to be an oxidation of homogeneous titanomagnetite during the heating experiment. The presence of unoxidized homogeneous titanomagnetites should be a cause of instability. Grommé et al.(1970) discussed the irreversibility of the strong-field magnetization curve observed in samples from the Ngorongoro caldera, Tanzania. Though the age and lithology of those rocks are different from our samples, they resemble each other in magnetic property. The reason of the similarity may be attributable to the high titanium contents of the magnetic minerals.

Table 4 Summary of palaeomagnetic data.

SITE	AFD	D	I	A_{95}	k	N	R	W.T	VLAT	VLON	dp	dm
1	100	- 99.3	-70.1	58.7	1.8	8	4.213	r				
2	100	- 58.7	-60.6	37.3	3.2	8	5.785	s	22.5	260.6	18.7	56.8
3	300	144.7	-34.9	24.5	8.4	6	5.405	s	-50.6	157.5	12.3	28.2
4	200	114.5	-11.1	31.3	5.5	6	5.097	s	-24.4	133.8	15.7	31.7
7	200	- 7.9	56.6	35.3	4.6	6	4.902	s	52.6	26.5	17.7	51.1
8	400	- 37.1	-15.6	17.6	12.7	7	6.529	s	52.1	293.2	8.8	18.1
9	200	97.9	49.8	59.6	2.0	7	3.968	r				
10	300	15.5	15.0	34.5	4.7	6	4.941	s	73.0	101.5	17.3	35.4
11	200	- 41.2	17.9	43.6	3.3	6	4.491	s	48.1	320.1	21.8	45.2
12	200	21.6	- 3.4	11.4	35.4	6	5.857	s	68.3	132.6	5.7	11.4
13	500	-172.3	28.5	25.7	7.8	6	5.356	s	-72.6	11.2	12.9	28.2
14	500	115.1	57.6	106.4	1.4	6	2.342	r				
15	500	-178.4	4.0	52.0	2.3	7	4.393	s	-87.1	3.7	26.0	52.1
16	300	26.6	29.3	38.7	3.9	6	4.733	s	59.7	95.4	19.4	42.7
17	200	35.4	0.3	32.8	5.1	6	5.022	s	54.6	127.2	16.4	32.8
18	200	-124.5	5.2	142.4	1.2	6	1.885	r				
19	300	62.7	-36.2	71.0	1.8	6	3.295	r				
20	200	- 70.2	-32.7	113.3	1.3	7	2.218	r				
21	400	172.5	41.6	60.0	2.6	5	3.451	r				
22	200	1.5	-37.4	51.5	2.6	6	4.110	s	68.6	213.0	25.8	60.6
24	200	29.7	17.2	73.4	1.5	8	3.421	r				
25	200	- 31.7	-69.2	45.6	3.1	6	4.394	s	30.6	238.5	22.8	77.7
26	200	1.4	0.8	22.5	9.8	6	5.492	s	88.6	128.9	11.3	22.5
27	800	118.0	-17.0	107.9	1.4	6	2.314	r				
28	200	- 5.9	- 6.5	17.1	16.2	6	5.692	s	83.0	274.6	8.6	17.2
29	400	6.1	-15.1	22.4	9.9	6	5.496	s	79.8	180.2	11.2	23.0
30	200	- 3.1	0.6	5.0	148.9	7	6.960	s	86.9	304.1	2.5	5.0

AFD: optimum field value of partial AFD in oersted. D: mean declination. I: mean inclination. A_{95} and k: Fisher's statistical parameters. N: number of calculated vectors. R: resultant of N vectors. W.T.: response to Watson's test at 5% significant point (s; significant, r; random). VLAT and VLON: latitude and longitude of VGP. dp and dm; error angle of VGP.

Site-mean directions of NRM are summarized in the Table 4 except Site 5, 6, and 23. Site 5 and 6 were collected from siltstone of the Kirimun Formation, and are too weak to measure after partial AFD of 100 Oe. Site 23 was excluded from calculation because of the ambiguity of the tilting angle of the outcrop. Virtual geomagnetic pole (VGP) positions were calculated only for the sites whose mean directions passed test for randomness at five percent significance (Watson, 1956). Eighteen sites were accepted by the criterion as listed in the table. Generally speaking, the degree of within site scatter, as shown by the value of circle of confidence and/or precision parameter (Fisher, 1953), is considerably large. This may be attributable to the difficulty of the complete demagnetization mentioned in the former paragraph.

The site-mean directions we view as primary are plotted on the equal area projection diagrams according to their stratigraphic order (Fig. 24). Fig. 24-a shows the mean directions of seven sites from the Upper Rumuruti Phonolite. Except for the intermediate directions of Site 3, the other data are all pointing normal polarity. Samples from Site 3 were collected from the top of a small outlier of the porphyritic phonolite lava, close to Shackleton Kirimun. The mean direction of the Site 4, the pitchstone underneath the porphyritic phonolite of Site 3, is also pointing in a similar direction to that of Site 3. Although the lava of Site 3 was geologically correlated to the Upper Rumuruti Phonolite, Site 3 should perhaps be excluded from the group of the Upper Rumuruti Phonolite. Fig. 24-b shows the results of the Lower Rumuruti Phonolite. This results appear somewhat confusing. It possibly represents reversed polarity. NRM directions of the composite lava from Seya area are show normal polarity (Fig. 24-c). Fig. 24-d shows the results from the Infra-Rumuruti Phonolite, thought to be normal polarity. There is only one NRM direction from the Kirimun Formation, and it shows intermediate direction (Fig. 24-e).

VGPs are plotted on the polar equal area net of the northern hemisphere (Fig. 25). They are randomly scattered around the present rotational axis. VGPs which have higher latitude than sixty degrees are only eight in number. Brock (1981) has

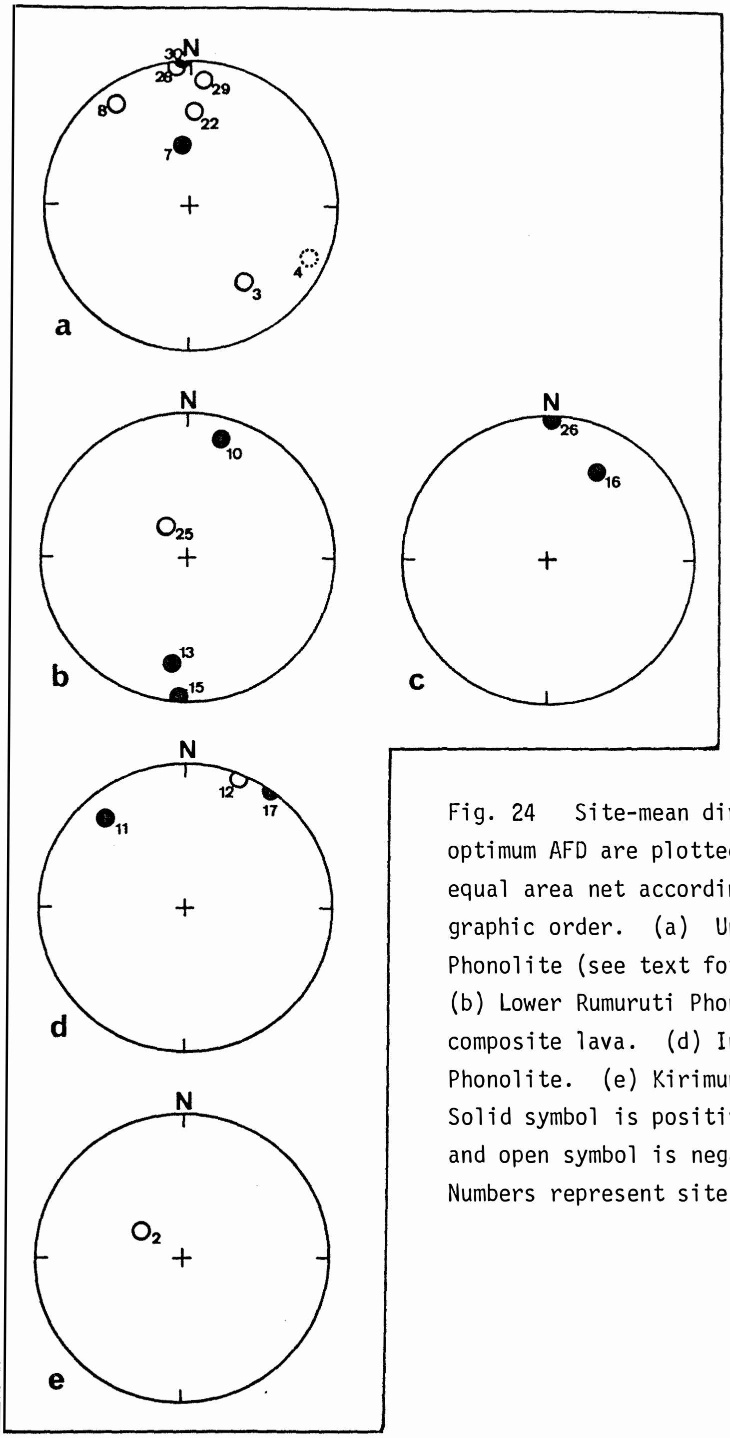


Fig. 24 Site-mean directions after optimum AFD are plotted on Schmidt equal area net according to the stratigraphic order. (a) Upper Rumuruti Phonolite (see text for Site 3 and 4). (b) Lower Rumuruti Phonolite. (c) Seya composite lava. (d) Infra-Rumuruti Phonolite. (e) Kirimun Formation. Solid symbol is positive inclination, and open symbol is negative inclination. Numbers represent site as shown in Table 3.

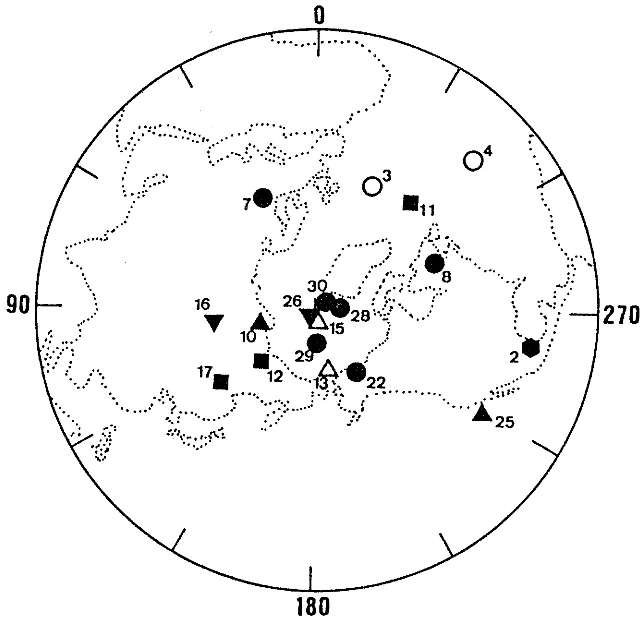


Fig. 25 VGP of each site is plotted on polar equal area projection of northern hemisphere. Symbols of circle, triangle, inverse triangle, square, and hexagon correspond to Upper Rumuruti Phonolite, Lower Rumuruti Phonolite, Seya composite lava, Infra-Rumuruti Phonolite, and Kirimun Formation, respectively. Solid symbol is north pole, and open symbol is south pole. Numbers represent site as shown in Table 3.

summarized palaeomagnetic data from Africa. He found most of the Cenozoic VGPs from Africa were close to the present pole. Thus the large deviation from the present pole as shown in the figure may be affected by a spurious magnetization which we could not completely remove by the demagnetization treatments. This study suggests that the most of the samples from the Kirimun district are magnetically soft and an additional sample collection is needed to obtain reliable results.

5. Summary of the geology for the Kirimun district

The Kirimun Formation is mainly distributed in a depression of Precambrian basement rocks from the Seya River in the north to Palagalagi in the south. It is about twenty kilometres from north to south.

Most of the formation is overlain by phonolite lavas which are divided into three formations, the Infra-Rumuruti Phonolite, Lower Rumuruti Phonolite and Upper Rumuruti Phonolite. A small part of the formation is intercalated in the phonolite lavas. The Kirimun Formation is composed of conglomerate, sandstone and mudstone, and includes intercalated beds of laminated diatomaceous mudstone. It is 40 m in maximum thickness and generally horizontal. The conglomerate contains pebbles and cobbles mainly of quartzite. The sandstone is generally quartzose and ill-sorted.

The fossil land mammals were found in sandstone and mudstone, and fossil crocodile, chelonia and fish were found in mudstone and laminated mudstone. Calcareous coatings on the clastics and fossils were commonly found in the sediments. Fresh-water gastropoda fossils were collected from South Kirimun Ripple marks on hard sandstone are developed in Mbagathi South. Thus, the Kirimun Formation was deposited under fluviatile and lacustrine conditions which repreatedly followed one after the other.

The Kirimun Formation is considered to be early Miocene age for it yields Deinotherium hobleyi and Mastodon sp. from Shackleton Kirimun.

When the subvolcanic sediments of the Kirimun area deposited, volcanic activity had possibly already started in the Kenya rift valley. The Infra-Rumuruti Phonolite and ash flow deposit were found in the valley of the Nayantoloo River. The former is 11.4 ± 0.6 Ma in K-Ar age and the latter is 15 ± 1 Ma in fission-track age. The fossiliferous Kirimun Formation is older than those and is possible of the early Miocene age.

6. Reconnaissance in the Baragoi area

The Baragoi area is about 80 km north of Maralal. The preliminary field survey was done in the vicinity of GR3997, about 15 km west of Bragoi town (Fig. 26). In addition, GR4090, GR3388, GR4981 (Tipaku) and GR2992 (Lokwertom) areas were visited.

The Baragoi area is underlain by metamorphic rocks, and Tertiary rocks (Baker, 1963). The former are exposed west of the line drawn from Nachola to Tipaku.

They consists mainly of amphybolite with a subordinate amount of marble (crystalline limestone) and pegmatite. Tertiary rocks are also found west of the line, unconformably overlying the former. The Tertiary rocks are mainly composed of volcanic rocks with intercalated sedimentary rocks. The volcanic rocks are composed of phonolite lavas, pyroclastic rocks, and basalt lavas. The sedimentary rocks are composed mainly of sandstone which intercalates thin beds of conglomerate and mudstone.

Fig. 27 shows the geologic columns of the Tertiary rocks observed A on the eastern slope of a hill on the east of GR3997, B on GR3997 itself, C 2 km south of GR3997 in the vicinity of GR4090, and D at GR4981 (Fig. 26).

At A, the Tertiary rocks unconformably rest on the metamorphic basement rocks, and from the base upwards consist of conglomerate, aphanitic basalt, sandstone including thin conglomerate and mudstone lenses, porphyritic basalt, sandstone with conglomerate lens and porphyritic phonolite. They dip 5° to 10°W and total 80 m in thickness.

At B, the Tertiary rocks consist of aphanitic basalts, sedimentary rocks consisting of sandstone, conglomerate and mudstone, aphanitic basalt, sandstone containing granules, porphyritic basalt, sandstone, and porphyritic phonolite, in ascending order. The aphanitic basalt intercalates a thin porphyritic basalt which containes a large amount of phenocrysts of olivine, pyroxene, and plagioclase, at 5-6 m above the base. They strike NS and gently dip west. Their total thickness is about 150 m. The sandstone bed between the upper porphyritic phonolite and the aphanitic

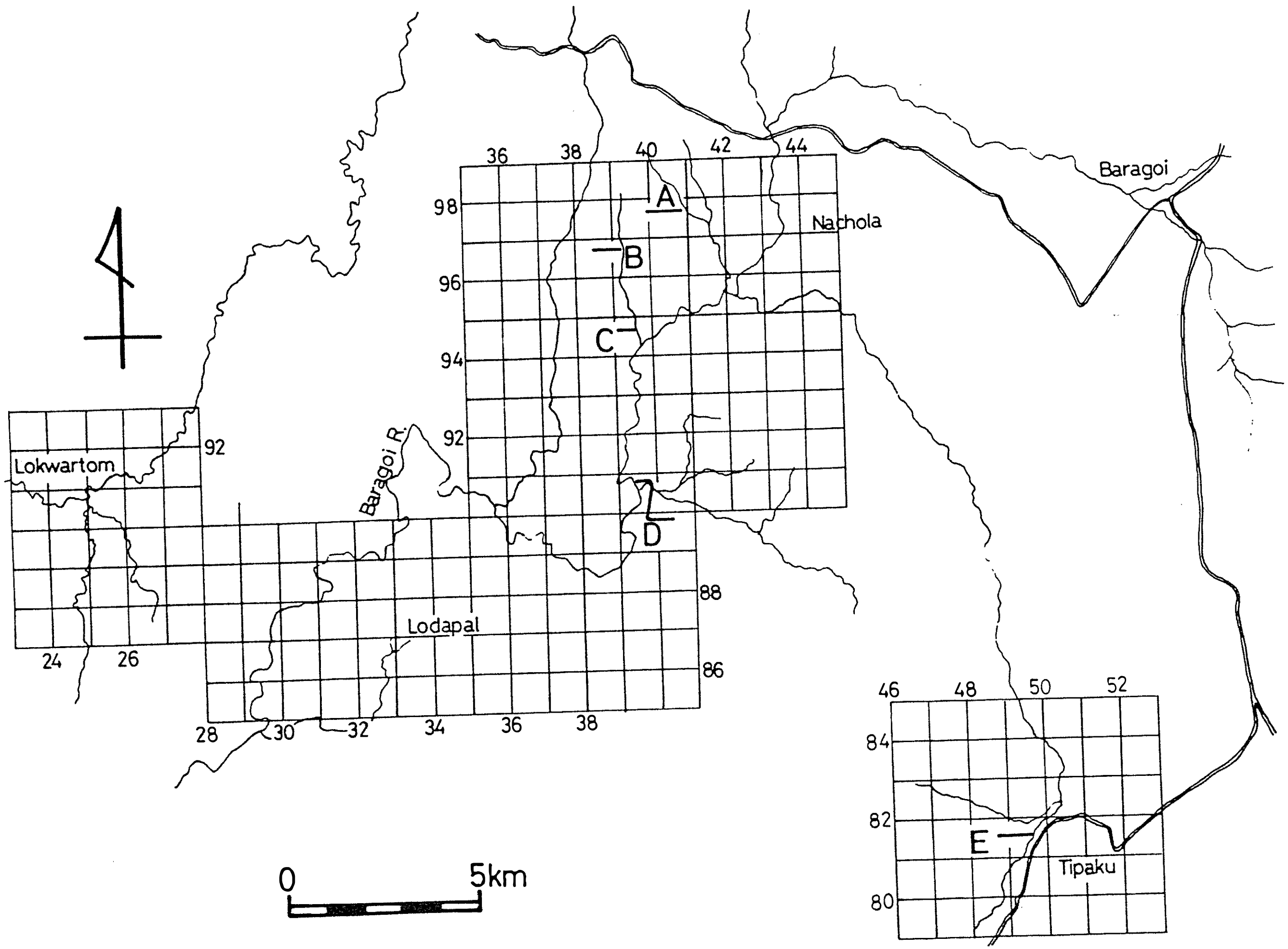


Fig. 26 Index map of the Baragoi area.

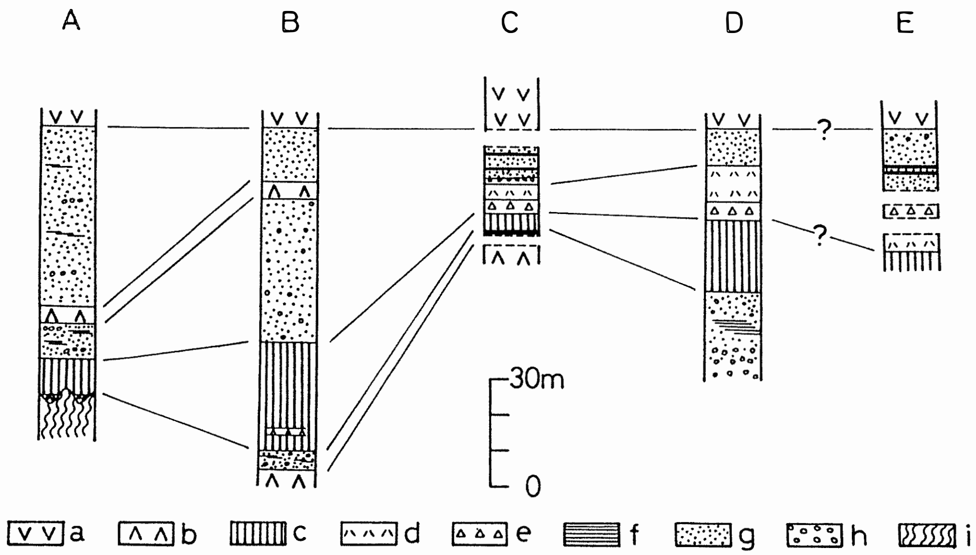
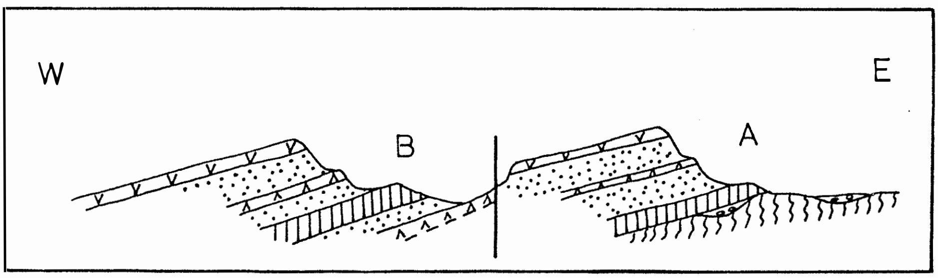


Fig. 27 Geologic columns for the Baragoi area. Locations of columns from <u>A</u> to <u>E</u> are indicated in Fig. 26. Lithologic symbols are as follows. a: porphyritic phonolite, b: porphyritic basalt, c: aphanitic basalt, d: phonolite coarse-grained tuff, e: phonolite tuff breccia, f: mudstone, g: sandstone, h: conglomerate, i: basement rocks.



Fig, 28 Ideal section across <u>A</u> to <u>B</u>. Lithologic symbols are same in Fig. 27.

basalt yields abundant fossils. The idealized section from A to B is illustrated in Fig. 28.

Two kilometres south of GR3997 (B), the Tertiary rocks from the base upwards consist of porphyritic basalt, mudstone, aphanitic basalt, phonolite tuff breccia (phyroclastic flow deposit), phonolitic coarse-grained tuff (ash flow deposit), sedimentary rocks composed of sandstone, mudstone and conglomerate, and porphyritic phonolite lava. They gently dip west, and are about 45 m in total thickness.

At D, the Tertiary rocks are made up of sedimentary rocks composed of sandstone and comglomerate, aphanitic basalt, phonolite tuff breccia (pyroclastic flow deposit), coarse-grained tuff (ash flow deposit), sandstone, and porphyritic phonolite lava, in ascending order. They dip 20°W, and are 75 m thick.

At E, the basement rocks are composed of biotite gneiss and amphibolite. Tertiary rocks unconformably overlie them, and consist of aphanitic basalt, phonolite coarse-grained tuff (ash flow deposit), tuff breccia (pyroclastic flow deposit), sandstone including intercalated beds of mudstone and conglomerate, and phophyritic phonolite lava, in ascending order. They are piled up horizontally, and about 40 m in total thickness. No fossil was obtained from this locality.

The correlation between these sedimentary rocks is shown in Fig. 27. The volcanic rocks of the lower part are composed of basalt, and the upper part are composed of phonolite. The sedimentary rocks exist between both. Baker (1963) correlated the basalt and phonolite with the Samburu Basalt and the Rumuruti Phonolite, respectively. Although Baker described these sedimentary rocks as subvolcanic, they are found to be intravolcanic. Consequently, the sedimentary rocks may be contemporaneous with the Kirimun Formation.

In the Vicinity of GR3388 (Lodapal), thick phonolite welded tuff composed of some flow units is exposed. It yields silicified fossils of wood from the upper non-welded part of a flow unit.

At GR2592 and southwards, the sedimentary rocks are widely exposed for 20 km distance. Only a few hours investigation was made at this site. Although no remarkable fossil was collected there, the locality is considered promising, judging from its thickness and wide distribution. We are now planning a detailed survey of this locality in 1982.

A little amount of surface collection of fossils were obtained from the Baragoi area. Four mammalian fossils collected from West Valley. One of them is considered metacarpal or metatalsus of Rhinocerotidae. Only one mammalian bone fragment was found in East Valley. In Baragoi Y site, the collected fossils are counted up 333 specimens. But we could not classified such fragmental bones. Forty-five specimens were collected from Garagoi Z site. The fossils of surface collection from Baragoi area are as follows.

1. West Valley (east of A)
    Class Mammalia
        Order Perissodactyla
            Rhinocerotidae, gen. et sp. indet.
2. East Valley (west of A)
    Class Mammalia
            Mammalia, order, fam., gen. et sp. indet.
3. Baragoi Y (B itself)
    Class Mammalia
        Order Artiodactyla
            Ruminantia, fam., gen. et sp. indet.
    Class Reptilia
        Order Crocodilia
            Crocodylidae., gen. et sp. indet.
        Order Chelonia
            Chelonia, not Trionychidae
    Mollusca
4. Baragoi Z (D itself)
    Class Mammalia
        Order Artiodactyla
            Ruminantia, fam., gen. et sp. indet.
    Class Reptilia
        Order Chelonia
            Chelonia, not Trionychidae

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III Palaeontology

III PALAEONTOLOGY

1. Introductory

The Miocene vertebrate fossils occurred from the lacustrine and the fluvial sediments of the Kirimun Area near Maralal, western Kenya, were first reported by Shackleton (1946). He recorded two forms of Proboscidea such as *Prodeinotherium hobleyi* and "*Mastodon*" sp. as well as crocodile and chelonian remains. In 1949 L. S. B. Leakey visited several localities of this area and collected many fossils. After that time, the fossils of this area have been out of scope of palaeontologist except some recent works.

The description of the rodents fossils from "Kirimun" was given by Lavocat (1973) in his publication on the Lower Miocene rodents of East Africa. He recognized three forms of Thryonomyoid rodents, namely *Paraphiomys pigotti*, *P. stromeri stromeri* and *Diamantomys leuderitzi*. Wilkinson (1976) described two species of suids such as *Listriodon akatikubas* and *L. akatidogus* from "Mbagathi", south of Kirimun village. In regard to rhinocerotids, Hooijer (1978) mentioned the occurrence of *Aceratherium acutirostratum* and/or *Dicerorhinus leakeyi* from " Kirimun". Andrews (1978) also described a canine of *Proconsul major* from "Kirimun". Very recently, a brief summary of the mammalian faunae of " Kirimun"and "Mbagathi" was given in order to estimate the geological age of the sediments by Pickford (1981). In addition to the previous works, he newly listed two rhinocerotids (*Aceratherium acutirostratum*, *Chirotheridium pattersoni*) and two ruminants (*Dorcatherium parvum*, ?*Canthumeryx* sp.) from "Kirimun", as well as Proboscidea (Choerolophodont), rhinocerotids and *Dorcatherium chappuisi* from "Mbagathi".

In 1980, the authors carried out the field investigations of the several fossil localities of the Kirimun Area and the Baragoi Area which are situated south and north of Maralal respectively. More than 4800 specimens were collected from the both area by the surface collection and the excavation. Although most of them are fairly fragmental, some specimens are worthy to note. They might be new species or newly-recorded forms from this area. In this chapter, the authors intend to offer a brief synopsis for the palaeontological results of the investigations in 1980 and tentative description of the important specimens.

2. Synopsis of Palaeontological Results

The fossil specimens obtained by the present field investigation amount to 4808 in number. Additionally, 4 blocks of fossiliferous sedements were also obtained. All of them are stored in the International Louis Leakey Memorial Institute for African Prehistory (TILLMIAP) in Nairobi. Of them, 4425 specimens and 4 blocks were collected from the Kirimun Area where as 383 specimens from the Baragoi Area. Majority of the former materials were occurred from three main localities, such as South Kirimun, GR6371, and Mbagathi.

In regard to the component of the present collection, mammals, crocodiles chelonians and fishes are remarkably predominant. Most of them are too fragmental to determine precise taxonomic position except the fish remains.

The list of all present specimens are given in the following table as the synopsis of the palaeontological result of the field investigations in 1980.

I. Kirimun Area

1. Garuma (Surface Collection)

Mammalia, order, fam., gen. et sp. indet.
1 tooth fragment (KIR-342-80), 1 tibia fragment (KIR-340-80)
1 bone fragment (KIR-341-80).

2. Nkoteyia (Surface Collection)

Pelomedusidae, gen. et sp. indet.
1 neural plate (KIR-328-80)

Chelonia, other than Trionychidae
1 left hypoplastron (KIR-335-80), 19 shell fragments (KIR-327-80, KIR-329-80, KIR-331-80, KIR-336-80~KIR-339-80, KIR-2339-80~KIR-2349-80).

Crocodylidae, gen. et sp. indet.
1 cervical vertebra (KIR-2335-80), 1 vertebra (KIR-2336-80),
2 fragments of bony plate (KIR-2337-80, KIR-2338-80).

Pisces, order, fam., gen. et sp. indet.
2 vertebrae (KIR-332-80, KIR-2350-80).

Vertebrata, taxon indeterminable
3 bone fragments (KIR-333-80, KIR-334-80, KIR-2351-80).

3. North Kirimun (Surface Collection)

Gomphotheriidae, gen. et sp. indet.
21 cheek teeth fragments (KIR-255-80, KIR-256-80).

Rhinocerotidae, gen. et sp. indet.
1 fragment of left lower cheek teeth (KIR-2352-80), 1 upper premolar fragment (KIR-2353-80).

Mammalia, order, fam., gen. et sp. indet.
2 tusk fragments? (KIR-253-80, KIR-254-80), 1 tooth fragment (KIR-2354-80), 1 carpal or tarsal bone (KIR-257-80), 1 bone fragment (KIR-258-80).

4. South Kirimun

4-1. Site A (Excavated specimens)

Crocodylidae, gen. et sp. indet.

1 dorsal vertebra (KSE-880-80), 1 caudal vertebra (KSE-884-80), 2 vertebrae (unnumbered), 1 humerus (KSE-883-80), 1 phalanx (KSE-881-80), 5 long bones (unnumbered), 16 fragments of bony plate (KSE-878-80, KES-879-80, KSE-882-80, other 13 specimens are unnumbered), 3 bone fragments (unnumbered).

Vertebrata, taxon indeterminable

52 bone fragments (unnumbered).

Coprolite

1 specimen (unnumbered).

4-2. Site B

4-2-1. Excavated specimens

Chelonia, other than Trionychidae

1 shell fragment? (unnumbered).

Crocodylidae, gen. et sp. indet.

1 fragment of caudal vertebra (KSE-795-80), 8 vertebrae (KSE-782-80~KSE-789-80), 2 left humeri (KSE-790-80, KSE-805-80), 1 ulna (KSE-807-80), 1 radius (KSE-791-80), 1 metacarpal bone (KSE-794-80), 1 tibia (KSE-831-80), 1 fibula (KSE-817-80), 1 tarsal bone (KSE-824-80), 7 metatarsal bones (KSE-792-80, KSE-793-80, KSE-832-80~KSE-836-80), 42 phalanges (KSE-800-80~KSE-802-80, KSE-806-80~KSE-816-80, KSE-818-80~KSE-821-80, KSE-823-80, KSE-829-80, KSE-830-80, KSE-837-80~KSE-844-80, KSE-860-80~KSE-871-80, other 3 specimens are unnumbered), 9 long bone fragments (unnumbered), 150 fragments of bony plate (unnumbered).

Pisces, order, fam., gen. et sp. indet.

2 blocks of fossiliferous sediments (unnumbered).

Vertebrata, taxon indeterminable

1 rib fragment (unnumbered), 189 bone fragments (unnumbered).

Coprolite

14 specimens (unnumbered).

4-2-2. Surface collection

Crocodylidae, gen. et sp. indet.

1 left quadrate (KSE-645-80), 1 right quadrate (KSE-709-80),

2 left dentaries (KSE-493-80, KSE-519-80), 1 right dentary (KSE-492-80), 17 dentary fragments (KSE-520-80, KSE-522-80～KSE-527-80, KSE-531-80, KSE-536-80, KSE-539-80, KSE-544-80, KSE-549-80, KSE-578-80, KSE-664-80, KSE-673-80, KSE-675-80, KSE-685-80), 1 left articular (KSE-516-80), 1 right articular (KSE-514-80), 18 jaw fragments (KSE-521-80, KSE-528-80～KSE-530-80, KSE-532-80～KSE-535-80, KSE-636-80～KSE-644-80, KSE-776-80, KSE-777-80), 1 axis (KSE-498-80), 8 cervical vertebrae (KSE-495-80～KSE-497-80, KSE-499-80, KSE-500-80, KSE-502-80, KSE-504-80, KSE-510-80), 4 vertebra fragments (KSE-501-80, KSE-503-80, KSE-505-80, KSE-511-80), 3 cervical ribs (KSE-519-80, KSE-728-80, KSE-734-80), 4 rib fragments (KSE-512-80, KSE-513-80, KSE-671-80, KSE-672-80), 1 right humerus (KSE-494-80), 1 ulna (KSE-506-80), 1 right radius (KSE-664-80), 2 carpal bones (KSE-517-80, KSE-518-80), 26 long bone fragments (KSE-507-80, KSE-509-80, KSE-646-80～KSE-663-80, KSE-665-80～KSE-670-80), 97 fragments of bony plate (KSE-537-80, KSE-539-80～KSE-543-80, KSE-545-80～KSE-548-80, KSE-550-80～KSE-577-80, KSE-579-80～KSE-635-80), 5 bone fragments (KSE-515-80, KSE-674-80, KSE-677-80, KSE-679-80, KSE-682-80).

Pisces, order, fam., gen. et sp. indet.

1 bone fragment (KSE-781-80).

Vertebrata, taxon indetermined

94 bone fragments (KSE-676-80, KSE-678-80, KSE-680-80, KSE-681-80, KSE-683-80, KSE-684-80, KSE-686-80～KSE-708-80, KSE-710-80～KSE-727-80, KSE-729-80～KSE-733-80, KSE-735-80～KSE-775-80, KSE-780-80)

4-3. Site C (Excavated specimens)

Paraphiomys cf. *pigotti* Andrews

1 left maxilla with dP^4 and M^1 (KSE-8-80), 1 left maxilla with dP^4～M^3 (KSE-7-80), 1 left M^3 (KSE-12-80), 1 right maxilla with dP^4～M^3 (KSE-7-80), 1 left dP_4 (KSE-162-80), mandible with I and dP_4～M_2 (KSE-16-80), 1 left dP_4 (KSE-162-80), 1 right dP_4 (KSE-9-80), 1 right M_2 (KSE-153-80)

Paraphiomys sp.

1 left M_3 (KSE-154-80).

?*Megapedetes* sp.

1 left M_1? (KSE-161-80).

Afrocricetodon sp.

1 right M^3 (KSE-155-80).

Rodentia, fam., gen. et sp. indet.

5 left upper incisors (KSE-20-80, KSE-164-80～KSE-167-80), 1 right

upper incisor (KSE-19-80), 7 left lower incisors (KSE-17-80, KSE-18-80, KSE-87-80, KSE-171-80~KSE-174-80), 7 right lower incisors (KSE-22-80, KSE-168-80 KSE-177-80, KSE-175-80, KSE-176-80, KSE-480-80), 2 lower incisor fragments (KSE-10-80, KSE-23-80), 7 incisor fragments (KSE-25-80, KSE-177-80), 1 lower molar (KSE-356-80), 5 molar fragments (KSE-156-80~KSE-160-80), 2 thoracic vertebrae? (KSE-263-80, KSE-264-80), 2 lumbar vertebrae? (KSE-262-80, KSE-265-80), 1 right humerus fragment (KSE-102-80), 1 right ulna fragment (KSE-103-80), 1 left tibia fragment (KSE-101-80), 1 right talus (KSE-388-80), 1 right calcaneus? (KSE-389-80).

Carnivora, fam., gen. et sp. indet.

1 left upper canine (KSE-27-80).

Deinotheriidae, gen. et sp. indet.

1 left M_2 or M_3 fragment (KSE-50-80)

Proboscidea, fam., gen. et sp. indet.

2 cheek teeth fragments (KSE-51-80, KSE-53-80).

Procaviidae, gen. et sp. indet.

1 left M^2 (KSE-163-80).

Brachypotherium heinzelini Hooijer

1 left M^2 fragment (KSE-47-80), 1 left upper molar fragment (KSE-48-80), 1 right I_2 (KSE-6-80), 1 right P_2 (KSE-37-80), 1 left P_3 (KSE-34-80), 1 left P_4 (KSE-35-80), 1 right M_1 (KSE-39-80), 1 right M_2 (KSE-38-80), 1 left M_3 (KSE-36-80), 1 right M_3 (KSE-40-80).

Rhinocerotidae, gen. et sp. indet.

1 right upper molar fragment (KSE-486-80), 1 right lower molar fragment (KSE-45-80), 9 cheek teeth fragments (KSE-487-80), 8 tooth fragments (KSE-41-80~KSE-43-80, KSE-46-80, KSE-49-80).

Sanitherium sp.

1 right P^1 (KSE-181-80), 1 right P^2 (KSE-477-80), 1 left mandible fragment with M_2 (KSE-2-80), 1 left I_1 (KSE-4-80), 1 left lower canine (KSE-99-80), 1 left P_3 (KSE-180-80), 1 right P_3 (KSE-26-80), 1 left M_1 (KSE-3-80), 1 fragment of left M_2 (KSE-491-80), 1 left M_3 (KSE-478-80), 1 right M_3 (KSE-1-80), 1 premolar fragment (KSE-483-80), 2 molar fragments (KSE-178-80, KSE-179-80), 1 root fragment of molar (KSE-435-80).

Giraffidae, gen. et sp. indet. (cf. *Samotherium*)

1 fragment of left upper molar (KSE-54-80).

Dorcatherium cf. *pigotti* Whitworth

1 left M^2 (KSE-33-80).

Dorcatherium sp.

1 left mandible with M_3 (KSE-28-80), 1 right M_2 (KSE-183-80).

Tragulidae, gen. et sp. indet.

1 right tibia fragment (KSE-63-80), 2 left naviculo-cuboid (KSE-59-80, KSE-107-80), 1 right naviculo-cuboid (KSE-29-80), 1 proximal phalanx (KSE-359-80), 1 middle phalanx (KSE-61-80).

Ruminantia, fam., gen. et sp. indet.

1 left lower incisor? (KSE-182-80), 1 humerus fragment (KSE-58-80)

Mammalia, order, fam., gen. et sp. indet.

15 cheek teeth fragments (KSE-52-80, KSE-55-80, KSE-75-80, KSE-100-80, KSE-184-80～KSE-190-80, KSE-484-80), 25 tooth fragments (KSE-21-80, KSE-56-80, KSE-57-80, KSE-88-80, KSE-109-80, KSE-113-80), 2 root fragments of tooth (KSE-358-80, KSE-481-80), 10 vertebrae (KSE-354-80, KSE-436-80), 1 rib fragment (KSE-460-80), 1 ulna (KSE-104-80), 1 femur (KSE-402-80), 1 tibia (KSE-392-80), 1 talus (KSE-390-80), 1 calcaneus (KSE-391-80), 1 carpal or tarsal bone (KSE-145-80), 17 phalanges (KSE-13-80, KSE-62-80, KSE-108-80, KSE-359-80, KSE-370-80～KSE-372-80, KSE-393-80～KSE-401-80, KSE-403-80), 16 bone fragments (KSE-64-80, KSE-110-80, KSE-112-80, KSE-373-80～KSE-379-80, KSE-437-80～KSE-440-80, KSE-482-80, KSE-485-80).

Chelonia, other than Trionychidae

33 shell fragments (KSE-114-80～KSE-130-80, KSE-231-80～KSE-246-80).

Lacertilia, fam., gen. et sp. indet.

3 vertebrae (KSE-65-80, KSE-247-80, KSE-473-80).

Ophidia, fam., gen. et sp. indet.

16 vertebrae (KSE-106-80, KSE-248-80～KSE-261-80, KSE-355-80).

Crocodylidae, gen. et sp. indet.

38 isolated teeth (KSE-66-80～KSE-74-80, KSE-76-80, KSE-105-80, KSE-196-80～KSE-222-80, KSE-433-80), 6 tooth fragments (KSE-78-80, KSE-223-80～KSE-227-80), 1 vertebra (KSE-79-80), 1 cervical rib (KSE-334-80), 4 fragments of bony plate (KSE-192-80～KSE-195-80).

Reptilia, order, fam., gen. et sp. indet.

1 vertebra? (KSE-268-80)

Anura, fam., gen. et sp. indet.

1 left humerus (KSE-363-80), 1 right humerus (KSE-352-80), 2 left radio-ulnae (KSE-361-80, KSE-362-80), 2 right radio-ulnae (KSE-360-80, KSE-364-80), 7 bone fragments (KSE-425-80~KSE-431-80).

Pisces, order, fam., gen. et sp. indet.

5 jaw fragments (KSE-84-80, KSE-139-80, KSE-348-80, KSE-349-80, KSE-434-80), 82 vertebrae (KSE-85-80, KSE-86-80, KSE-269-80~KSE-347-80, KSE-479-80), 16 spines (KSE-350-80, KSE-353-80), 55 bone fragments (KSE-351-80)

Vertebrata, taxon indeterminable

1 skull fragment (KSE-443-80), 44 tooth fragments (KSE-5-80, KSE-11-80, KSE-77-80, KSE-191-80, KSE-228-80~KSE-230-80, KSE-488-80), 2 vertebra fragments (KSE-475-80, KSE-476-80), 1 ulna or calcaneus fragment (KSE-461-80), 1 femur fragment (KSE-462-80), 1 phalanx (KSE-14-80), 214 bone fragments (KSE-15-80, KSE-24-80, KSE-30-80~KSE-32-80, KSE-60-80, KSE-89-80~KSE-98-80, KSE-111-80, KSE-131-80~KSE-138-80, KSE-140-80~KSE-144-80, KSE-146-80~KSE-150-80, KSE-152-80, KSE-266-80, KSE-267-80, KSE-365-80~KSE-368-80, KSE-380-80~KSE-387-80, KSE-404-80~KSE-424-80, KSE-432-80, KSE-441-80, KSE-442-80, KSE-444-80~KSE-459-80, KSE-463-80~KSE-472-80, KSE-489-80, KSE-490-80).

Gastropoda, fam., gen. et sp. indet.

22 opercula (KSE-357-80).

Coprolite

4 specimens (KSE-80-80, KSE-83-80).

4-4. Site D (Excavated specimens)

Coprolite

1 specimen (unnumbered).

4-5. Site E (Excavated specimens)

Mammalia, order, fam., gen. et sp. indet.

1 rib (unnumbered).

Vertebrata, taxon indeterminable

21 bone fragments (unnumbered).

4-6. Site F (Excavated specimens)

Chelonia, other than Trionychidae

1 shell fragment (unnumbered).

Crocodylidae, gen. et sp. indet.

1 tooth (KSE-890-80).

Vertebrata, taxon indeterminable

1 tooth fragment (unnumbered), 27 bone fragments (unnumbered).

4-7. Site G (Excavated specimens)

Crocodylidae, gen. et sp. indet.

4 vertebrae (unnumbered), 1 left humerus (KSE-889-80), 52 fragments of bony plate (unnumbered).

Pisces, order, fam., gen. et sp. indet.

2 blocks of fossiliferous sediments (unnumbered).

Vertebrata, taxon indeterminable

7 vertebra fragments (unnumbered), 60 bone fragments (unnumbered).

4-8. T1 Site (Excavated specimens)

Mammalia, order, fam., gen. et sp. indet.

1 fragmental innominate bone (unnumbered).

4-9. T2 Site (Excavated specimens)

Rhinocerotidae, gen. et sp. indet.

1 right innominate bone (unnumbered)

Mammalia, order, fam., gen. et sp. indet.

4 ribs (unnumbered)

Chelonia, other than Trionychidae

2 shell fragments (unnumbered).

Crocodylidae, gen. et sp. indet.

1 right ulna (KSE-885-80), 1 right radius (KSE-886-80), 2 right femora (KSE-887-80, KSE-888-80), 2 long bones (unnumbered), 8 fragments of bony plate (KSE-891-80, other 7 specimens are unnumbered).

Vertebrata, taxon indeterminable

65 bone fragments (unnumbered).

4-10. South Kirimun (Surface Collection)

Gomphotheriidae, gen. et sp. indet.
2 cheek teeth fragments (KIR-222-80, KIR-223-80).

Deinotheriidae, gen. et sp. indet.
1 cheek teeth fragment (KIR-247-80).

Proboscidea, fam., gen. et sp. indet.
1 tooth fragment (KIR-212-80), 3 tusk fragments (KIR-213-80, KIR-214-80, KIR-250-80).

Giraffidae, gen. et sp. indet. (cf. *Palaeotragus*)
1 left P_2? (KIR-251-80).

Mammalia, order, fam., gen. et sp. indet.
1 skull fragment (KIR-215-80), 8 tooth fragments (KIR-224-80～KIR-229-80, KIR-234-80, KIR-235-80), 1 tusk fragment (KIR-233-80), 1 vertebra fragment (KIR-239-80), 3 rib fragments (KIR-236-80～KIR-238-80), 1 innominate bone fragment (KIR-252-80), 10 bone fragments (KIR-216-80～KIR-218-80, KIR-240-80～KIR-245-80, KIR-248-80).

Chelonia, other than Trionychidae
5 shell fragments (KIR-210-80, KIR-231-80, KIR-232-80, KIR-2355-80, KIR-2356-80).

Crocodylidae, gen. et sp. indet.
1 cervical vertebra (KIR-205-80), 5 vertebrae (KIR-206-80～KIR-209-80, KIR-230-80), 1 limb bone (KIR-249-80), 1 phalanx (KIR-246-80), 1 fragment of bony plate (KIR-2357-80).

Pisces, order, fam. gen. et sp. indet.
2 vertebrae (KIR-204-80, KIR-211-80).

Vertebrata, taxon indeterminable.
2 bone fragments (KIR-219-80, KIR-220-80).

Plant
1 silicified wood (KIR-221-80).

5. Shackleton Kirimun (Surface Collection)

Gomphotheriidae, gen. et sp. indet.
31 cheek teeth fragments (KIR-306-80).

Proboscidea, fam., gen. et sp. indet.
2 cheek teeth fragments (KIR-2319-80, KIR-2320-80), 12 tusk fragments (KIR-2321-80, KIR-2322-80).

Rhinocerotidae, gen. et sp. indet.

1 left tibia fragment (KSE-259-80).

Mammalia, order, fam., gen. et sp. indet.

1 rib fragment (KIR-2317-80), 37 fragments of innominate bone (KIR-261-80~KIR-297-80), 28 bone fragments (KIR-260-80, KIR-298-80, KIR-307-80~KIR-321-80, KIR-323-80~KIR-325-80, KIR-2323-80~KIR-2330-80).

Chelonia, other than Trionychidae

4 shell fragments (KIR-322-80, KIR-326-80, KIR-2312-80, KIR-2333-80).

Crocodylidae, gen et sp. indet.

1 fragment of bony plate (KIR-2311-80).

Pisces, order, fam., gen. et sp. indet.

8 bone fragments (KIR-299-80~KIR-305-80, KIR-2313-80).

Vertebrata, taxon indeterminable

7 bone fragments (KIR-2314-80~KIR-2316-80, KIR-2318-80, KIR-2331-80, KIR-2332-80, KIR-2334-80).

6. GR6371 (Surface Collection)

Gomphotheriidae, gen. et sp. indet.

5 cheek teeth fragments (KIR-1509-80, KIR-1804-80, KIR-2138-80, KIR-2174-80, KIR-2505-80).

Deinotheriidae, gen. et sp. indet.

1 right M_2 fragment? (KIR-2502-80), 1 right M_3 fragment? (KIR-2487-80), 8 cheek teeth fragments (KIR-1398-80, KIR-1405-80, KIR-1522-80, KIR-1524-80, KIR-1556-80, KIR-1783-80, KIR-1806-80, KIR-1838-80, KIR-KIR-2507-80).

Proboscidea, fam., gen. et sp. indet.

168 cheek teeth fragments (KIR-1326-80~KIR-1328-80, KIR-1336-80~KIR-1338-80, KIR-1369-80~KIR-1374-80, KIR-1397-80, KIR-1401-80~KIR-1403-80, KIR-1406-80~KIR-1411-80, KIR-1413-80~KIR-1416-80, KIR-1477-80~KIR-1483-80, KIR-1500-80~KIR-1505-80, KIR-1511-80, KIR-1512-80, KIR-1517-80, KIR-1523-80, KIR-1525-80~KIR-1531-80, KIR-1557-80~KIR-1563-80, KIR-1735-80~KIR-1738-80, KIR-1758-80~KIR-1761-80, KIR-1782-80, KIR-1784-80~KIR-1790-80, KIR-1802-80, KIR-1803-80, KIR-1805-80, KIR-1807-80~KIR-1813-80, KIR-1839-80~KIR-1857-80, KIR-1871-80~KIR-1873-80, KIR-1886-80~KIR-1888-80, KIR-1903-80~KIR-1909-80, KIR-1918-80, KIR-1919-80, KIR-1924-80, KIR-1927-80, KIR-1966-80~KIR-1973-80, KIR-2009-80~KIR-2013-80, KIR-2045-80~KIR-2048-80, KIR-2139-80, KIR-2140-80,

KIR-2175-80~KIR-2177-80, KIR-2204-80, KIR-2225-80, KIR-2304-80, KIR-2308-80), 39 tusk fragments (KIR-1465-80, KIR-1466-80, KIR-1484-80, KIR-1485-80, KIR-1532-80, KIR-1792-80, KIR-2124-80, KIR-2226-80~KIR-2228-80, KIR-2305-80), 14 tooth fragments (KIR-1516-80, KIR-2178-80, KIR-2199-80, KIR-2200-80, KIR-2205-80, KIR-2206-80).

Rhinocerotidae, gen. et sp. indet.

1 right P_3 or P_4 (KIR-2302-80), 1 left P_4 fragment? (KIR-2303-80), 1 right lower premolar fragment (KIR-1510-80), 12 cheek teeth fragments (KIR-1399-80, KIR-1400-80, KIR-1404-80, KIR-1412-80, KIR-1513-80, KIR-1514-80, KIR-1636-80, KIR-1739-80, KIR-1740-80, KIR-1902-80, KIR-1910-80, KIR-1913-80), 1 tooth fragment (KIR-2307-80), 1 left unciform (KIR-2196-80).

Tragulidae, gen. et sp. indet.

1 right talus (KIR-2491-80), 1 middle phalanx (KIR-2495-80).

Giraffidae, gen. et sp. indet.

1 left M_1 (KIR-2497-80)

Ruminantia, fam., gen. et sp. indet.

1 left M^1 (KIR-2044-80), 1 upper molar fragment (KIR-2031-80), 1 left femur fragment (KIR-2508-80), 1 left tibia fragment (KIR-2496-80), 1 right talus (KIR-2123-80), 1 right calcaneus (KIR-2492-80), 1 metacarpal or metatarsal bone (KIR-1333-80), 1 proximal phalanx (KIR-1332-80)

Artiodactyla, fam., gen. et sp. indet.

1 left femur fragment (KIR-2484-80).

Mammalia, order, fam., gen. et sp. indet.

1 incisor fragment? (KIR-2486-80), 65 cheek teeth fragments (KIR-1515-80, KIR-1564-80~KIR-1569-80, KIR-1676-80, KIR-1677-80, KIR-1814-80~KIR-1816-80, KIR-1858-80~KIR-1867-80, KIR-1919-80, KIR-1974-80, KIR-2493-80), 8 tusk fragments (KIR-1912-80), 99 tooth fragments (KIR-1417-80, KIR-1570-80, KIR-1571-80, KIR-1762-80, KIR-1791-80, KIR-1817-80, KIR-1874-80, KIR-1889-80, KIR-1890-80, KIR-1911-80, KIR-1914-80, KIR-1975-80, KIR-2014-80, KIR-2032-80, KIR-2033-80, KIR-2049-80~KIR-2051-80, KIR-2141-80~KIR-2146-80, KIR-2179-80, KIR-2201-80), 1 horn fragment (KIR-1649-80), 17 rib fragments (KIR-1448-80, KIR-1653-80, KIR-1654-80, KIR-1655-80, KIR-1669-80, KIR-1770-80~KIR-1776-80, KIR-1884-80, KIR-2283-80 KIR-2286-80), 5 femur fragments (KIR-1368-80),

2 tibia fragments (KIR-1519-80, KIR-2309-80), 1 metacarpal or metatarsal bone fragment (KIR-2202-80), 1 phalanx (KIR-1518-80), 34 bone fragments (KIR-1334-80, KIR-1335-80, KIR-1356-80～KIR-1364-80, KIR-1453-80, KIR-1467-80～KIR-1476-80, KIR-1496-80, KIR-1497-80, KIR-1507-80, KIR-1520-80, KIR-1521-80, KIR-1650-80, KIR-1652-80, KIR-1899-80, KIR-1925-80, KIR-2118-80, KIR-2127-80, KIR-2134-80～KIR-2136-80, KIR-2197-80, KIR-2198-80).

Testudinidae, gen. et sp. indet.

1 neural plate (KIR-1684-80)

Trionychidae, gen. et sp. indet.

80 shell fragments (KIR-1330-80, KIR-1331-80, KIR-1354-80, KIR-1355-80, KIR-1382-80～KIR-1385-80, KIR-1430-80～KIR-1435-80, KIR-1473-80, KIR-1494-80, KIR-1539-80, KIR-1623-80～KIR-1629-80, KIR-1648-80, KIR-1727-80, KIR-1797-80, KIR-1828-80, KIR-1829-80, KIR-1880-80, KIR-1881-80, KIR-1898-80, KIR-1982-80, KIR-2019-80, KIR-2020-80, KIR-2039-80, KIR-2040-80, KIR-2074-80～KIR-2106-80, KIR-2130-80, KIR-2160-80～KIR-2168-80, KIR-2188-80).

Pelomedusidae, gen. et sp. indet.

2 neural plates (KIR-1579-80, KIR-1592-80), 2 peripheral plate (KIR-1672-80, KIR-1680-80), 1 xiphiplastron (KIR-1622-80).

Chelonia, other than Trionychidae

316 shell fragments (KIR-1329-80, KIR-1341-80～KIR-1353-80, KIR-1375-80～KIR-1381-80, KIR-1419-80～KIR-1429-80, KIR-1491-80～KIR-1493-80, KIR-1506-80, KIR-1535-80～KIR-1538-80, KIR-1550-80, KIR-1577-80, KIR-1578-80, KIR-1580-80～KIR-1591-80, KIR-1593-80～KIR-1621-80, KIR-1678-80, KIR-1679-80, KIR-1681-80～KIR-1683-80, KIR-1685-80～KIR-1726-80, KIR-1734-80, KIR-1763-80～KIR-1769-80, KIR-1794-80～KIR-1796-80, KIR-1823-80～KIR-1827-80, KIR-1868-80, KIR-1877-80～KIR-1879-80, KIR-1891-80～KIR-1897-80, KIR-1915-80, KIR-1928-80～KIR-1959, KIR-1976-80, KIR-1977-80, KIR-1980-80, KIR-1981-80, KIR-2021-80～KIR-2026-80, KIR-2034-80～KIR-2038-80, KIR-2052-80～KIR-2073-80, KIR-2129-80, KIR-2147-80～KIR-2159-80, KIR-2181-80～KIR-2187-80, KIR-2192-80, KIR-2207-80～KIR-2214-80, KIR-2229-80, KIR-2277-80, KIR-2297-80～KIR-2301-80) 2 dermal bones (KIR-2223-80, KIR-2282-80), 2 bone fragments (KIR-2137-80, KIR-2171-80).

Crocodylidae

9 isolated teeth (KIR-1675-80, KIR-2485-80, KIR-2489-80, KIR-2490-80, KIR-2498-80 KIR-2501-80 , KIR-2506-80),

80, KIR-2498-80～KIR-2501-80, KIR-2506-80), 20 vertebrae (KIR-1436-80, KIR-1572-80, KIR-1637-80, KIR-1663-80, KIR-1920-80, KIR-2000-80 KIR-2005-80, KIR-2015-80, KIR-2016-80, KIR-2180-80, KIR-2278-80 KIR-2281-80, KIR-2306-80, KIR-2503-80), 2 long bone fragments (KIR-2028-80, KIR-2504-80), 52 bony plate fragments (KIR-1339-80, KIR-1340-80, KIR-1437-80～KIR-1443-80, KIR-1486-80 KIR-1490-80, KIR-1533-80, KIR-1534-80, KIR-1573-80～KIR-1576-80, KIR-1793-80, KIR-1818-80～KIR-1822-80, KIR-1875-80, KIR-1876-80, KIR-1983-80, KIR-1999-80, KIR-2017-80, KIR-2018-80, KIR-2107-80, KIR-2108-80, KIR-2128-80, KIR-2169-80), 1 long bone fragment (KIR-2170-80).

Reptilia, other, fam., gen. et sp. indet.

2 long bone fragments (KIR-2193-80, KIR-2194-80).

Pisces, order, fam., gen. et sp. indet.

15 jaw fragments (KIR-1388-80, KIR-1390-80, KIR-1446-80, KIR-1544-80, KIR-1631-80～KIR-1633-80, KIR-1639-80～KIR-1642-80, KIR-1882-80, KIR-1883-80, KIR-2027-80, KIR-2112-80), 3 teeth (KIR-1418-80, KIR-1543-80, KIR-2488-80), 22 vertebrae (KIR-1385-80～KIR-1387-80, KIR-1389-80, KIR-1444-80, KIR-1445-80, KIR-1447-80, KIR-1540-80～KIR-1542-80, KIR-1630-80, KIR-1638-80, KIR-1742-80, KIR-1743-80, KIR-2109-80～KIR-2111-80, KIR-2131-80, KIR-2132-80, KIR-2215-80～KIR-2217-80), 1 spine (KIR-2133-80), 25 bone fragments (KIR-1495-80, KIR-1545-80～KIR-1555-80, KIR-1634-80, KIR-1635-80, KIR-1643-80～KIR-1647-80, KIR-1728-80～KIR-1730-80, KIR-2030-80, KIR-2218-80, KIR-2222-80, KIR-2224-80)

Vertebrata, taxon indeterminable

2 tooth fragments (KIR-1366-80, KIR-1367-80), 2 vertebrata fragments (KIR-1365-80, KIR-1674-80), 2 phalanges? (KIR-1885-80, KIR-2494-80), 123 bone fragments (KIR-1391-80～KIR-1396-80, KIR-1449-80～KIR-1464-80, KIR-1498-80, KIR-1499-80, KIR-1551-80, KIR-1552-80, KIR-1656-80～KIR-1662-80, KIR-1664-80～KIR-1668-80, KIR-1670-80, KIR-1671-80, KIR-1673-80, KIR-1731-80～KIR-1733-80, KIR-1744-80～KIR-1756, KIR-1777-80～KIR-1781-80, KIR-1798-80～KIR-1801-80, KIR-1830-80～KIR-1837-80, KIR-1869-80, KIR-1870-80, KIR-1900-80, KIR-1901-80, KIR-1916-80, KIR-1917-80, KIR-1921-80, KIR-1923-80, KIR-1926-80, KIR-1960-80～KIR-1965-80, KIR-1978-80, KIR-2006-80～KIR-2008-80, KIR-2029-80, KIR-2041-80～KIR-2122-80, KIR-2125-80, KIR-2126-80, KIR-2172-80, KIR-2173-80, KIR-2189-80～KIR-2191-80, KIR-2195-80, KIR-2203-80, KIR-2288-80～KIR-2296-80, KIR-2310-80).

Coprolite

1 specimen (KIR-1979-80)

Calcareous coatings

1 specimen (KIR-1553-80)

7. Mbagathi (Surface Collection)

Rhicerotidae, gen. et sp. indet.

1 right upper molar fragment (KIR-2481-80), 2 cheek teeth fragments (KIR-1302-80, KIR-2482-80).

Bovidae, gen. et sp. indet.

1 right horn fragment (KIR-1169-80).

Ruminantia, fam., gen. et sp. indet.

1 cheek teeth fragment (KIR-1303-80), 1 right naviculo-cuboid (KIR-1134-80), 1 metacarpal or metatarsal bone fragment (KIR-1175-80).

Artiodactyla, fam., gen. et sp. indet.

1 cheek teeth fragment (KIR-2483-80)

Mammalia, order, fam., gen. et sp. indet.

6 cheek teeth fragments (KIR-951-80, KIR-1304-80~KIR-1308-80), 1 tusk fragment (KIR-1309-80), 1 carpal or tarsal bone (KIR-1135-80), 2 phalanges (KIR-1176-80, KIR-2426-80), 17 bone fragments (KIR-1170-80, KIR-1171-80, KIR-1295-80, KIR-1301-80, KIR-1310-80~KIR-1332-80).

Trionychidae, gen. et sp. indet.

447 shell fragments (KIR-378-80~KIR-533-80, KIR-719-80~KIR-930-80, KIR-984-80, KIR-1021-80, KIR-1040-80~KIR-1076-80, KIR-1143-80~KIR-1154-80, KIR-1261-80, KIR-1287-80, KIR-1296-80).

Pelusios sp.

3 left mesoplastra (KIR-589-80, KIR-590-80, KIR-636-80), 3 fragments of mesoplastron (KIR-596-80, KIR-597-80, KIR-601-80).

Pelomedusidae, gen. et sp. indet.

1 left ischium (KIR-997-80), 1 fragment of bridge (KIR-1121-80), 1 neural plate (KIR-697-80), 2 left peripheral plates (KIR-986-80, KIR-1031-80), 1 right peripheral plate (KIR-1030-80), 1 fragment of peripheral plate (KIR-1025-80), 1 left hypoplastron (KIR-615-80), 2 right hypoplastra (KIR-593-80, KIR-1029-80), 2 left xiphiplastra (KIR-1024-80, KIR-1028-80), 3 right xiphiplastra (KIR-591-80, KIR-604-80, KIR-632-80), 2 fragments of xiphiplastron (KIR-710-80, KIR-1035-80).

Chelonia, other than Trionychidae

1 fragment of bridge (KIR-586-80), 2 pleural plates (KIR-1018-80, KIR-1023-80), 1 left peripheral plate (KIR-622-80), 5 peripheral plates (KIR-599-80, KIR-600-80, KIR-1020-80, KIR-1022-80, KIR-1032-80), 1 left hypoplastron (KIR-639-80). 191 shell fragments (KIR-349-80~KIR-377-80, KIR-592-80, KIR-594-80, KIR-595-80, KIR-598-80, KIR-602-80, KIR-603-80, KIR-605-80~KIR-614-80, KIR-616-80~KIR-621-80, KIR-623-80~KIR-631-80, KIR-633-80~KIR-635-80, KIR-637-80, KIR-638-80, KIR-640-80~KIR-696-80, KIR-698-80~KIR-709-80, KIR-711-80~KIR-718-80, KIR-956-80~KIR-983-80, KIR-1017-80, KIR-1019-80, KIR-1026-80, KIR-1027-80, KIR-1033-80, KIR-1034-80~KIR-1039-80, KIR-1123-80, KIR-1124-80, KIR-1137-80~KIR-1142-80, KIR-1167-80, KIR-1168-80, KIR-1293-80).

Lacertilia, fam., gen. et sp. indet.

1 proximal phalanx (KIR-588-80).

Crocodylidae, gen. et sp. indet.

80 isolated teeth (KIR-343-80~KIR-347-80, KIR-1122-80, KIR-2394-80~KIR-2421-80, KIR-2427-80~KIR-2459-80, KIR-2469-80, KIR-2472-80, KIR-2473-80, KIR-2477-80, KIR-2478-80, KIR-2480-80), 9 tooth fragments (KIR-2422-80~KIR-2425-80, KIR-2460-80, KIR-2461-80, KIR-2474-80~KIR-2476-80), 6 vertebrae (KIR-1077-80, KIR-1078-80, KIR-1155-80, KIR-1232-80~KIR-1234-80), 1 metacarpal or metatarsal bone (KIR-1176-80), 4 limb bone fragments (KIR-1235-80~KIR-1238-80), 63 fragments of bony plates (KIR-931-80~KIR-937-80, KIR-985-80, KIR-1079-80, KIR-1177-80~KIR-1230-80).

Pisces, order, fam., gen. et sp. indet.

24 jaw fragments (KIR-549-80~KIR-551-80, KIR-952-80~KIR-955-80, KIR-1098-80~KIR-1107-80, KIR-1127-80, KIR-1130-80, KIR-1161-80, KIR-1256-80, KIR-1291-80, KIR-1297-80, KIR-1298-80), 74 vertebrae (KIR-534-80~KIR-548-80, KIR-938-80~KIR-942-80, KIR-1081-80~KIR-1097-80, KIR-1125-80, KIR-1126-80, KIR-1156-80~KIR-1160-80, KIR-1289-80, KIR-1290-80, KIR-2470-80), 25 spine fragments (KIR-552-80~KIR-554-80, KIR-943-80, KIR-1116-80, KIR-1128-80, KIR-1129-80), 42 bone fragments (KIR-555-80~KIR-565-80, KIR-944-80~KIR-950-80, KIR-1001-80~KIR-1080-80, KIR-1108-80~KIR-1115-80, KIR-1129-80, KIR-1162-80~KIR-1166-80, KIR-1257-80, KIR-1258-80, KIR-1288-80, KIR-1299-80, KIR-1300-80).

Vertebrata, taxon indeterminable

3 tooth fragments (KIR-348-80, KIR-2471-80, KIR-2479-80), 80 bone fragments (KIR-566-80~KIR-585-80, KIR-587-80, KIR-987-80~KIR-996-80,

KIR-998-80~KIR-1000-80, KIR-1007-80~KIR-1016-80, KIR-1117-80~KIR-1120-80, KIR-1131-80~KIR-1133-80, KIR-1136-80, KIR-1172-80~KIR-1174-80, KIR-1231-80, KIR-1239-80~KIR-1255-80, KIR-1259-80, KIR-1260-80, KIR-1294-80, KIR-1323-80, KIR-1324-80).

Gastropoda, fam., gen. et sp. indet.
1 fragmental shell (KIR-1325-80).

8. Palagalagi (Surface Collection)

Proboscidea, fam., gen. et sp. indet.
1 tooth fragment (KIR-2359-80)

Rhinocerotidae, gen. et sp. indet.
1 right P_3 fragment (KIR-2509-80).

Trionychidae, gen. et sp. indet.
2 shell fragments (KIR-2370-80, KIR-2371-80).

Chelonia, other than Trionychidae
13 shell fragments (KIR-2361-80, KIR-2369-80, KIR-2378-80~KIR-2381-80).

Crocodylidae, gen. et sp, indet.
1 isolated tooth (KIR-2501-80), 1 fragment of bony plate (KIR-2360--80).

Pisces, order, fam., gen. et sp. indet.
4 vertebrae (KIR-2372-80~KIR-2375-80), 1 bone fragment (KIR-2376-80).

Vertebrata, taxon indeterminable
1 bone fragment (KIR-2377-80).

9. Kirimun Area, Locality Unknown (Surface Collection)

Ruminantia, fam., gen. et sp. indet.
1 right talus fragment (KIR-2358-80)

Crocodylidae, gen. et sp. indet.
14 isolated teeth (KIR-2511-80~KIR-2524-80), 1 tooth fragment (KIR-2525-80), 1 vertebra (KIR-2392-80).

Pisces, order, fam., gen. et sp. indet.
9 vertebrae (KIR-2382-80, KIR-2390-80), 1 spine (KIR-2391-80).

Vertebrata, taxon indeterminable
1 bone fragment (KIR-2393-80)

II. Baragoi Area

GR 3997 (Surface Collection)

Rhinocerotidae, gen. et sp. indet.

1 right metetarsal bone (BAR-4-80).

Tragulidae, gen. et sp. indet.

1 right talus (unnumbered).

Ruminantia, fam., gen. et sp. indet.

1 left naviculo-cuboid fragment (unnumbered), 1 middle phalanx (unnumbered).

Mammalia, order, fam., gen. et sp. indet.

3 bone fragments (BAR-1-80～BAR-3-80), 2 bone fragments (unnumbered).

Chelonia, other than Trionychidae

37 shell fragments (unnumbered).

Crocodylidae, gen. et sp. indet.

14 fragments of bony plate (unnumbered).

Vertebrata, taxon indeterminable

327 bone fragments (unnumbered)

Mollusca, order, fam., gen. et sp. indet.

1 specimen (unnumbered)

Coprolite

1 specimen (unnumbered)

3. Description of the Important Specimens

Class Mammalia

Order Rodentia Bowdich,1821

Super family Thryonomyoidea Wood, 1955

Family Thryonomyidae Pocock, 1922

Genus _Paraphiomys_ Andrews,1914

Paraphiomys cf. _pigotti_ Andrews, 1914

(Pl. 3, figs. 1-10; Pl. 4, figs. 1-12; Pl. 5, figs. 1-3; Pl. 7, fig. 6)

MATERIAL —— 1 left maxilla with dP^4 and M^1 (KSE-8-80), 1 left maxilla with $dP^4 \sim M^3$ (KSE-12-80), 1 right maxilla with $dP^4 \sim M^3$ (KSE-7-80), 1 left mandible with I and dP_4 M_2 (KSE-16-80), 1 left dP_4 (KSE-162-80), 1 right dP_4 (KSE-9-80), 1 right M_2 (KSE-153-80)

LOCALITY —— Site C of South Kirimun

AGE —— Early or Middle Miocene

DESCRIPTION:

Middle sized Thrionomyoid with lophate cheek teeth. The maxillae and the mandible of the present materials are too fragmental to describe in detail.

Upper cheek teeth; The outline of the tooth is sub-quadrate or sub-round in occlusal view. The size of the crown gradually increases from dP^4 to M^3. The crown has four-lophed pattern with one internal and three external valleys. The internal valley is deep and remarkably directs backward. On the other hand, the antero-external and the postero-external valleys are narrow and shallow, so that they become slender enamel rings by the attrition of the crown. The middle external valley are considerably broad and deep. These external valleys extend slightly backward.

The protocone is large and increases in size from dP^4 to M^3, but the hypocone is gradually reduced inversely. The anterior cingulum is strong and run parallel to the protoloph from the protocone to the antero-external corner. In dP^4 and M^1, the short mesoloph extends backward and connects with metaloph at its middle point, so that a small round basin is formed. The posterior cingulum is short, because it branches from the metaloph just behind the junction of the mesoloph and the metaloph. In M^1 and M^2, the mesoloph is not present, and the metaloph and the posterior cingulum extends directly from the hypocone. But the identification of these crests are difficult, because the present specimens are considerably worn. If the anterior crest extends labially from the hypocone is mesoloph, the posterior cingulum is absent in M^1 and M^2.

<u>Lower incisor</u>: The cross section of the lower incisor is sub-triangular. (Pl. 7, fig. 6). The enamel cover of the lower margin is considerably thick which extends upward along the inner and the outer margins.

<u>Lower cheek teeth</u>: The outline of the crown of dP_4 is sub-oval in occlusal view, but those of M_1 and M_2 exhibet sub-quadrate shape with round corners. The size of the crown increases from dP_4 to M_2 rather abruptly than that of the upper teeth. The crown has three-lophed pattern with two internal and one external valleys. The inernal valleys extend rather transversely, but the external valley somewhat directs forward. The antero-internal valley is broad and deep.

The protoconid and the hypoconid are well developed in general, and are approximately same in size. But the protoconid of dP_4 is somewhat reduced as well as their metaconid . The posterior arm of protoconid is completely lacking in dP_4 , M_1 and M_2 (KSE-16-80). In some dP_4 (KSE-9-80, KSE-162-80), however, a short ond weak crest from the protoconid extends into the antero-internal valley. A small tubercle is present on the anterior wall of the protoconid in M_1 and M_2. The anterior and the middle transverse crest, namely metalophid and the entolophid respectively, run parallel to each other. The hypolophid is convex posteriorly.

MEASUREMENT:

Dimensions of the cheek teeth are given in Table 1.

Table 5 Measurements of the cheek teeth of Paraphiomys cf. pigotti Andrews from Site C of South Kirimun in mm.

		Length	Breadth
dP^4	(KSE-8-80)	3.04	2.92
	(KSE-7-80)	2.71	2.90
	(KSE-12-80)	2.77	—
M^1	(KSE-8-80)	2.96	3.12+
	(KSE-7-80)	2.89	3.33
	(KSE-12-80)	2.90	3.2
M^2	(KSE-7-80)	2.80	3.69
	(KSE-12-80)	2.83	3.45
M^3	(KSE-7-12)	2.91	3.72
	(KSE-12-12)	2.73	3.43
dP_4	(KSE-16-80)	2.74	2.10
	(KSE-162-80)	3.33	—
	(KSE-9-80)	3.19	2.43
M_1	(KSE-16-80)	3.09	2.84
M_2	(KSE-16-80)	3.28	3.30
	(KSE-153-80)	3.48	3.87±

DISCUSSION:

The above-mentioned tooth characters of the present materials, namely lophate pattern, lack of posterior arm of protoconid in gereral, size (Text-fig. 1-2) and so on, are well coincident with that of the genus Paraphiomys. Lavocat (1973) already described two species of Paraphiomys from Kirimun, such as P. pigotti and P. stromeri stromeri.

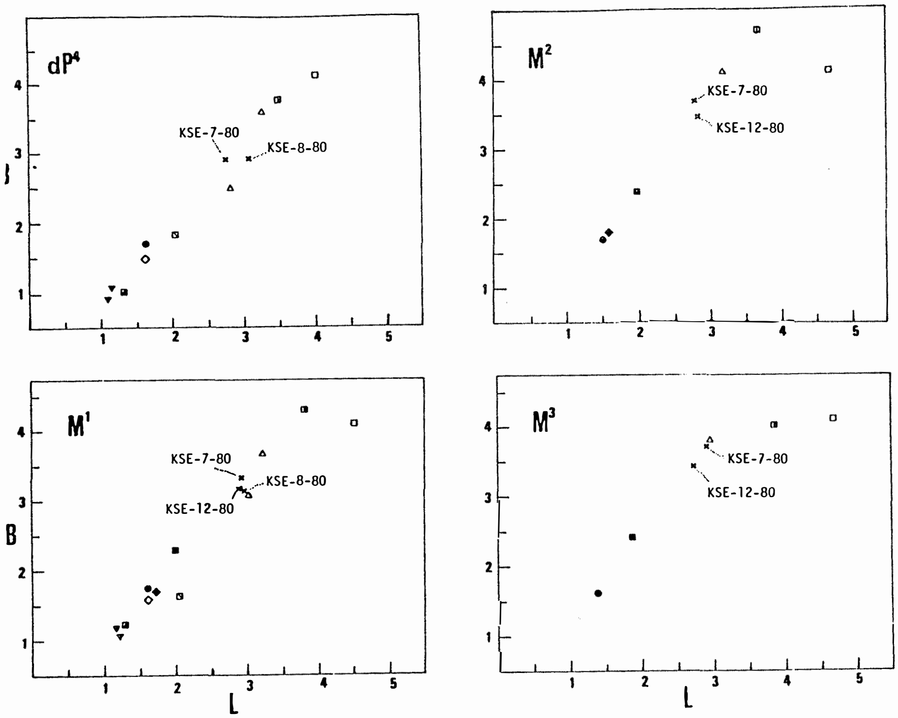
The following four species of *Paraphiomys* are known from the Oligocene to the Miocene in Africa.

1. *Paraphiomys simonsi* Wood, 1968 -----Middle sized species. Oligocene, Egypt.
2. *P. pigotti* Andrews, 1914 ---------Large to middle sized species. Mainly early Miocene, East Africa and Namib.
3. *P. stromeri* (Hopwood), 1929 ------- Small sized species. Mainly early Miocene, East Africa and Namib.
4. *P. occidentalis* Lavocat, 1961 ------ Large sized species. Late Miocene, Morocco.

P. stromeri is easily separable from others by its smaller size. But it is quite difficult to distinguish other three species. Wood (1968) discussed the differences among them. Although Lavocat (1961) distinguished *P. occidentalis* from *P. pigotti* by the length of the posterior arm of protoconid in M_2, Wood (1968, p.50) stated "this difference is entirely expectable as an individual variant". He also suggested that *P. simonsi* had more reduced condition of the posterior arm of protoconid than either two species, and was separable from *P. pigotti* by its smaller dP_4 and the narrower anterior cheek teeth.

Two South-west African species such as *Neosciuromys africanus* described by Stromer (1922) and *Phthynilla fracta* by Hopwood (1929) were recently synonymized with *P. pigotti* by Lavocat (1973). Generally speaking, they are considerably smaller than the type specimen of *P. pigotti* described by Andrews (1914).

Consequently, *P. pigotti* has wide range of variation in tooth size as well as the length of the posterior arm of protoconid in accordance with the description of Lavocat (1973)



Text-fig. 1. Size distribution of several species of Thryonomyoidea from Africa. Length (L) and breadth (B) plots of upper cheek teeth in mm. "dP^4" includes P^4 in the original descriptions. "x" indicates the specimens from Soutn Kirimun. Data other than South Kirimun are cited from Andrews (1914) and Lavacat (1961, 1974).

Phiomyidae

● Phiomys andrewsi

Thryonomyidae

▽ Paraphiomys simonsi

△ P. pigotti

◧ P. occidentalis

■ P. stromeri

◆ Epiphiomys coryndoni

Diamantomyidae

□ Diamantomys leudritzi

Kenyamyidae

◩ Kenyamys mariae

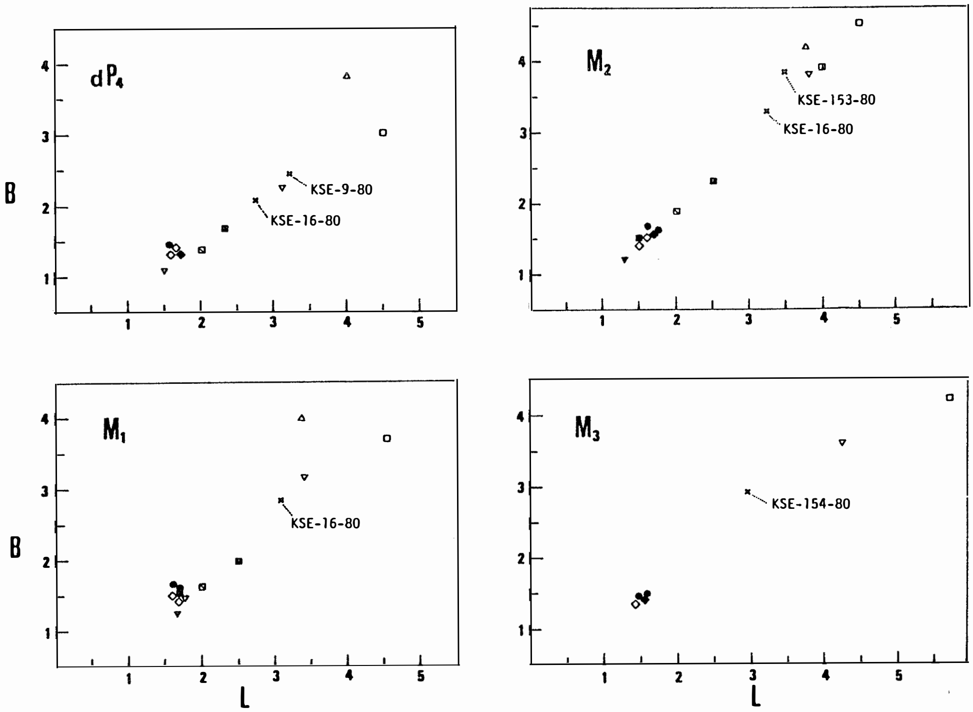
⊠ Simonimys genovefae

Miophiomyidae

◇ Myophiomys arambourgi

▼ Elmerimys woodi

▼ Prophiomys parvus



Text-fig. 2. Size distribution of several species of Thryonomyoidea from Africa. Length (L) and Breadth (B) plots of lower cheek teeth in mm. "dP_4" includes P_4 in the original descriptions. "x" indicates the specimens from South Kirimun. Data other than South Kirimun are cited from Lavacat (1961, 1974) and Wood (1968). Abbreviations as Text-fig. 1.

Paraphiomys sp.

(Pl. 3, figs. 8-10)

MATERIAL —— 1 left M_3 (KSE-154-80)

LOCALITY —— Site C of South Kirimun

AGE —— Early or Middle Miocene

DESCRIPTION:

The present material is represented by only one isolated M_3, which has only faint trace of wearing. The crown pattern approximates to that of P. pigotti, but is four lophed. The size might be smaller than P. cf. pigotti described in this paper, although the comparable part of P. cf. pigotti is unknown (Text-fig. 1,2).

The outline is sub-round but the auterior margin is somewhat straight. Inner three and outer three valleys are present. The antero-internal valley extending transversely, is broad and deep, but its entrance is fairly constricted. Two small postero-internal valleys direct backward, and might form closed basins by wearing. Because of their constricted and shallow entrances. The external valley is deep and extends transversely.

The protoconid is large, but the hypoconid is somewhat reduced. Small tubercle is present on the anterior wall of the crown just anterior to the protoconid. The posterior arm of the protoconid never exist. The metaconid is situated at the antero-internal corner. The metaconid and the entoconid have a faint cingulum on their anterior wall. The metalophid and the entolophid run paralel with each other. The entolophid branches at the point near the ectoloph. This postero-internally directed branch reaches the margin of the crown and almost connects with the tip of the posterior cingulum.

MEASUREMENT:

Measurements of the tooth are as follows:

Length of crown----------2.95 mm

Breadth of crown---------2.91 mm

DISCUSSION:

This form is distinguishable from P. cf pigotti by its smaller size and the presence of the postero-internally directed branch from the entolophid. The size possibly corresponds to the smaller form of P. pigotti described by Lavocat

(1973) as *Phthynilla* type. The variability in tooth pattern and size is quite high, as far as the present authors examined the specimen labelled as *P. pigotti* stored in the National Museum of Kenya. They cannot exclude the possibility that the differences between this form and *P.* cf. *pigotti* are mere individual variation.

Superfamily Pedetoidea Ellerman, 1940

Family Pedetidae Owen, 1847

Genus *Megapedetes* MacInnes, 1957

? *Megapedetes* sp.

(Pl. 5, figs. 7-9; Text fig. 3)

MATERIAL—— Left M_1? (KSE-161-80)

LOCALITY—— Site C of South Kirimun

AGE—— Early or Middle Miocene

DESCRIPTION:

The present material represented by only one specimen is doubtfully assigned to M_1. But it is very difficult to determine the kind of the isolated tooth of pedetid, because all cheek teeth have extremely similar pattren.

The tooth is assumed to be low-crowned, although it is considerably worn. The crown has sub-round outline which is somewhat compressed antero-posteriorly. It is composed of two lobes with sub-equal size and shape, and each of them forms transversely elongated enamel ring on the occlusal surface. The long axis of the anterior ring is slightly convex anteriorly, and the central to the lingual part of the posterior wall of the ring somewhat folds anteriorly. The long axis of the posterior ring, however, is straight and forms a right angle with the antero-posterior axis of the tooth. The enamel is thick in every part of these rings. The mean thickness is 0.4 mm.

A narrow and deep groove extends transversely between the anterior and the posterior lobes. It gradually deepens toward the lingual end.

Three roots are present, namely one large labial root and two small lingual roots. The labial side of the latter two roots are united with the former. These roots are long and stout, and extends postero-inferiorly.

MEASUREMENT:

Method of measurement of the height are shown in Text-fig. 3.

Length of crown -- 2.79 mm

Breadth of crown -- 3.32 mm

Height of crown measured along lingual side (h_1 in Text-fig. 3) ------- 2.84 mm

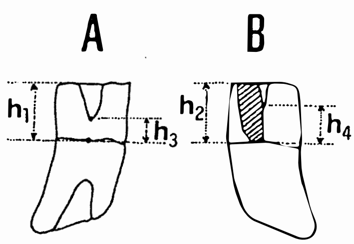
Ditto along labial side (h_3) -------------------------------------- 1.43 mm

Height of the base of the transverse groove along lingual side (h_2)-- 1.88 mm

Ditto along labial side (h_4) -------------------------------------- 1.10 mm

DISCUSSION:

The present material undoubtedly belongs to the family Pedetidae judging from its characteristic tooth pattern. Only three genera of Pedetidae are



Text-fig. 3. Method of measurements of the lower molar of ?Megapedetes sp. A, lingual view; B, labial view. Other abbreviations; see below text.

known from Africa, such as _Megapedetes_ from the Miocene, _Pedetes_ from the Pliocene to the Recent and _Parapedetes_ also from the Miocene. The detailed crown pattern and the brachydonty of the present specimen is rather similar to _Megapedetes_ than _Parapedetes_ illustrated by Stromer (1926) and the living _Pedetes_. The latter two genera have rather high-crowned teeth in which two enamel rings connects with each other on their labial or lingual ends even in the early stage of attrition.

Megapedetes is represented by single species, _M. pentadactylus_ originally described by MacInnes (1957) from Rusinga and Songhor. The occurrence of this species from Napak is also reported by Bishop (1962). According to MacInnes (1957), the characteristics of the cheek teeth of this species are summarized as follows:

The cheek teeth are low-crowned and of limited growth. There are no crown cementum. Two lobed crown is seperated by a vertical invagination of the occlusal enamel. This transverse fold does not penetrate the full depth of the crown. In the upper cheek teeth, it is slightly deeper on the labial side. Inversely, it is deeper on the lingual side of the lower cheek teeth.

These characters are well coincident with those of the present specimen, although it is considerably smaller than _Megapedetes pentadactylus_. On the other hand, Lavocat (1973) identified three teeth from Rusinga (KMN RU 2347-2349) as _Megapedetes_ sp. According to his description, the length and the breadth of the molar in these specimens are 2.7 mm and 3.5 mm respectively. These dimensions are much smaller than _M. pentadactylus_, but approach those of the present material. It is probable that the present specimen belongs to the same species as the Lavocat's "_Megapedetes_ sp."

Superfamily Muroidea Miller et Gidley, 1918

Family Cricetodontidae Schaub, 1925 emend.

Genus Afrocricetodon Lavocat, 1973

Afrocricetodon sp.

(Pl. 5, figs. 4-6)

MATERIAL —— One right M^3 (KSE-155-80)

LOCALITY —— Site C of South Kirimun

AGE —— Early or Middle Miocene

DESCRIPTION:

The crown has four cusped pattern. It exhibits sub-quadrate outline with round corners in occlusal view. The chief lingual and labial cusps arrange in opposite position.

The paracone is large and conical which is situated on the antero-external corner. It is the highest of the chief cusps. The protocone is also conical but much smaller than the paracone. The metacone and the hypocone are very large. The former seems to be higher than the latter, although their apexes are worn out. The enamel exposed on their ocolusal surface in fairly thick.

The crest extending antero-internally from metacone joints with the crest from the hypocone, and reaches the base of the protocone. The cingulum extends anteniorly from the metacone along the external wall of the crown, and surrounds the antero-external base of the paracone. This cingulum is followed by the anterior cimgulum which passes the antero-internal base of the protocone and reaches the anterior base of the hypocone.

The valley between the protocone and the hypocone is deep and directs antero-internally. The entrance of this valley is closed by the internal cingulum which forms the internal wall of the crown. The valley between the paracone and metacone is crescent in occlusal view, and extends along the base of paracone. This valley is also closed. The valley between metacone and hypocone is fairly deep. It opens posteriorly. No trace of tubercle and cimgulum is seen on its entrance.

Three roots are present, namely anterior two and posterior one. The anterior roots are sub-equal in size, but the posterior one is larger.

MEASUREMENT:

Length of crown --------------------- 2.20 mm

Breadth of crown -------------------- 2.28 mm

DISCUSSION:

This tooth with cricetodont pattern is provisionally referred to the genus Afrocricetodon Lavocat 1973. This genus is represented by only one species, A. songhori Lavocat 1973 which approximates the present specimen in size. A. songhori is recorded from the Lower Miocene of Rusinga, Songhor, Koru and Napak. The present specimen is distinguishable from A. songhori by the following points.

1) The outline of the present specimen is sub- quadrate. But that of A. songhori is usually more elongated antero-posteriorly.
2) The metacone and the hypocone are well developed in the present specimen, but smaller and lower in A. songhori.
3) The valley between the protocone and the paracone opens anteriorly at the central part of the anterior margin in the present specimen. In A. songori, it is blocked by the anterior marginal ridge which is extending from the protocone.
4) The valley between the hypoconid and the metaconid is deep and opens posteriorly in the present specimen. In A. songhori, it is relatively shallow and is closed.

The tooth pattern is somewhat similar to that of Notocricetodon petteri described by Lavacat 1973. But the following differences also exist:

1) N. petteri is much smaller than the present specimen.

2) The posterior cusps are much reduced in N. petteri.

The present form is not coincident with other African cricetodonts. As the similarity with Afrocricetodon is taken here, it is tentatively assigned to A. sp. Further studies well be requested.

Order Carnivora Bowdich, 1821

Carnivara, fam., gen. et sp. indet.

(Pl. 8, figs. 1-3)

MATERIAL —— 1 left upper canine (KSE-27-80)

LOCALITY —— Site C of South Kirimun

AGE —— Early or Middle Miocene

DESCRIPTION:

The tooth is rather slender. It has a relatively small crown extending postero-inferiorly and a large root extending postero-superiorly like other carivore upper canine. The apex of the crown is damaged. The distinct longitudinal grooves are present on the surface of the crown. On the other hand, the horizontal growth line are preserved on the surface of the root.

MEASUREMENT:

Maximum antero-posterior diameter of the root ------------- 3.94 mm

Maximum labio-lingual diameter of the root ---------------- 2.57 mm

DISCUSSION:

The Carnivore remain is extremely rare in the present collection. The present material possibly belong to small mustelid or small viverrid judging from the grooves on the crown.

Order Proboscidea Illiger,1811

Suborder Elephantoidea Osborn,1921

Family Gomphotheriidae Hay,1922

Gomphotheriidae, gen. et sp. indet.

(Pl. 8, figs. 9-11; Text-figs. 4-5)

MATERIAL——— 1 fragmant of molar (KIR-222-80)

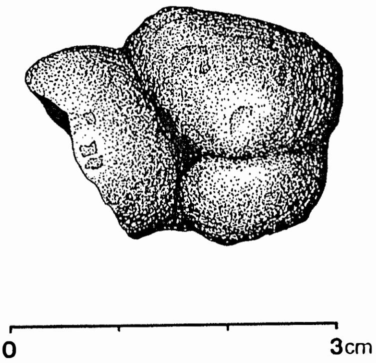
LOCALITY——— South Kirimun (Surface Collection)

AGE——— Miocene

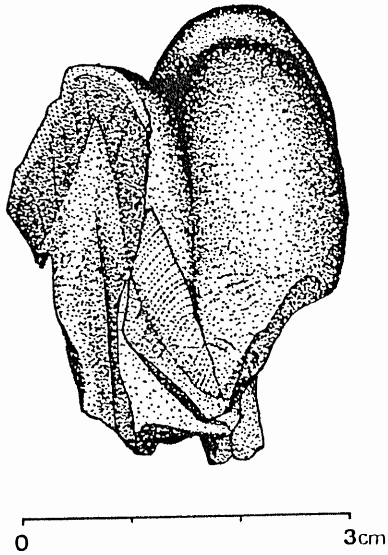
DESCRITPION:

The cheek teeth fragments of gomphothere are considerably abundant in the present collection. Like deinothere remains, almost all of them are so fragmantal that the further discussions on morphology and taxonomy are impossible. Only one specimen is worthy to note (Text-fig.4-5).

Three bunoid cusps are preserved on this specimens. The grooves among these cusps are not so deep. The thick enamel is observable on the broken surface of the crown.



Text-fig. 4. Gomphotheriidae, gen. et sp. indet. Molar fragment (KIR-222-80) from South Kirimun. Occlusal view.



Text-fig. 5. Gomphotheriidae, gen. et sp. indet. Molar fragment (KSE-222-80) from South Kirimun. Side view.

DISCUSSION:

The family Gomphotheriidae is ranging from the Late Eocene to the Middle Pleistocene of Africa. It is represented by six genera such as Palaeomastodon, Gomphotherium, Platybelodon, Tetralophodon, Choerolophodon and Anancus (Coppens et al., 1976). They are indistinguishable by small pieces of the cheek teeth.

Suborder Deinotherioidea Osborn, 1921

Family Deinotheriidae Bonaparte, 1845

Deinotheriidae, gen. et sp. indet.

(Pl. 8, figs. 4-8; Text-figs. 6-7)

MATELIAL & LOCALITY —— 3 cheek teeth fragments (KSE-50-80 from Site C of South Kirimun. KIR-2487-80 and KIR-2502-80 from GR6371)

AGE —— Miocene

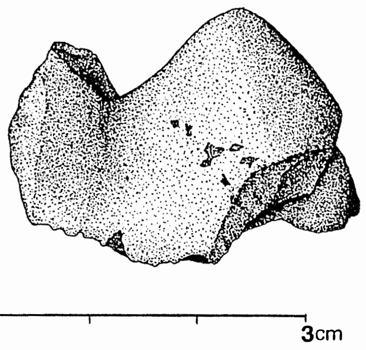
DESCRIPTION:

Deinothere remains are abundant in the present collection, but the most of them are small chips of cheek teeth. Only 3 specimens described here are somewhat large fragmants, although they are too fragmantal to identify generically and specifically.

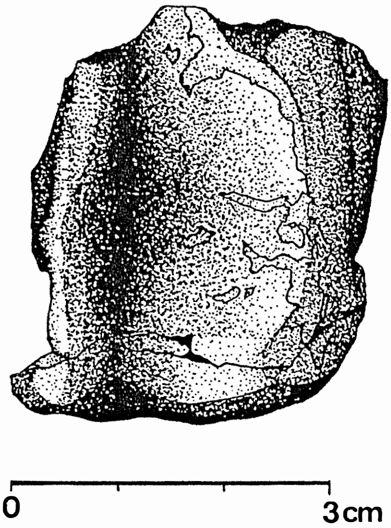
KSE-50-80: The specimen is provisionally assigned to the lingnal part of the posterior crest of the left M_2 or that of the middle crest of the left M_3. The size might be as large as Prodeinotherium hobleyi.

KIR-2487-80 (Text-figs 6-7): The specimen is possibly assigned to the lingual half of the middle crest of the right M_3. The crests run parallel with the transverse valley which penetrates from the lingual to the labial margin. The lingual face is smooth. The size is about the same as P. hobleyi.

KIR-2502-80: The specimen is somewhat doubtfully attributed to the labial half of the anterior crest of the right M_2. The crown is considerably worn. The length from the anterior margin to the bottom of the median transverse valley is 24.54 mm which approximates the dimension of P. hobleyi.



Text-fig. 6. Deinotheriidae, gen. et ap. indet. Fragment of right M_3 (KSE-2487-80) from 6371. Occlusal view.



Text-fig. 7. Deinotheriidae, gen. et sp. indet. Fragment of right M_3 (KIR-2487-80) from GR6371. Lingual view.

DISCUSSION:

Only two species of deinotheres are known from Africa, such as *Prodeinotherium hobleyi* Andrews 1914 and *Deinotherium bozasi* Arambourg 1934. The former is the smaller species of the Early to the Late Miocene. On the other hand, the latter is the larger species ranging from the Late Miocene to the Early Pleistocene. The present materials possibly belong to the former species because of their small size. This provisional view is consistent with their geological age.

Order Hyracoidea Huxley, 1869

Family Procaviidae Thomas, 1892

Procaviidae, gen. et sp. indet.

(Pl. 8, figs. 12-13; Text-fig. 8)

MATERIAL—— One left M^2 (KSE-163-80)

LOCALITY —— Site C of south Kirimun

AGE —— Early or Middle Miocene

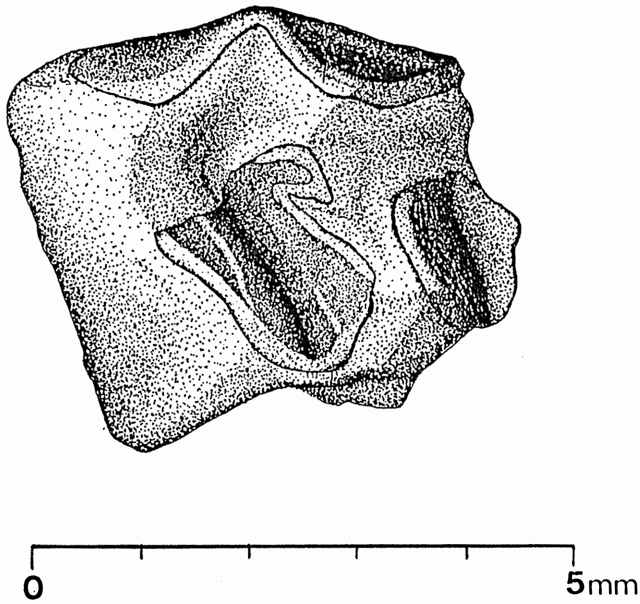
DESCRIPTION:

The present specimen is badly preserved. The anterior, the posterior and the lingual margins of the crown are lost, and the occlusal surface is somewhat damaged as well.

The tooth seems to be of low-crowned, although it is considerably worn. The ectoloph is of W-shaped. The mesoloph is not so strong as *Prohyrax*, but as the living genera such as *Procavia*, *Dendrohyrax* and *Heterohyrax*. The protoloph and the metaloph direct postero-lingually. The buccal end of the medisunus projects backward into the basal part of the metaloph, so that the latter is somewhat constricted. The broad post-fossette is present behind the metaloph. The cingula extend anteriorly and posteriorly from the mesostyle along the basal part of the labial face of the crown.

DISCUSSION

The tooth pattern of the present material is different from that of *Myohyrax* which had originally been described by Andrews (1914) as Hyracoid but later emended as Insectivora. Among the African Miocene Hyracoid, the tooth pattern is somewhat similar to *Prohyrax tertiarius* reported by Stromer (1926) from South-west Africa, but the size is much smaller. *Prohyrax* sp. figured by Meyer (1976) is different from the present material.



Text-fig. 8. Procaviidae, gen. et sp. indet. Damaged left M^2 (KSE-163-80) from site C of South Kirimun. Occlusal view.

The detailed morphology of the present material approach to the living genera of Procariidae rather than any fossil forms. Among the living genera, Dendrohyrax has low-crowned teeth as the present material. The presence of the post-fossette and the posterior projection of the labial part of the medisinus are common characters to Procavia and the present material. The external cingulum of the present material is also seen in Heterohyrax. But the present material is too fragmental to discuss the further taxonomic position.

Order Perissodactyla Owen, 1848

Suborder Ceratomorpha Wood, 1937

Superfamily Rhinocerotoidea Gill, 1872

Family Rhinocerotidae Owen, 1845

Genus Brachypotherium Roger, 1904

Brachypotherium heinzelini Hooijer, 1963

(Pl. 9, figs. 1-12; Pl. 10, figs. 1-10; Text-fig. 9)

1963 Brachypotherium heinzelini Hoojer, Ann. Mus Roy. de l'Afrique Cent. Tervuren, Belg., Sci. Géol. 46: 45-50

1966 Brachypotherium heinzelini Hooijer. Hooijer, Bull. Brit. Mus. Nat. Hist. (Geol.), 13: 142-150.

1971 Brachypotherium heinzelini Hooijer. Heissig, Mitt. Bayer. Staats-Paläont. Hist. Geol. 11: 125-128.

MATERIAL —— 1 left M^2 fragmant (KSE-47-80), 1 upper molar fragment (KSE-48-80), 1 right I_2 (KSE-6-80), 1 right P_2 (KSE-37-80), 1 left P_3 (KSE-34-80), 1 left P_4 (KSE-35-80). 1 right P_2 (KSE-37-80), 1 left P_3 (KSE-34-80), 1 left P_4 (KSE-35-80). 1 right M_1 (KSE-39-80), 1 right M_2 (KSE-38-80), 1 left M_3 (KSE-36-80), 1 right M_3 (KSE-40-80).

LOCALITY —— Site C of Sorth Kirimun

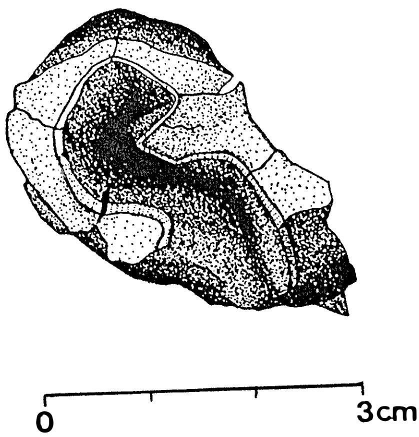
AGE —— Early or Middle Miocene

DESCRIPTION:

The terminology for the cheek teeth are cited from Hamilton (1971).

Upper molar: The upper molar of rhinocerotid are relatevely few in the present collection. Only two specimens (KSE-47-80 and KSE-48-80) are referred to this species.

KSE-47-80 (Teft-fig.9) is a fragment of left M^2 in which all marginal parts of the crown are lost. The antecrochet is somewhat strong, but the crista is absent. The crochet is also well-developed and extends anteriorly. The medifossette which form a deep fold labial to the crochet, is a posterior extension of the medisinus. The enamel exposed on the occlusal surface is rather thin. Adding to these characters, the general feature of this specimen is very similar to M^2 (Sinda No.2) of *Brachypotherium heinzelini* in the description of Hooijer (1963, pl. 8, fig.4), which had been originally referred to *Aceratherium* cf. *tetradactylus*, but was reidentified later as this species (Hooijer, 1966).



Text-fig. 9. *Brachypotherium heinzelini* Hooijer. Damaged left M^2 (KSE-47-80) from Site C of South Kirimun. Occlusal view.

KSE-48-80 is the labial wall of the upper molar. There is a strong labial cingulum, as noted in the Hooijer's description of the holotype of *B. heinzelini*.

Lower incisor: I_2 is represented by only one specimen (KSE-6-80). The inner margin of the tooth is damaged. It is long and stout, exhibiting tusk-like form which approaches to rodent lower incisors. The labial margin is slightly convex externally in the upper view. The occlusal surface is seen on the upper surface of the anterior tip of the crown. It may exhibit elliptical shape elongating antero-posteriorly, although its inner half is lost. The enamel cover of the crown is thin.

Lower cheek teeth: P_2 is represented by one specimen of well preservation (KSE-37-80). The outline of the crown in occlusal view is of sub-triangular. The labial side is flat with no trace of the labial groove. Only one lingual valley is present. It is relatively shallow, extending somewhat postero-lingnally. The posterior margin of the crown is slightly concave. The posterior root is much larger than the anterior one.

P_3 is also represented by one specimen (KSE-34-80) in which both the crown and the root are completely preserved. The outline of the crown is of sub-triangular in occlusal view. The labial groove is very faint. The antero-lingual valley is very weak and shallow, so that the metalophid extends almost straight antero-posteriorly. On the other hand, the postero-lingual valley is rather deep, and its entrance is as open as B. snowni of Hamilton (1971, pl.6, fig. 4). The antero-labial corner is broken, so that wheather the cingulum is present or not at this corner is unknown. A weak cingulum extends from the antero-lingual corner to the entrance of the postero-lingual valley along the basal part of the lingual side. The posterior wall of the crown is nearly straight and no cingulum, although feeble trace of cingulum is present at the postero-labial corner. Two roots with similar size are very long, and slightly curve postero-inferiorly.

The specimen referred to P_4 is KSE-35-80. The crown is well preserved, whereas the root is almost lost. The outline in occlusal view is of sub-rectangular with round corners. The labial groove is shallow. The anterior end of metalophid is flexed lingually as B snowi. The antero-lingual valley is shallow and extending antero-lingually. The postero-lingual valley directing lingually is rather broad and deep. These lingual valleys are as open as those of B. snowi. The weak cingulum is present on the anterior wall of the crown, which extends to the entrance of the antero-lingual valley to form a small tubercle. The similar weak cingulum is also seen on the posterior wall of the crown.

M_1 is represented by one badly preserved specimen (KSE-39-80). The crown is considerably damaged. Its antero-lingual part is completely lost, whereas the roots are rather well preserved. The labial groove is also shallow as well as M_2 and M_3. It is the common character of the lower cheek teeth of most Brachypotherium. A weak cingulum and a small tubercle are present on the posterior wall of the crown and the entrance of the postero-lingual valley respectively. The roots are long and stout. The anterior root is somewhat twisted.

KSE-38-80 is only one specimen referable to M_2. This specimen is badly preserved. The anterior part and the lingual margin of the crown are lost as well as the most part of the roots. The tooth pattern is approximately the same as M_1 and M_3.

M_3 is represented by two specimens in the similar stage of attrition (KSE-36-80 and KSE-40-80). KSE-36-80 is rather seriously damaged, in which the postero-lingual part of the crown and the most part of the roots are absent. On the other hand, the crown of KES-40-80 is beautifully preserved in spite of the poor preservation of its roots. The outline of the crown is of sub-rhomboid with round corners. The antero-lingual valley is as broad and deep as the postero-lingual valley. The metalophid is longer than the hypolophid. The weak cingula are present on the anterior and the posterior wall of the crown. Any tubercles on the entrances of the lingual valleys are nonexistent. The height of the metalophid- hypolophid junction above the base of the crown is 24.7 mm in KSE-36-80 and 26.1 mm in KSE-40-80. The crown of these specimens are lower than M_3 of B. snowi in Hamilton's description (M29261), in which the height is over 30 mm.

Table 6 Measurements of the lower cheek teeth of Brachypotherium heinzelini Hooijer from Site C of Kirimun South in mm.

	P_2 (KSE-37-80)	P_3 (KSE-34-80)	P_4 (KSE-35-80)	M_1 (KSE-39-80)	M_2 (KSE-38-80)	M_3 (KSE-36-80)	M_3 (KSE-40-80)
1. Length of crown	24.7+	35.0±	38.7	41.0±	43.4+	49.8+	52.4
2. Breadth of anterior part of crown	13.2	21.1	24.6	21.4	–	–	31.5
3. Breadth of posterior part of crown	16.5	23.6	27.1	27.5	21.5+	29.5	28.6
4. Ratio of the anterior and the posterior breadth (2/3)	0.70	0.89	0.91	0.78	–	–	1.10
5. Height of the anterior part of crown	23.7	30.8	35.2	21+	43.0	41.6	42.5
6. Height of the posterior part of crown	27.3	26.5	33.1	31.1	38.3	35.5	36.9
7. Height of the anterior part of tooth*	–	76.3	–	67+	–	–	–
8. Height of the posterior part of tooth*	–	68.0	–	76.0	–	–	–

* Height from the lowest point of crown to the lowest point of root.

MEASUREMENT:

Measurements are given in Table 2.

DISCUSSION:

The dental characters of the genus Brachypotherium are summarized by Hooijer (1978) as follows: "Very brachydont upper molars with ectolophs that are flattened behind the paracone style, antecrochets that are only weakly developed, and very slightly marked protocone constrictions. External cingula and flattened external grooves are usually present on the lower molars". These characters are well coincident with those of the present material mentioned above. Three species of this genus have been recorded from Africa, such as B. snowi (Fouteau) 1918, B. heinzelini Hooijer 1963 and B. lewisi Hooijer et Patterson 1972. B. lewisi is the Late Miocene species known from Kenya (Lothagam-1, Ngorora, Mpesida Beds) and Lybia (Sahabi) in accordance with Hooijer & Patterson (1972) and Hooijer (1971, 1973). This species is much larger than the present materials and has lower cheek teeth with deep labial groove.

B. snowi was reported from Moghara, Siwa and Gebel Zelten, all in North Africa (Hamilton, 1973). The geological age of these localities are estimated as the Early Miocene. On the other hand, *B. heinzelini* is known from the East African localities such as Sinda Bed, Rusinga, Karungu and Napak (Hooijer, 1963; 1966) and from Langental of South-west Africa (Heissig, 1971). These localities are also the Early Miocene in age. The following differences between these two species are discussed by Hamilton:

In P^4, the labial cingulum is present in *B. heinzelini* from Congo, but absent in the same species from Rusinga and *B. snowi*. P^4 is generally larger and narrower in B. heinzelini than *B. snowi*. M^1 of *B. heinzelini* from Karungu has a labial cingulum, but it is very reduced in *B. snowi*. In the M^2 of *B. heinzelini* from Congo, the labial wall is more flattened and antecrochet is stronger. The crochet of the Congo specimen appears double.

The difference in the lower teeth are not fully discussed, because of the scarcity of the lower teeth of *B. heinzelini*. Hamilton stated the labial groove of M_1 in *B. snowi* was similar in strength to that in *B. heinzelini*. He also mentioned the difference in size between these species. These differences, however, seems to be minor so that the distinction of these two species are very difficult. The tooth pattern in M^2 of the present materials are very similar to that of *B. heinzelini* in the figure of Hooijer (1963, pl.8, fig.4), and the upper molar of the present materials has a cingulum on the labial wall. The size of the present specimens is slightly smaller than *B. snowi*, but approximates to *B. heinzelini*. Therefore the present materials are provisionally referred to *B. heinzelini*.

Order Artiodactyla Owen, 1848

Suborder Suiformes Jaeckel, 1911

Infraorder Suina Gray, 1868

Superfamily Suoidea Cope, 1887

Family Suidae Gray, 1821

Genus Sanitherium Meyer, 1866

Sanitherium sp.

(Pl. 11, figs. 3-24, Pl. 12, figs. 21-22; Text-figs. 10-11)

MATERIAL —— 1 right P^1 (KSE-181-80), 1 right P^2 (KSE-477-80), 1 left mandible fragment with M_2 (KSE-2-80), 1 left I_1 (KSE-4-80), 1 left lower canine (KSE-99-80), 1 left P_3 (KSE-180-80), 1 right P_3 (KSE-26-80), 1 left M_1 (KSE-3-80) 1 fragment of left M_2 (KSE-491-80), 1 left M_3 (KSE-478-80), 1 right M_3 (KSE-1-80), 1 premolar fragment (KSE-483-80), 2 molar fragments (KSE-178-80, KSE-179-80), 1 root fragment of molar (KSE-435-80).

LOCALITY —— Site C of South Kirimun.

AGE —— Early or Middle Miocene.

DESCRIPTION

The suid remains from South Kirimun are relatively abundant in number. Most of them are tooth remains. The mandible remain is represented by only one specimen (KSE-2-80) which is too fragmental to describe. The detailed descriptions of each material are given as follows..

P^1: The crown of the present material (KSE-181-80) is well preserved. But the roots are considerably damaged. The anterior root is completely lost.

In occlusal view, the crown has sub-rectangular outline with round corners which is elongated antero-posteriorly. The main cusp is not so high and situated in the central part of the crown. From this cusp, one ridge extends forward to the antero-labial corner, and another ridge extends backward to the postero-labial corner. The gentle slope is formed lingual to the latter ridge. The narrow cingulum surrounds the base of the crown. A small tubercle is present at the junction of this cingulum and the posterior ridge.

This tooth may have two roots.

$\underline{P^2}$: The present material (KSE-477-80) is well preserved both in the crown and the roots. In occlusal view, the outline of the crown is somewhat similar to that of P^1, but its middle part is decidedly constricted labio-lingually. The main cusp is sharply pointed, and situated somewhat anterior to the center of the crown. Two ridges are extending anteriorly and posteriorly from this cusp respectively. The feeble cingulum surrounds the base of the crown without interruption.

There are two roots which extends postero-inferiorly.

$\underline{I_1}$: I_1 is represented by KSE-4-80, in which the crown and the root are well in preservation. The crown gradually broadens anteriorly in upper view. The upper surface of the crown is almost flat. But its marginal part except the anterior edge is slightly swelling and the slender central rib extends longitudinally. A small tubercle is present in the central part of the posterior marginal swelling. The anterior edge of the crown is oblique to the antero-posterior axis of the tooth. The root is long and slender, and compressed mesio-distally. It extends straight backward.

Lower canine: The specimen (KSE-99-80) is well preserved in general, but its labio-superior side is badly cracked. The tooth is rootless and shapes as ordinary suid canines. The cross section is of triangular with the vertical lingual side, the labio-superior side and the labio-inferior side. The surfaces of these sides are smooth. The enamel covers the former two sides from tip to tip. In upper view, It extends almost straight, but its posterior part slightly curve labially and is somewhat twisting. The occlusal surface with sub-oval shape is present on the anterior tip region of the labio-superior side.

$\underline{P_3}$: P_3 is represented by two specimens such as KSE- 26 -80 and KSE-180-80. The former is completely preserved, but the anterior half of the latter is lost. The crown has sub-oval outline in occlusal view. The position of the main cusp is slightly anterior to the center of the crown. A weak cinglum surrounds the base of the crown except the labial side. Small tubercles are present on the ciugulum at the junctions with the ridges extending anteriorly and posteriorly from the main cusp. The posterior ridge has a sharp edge. Lingual to this ridge, there is a gentle slope as P^1.

This tooth has two roots extending straight downward.

$\underline{M_1}$: M_1 is represented by KSE-3-80. Its preservation is fairly well, exepting that the lingual side of the entoconid is damaged. The crown is considerably worn so that the dentine is exposed widely between the protoconid and the metaconed, and on the anterior side of the hypocone. These wear surfaces are inclined medially.

In occlusal view, the crown has sub-rectangular outline with round couners, in which the middle part is distinctly constricted labio-lingually. The lingual cusps are higher than the labial ones. But the shape of these cusps are unknown because of their attrition. The central ridge extending antero-lingually from the hypoconid reaches the central part of the anterior lobe. The lingual median valley is deeper than the labial one. Any tubercles are not present at the entrances of these valleys. The labial and the anterior cingulum are well developed. But they are slightly interrupted at the labial base of protoconid and at the center of the anterior margin. The lingual face of the crown is smooth without any cingula. Four roots are present beneath the main cusps. They are not united each other.

$\underline{M_2}$: KSE-2-80 is one fragment of mandible with M_2. This mandible is a badly damaged small fragment. M_2, however, is completely preserved. Its cusps are faintly worn.

The general pattern of the crown is similar to that of M_1. The outline of the crown is of sub-rectangular, which is constricted in the central part as M_2. The main cusps are opposite in position, but not alternated. Generally, they are remarkably bunoid is shape. The lingual cusps are conical and high, whereas the labial cusps are lower and not so pointed. The hypoconulid is situated on the central part of the posterior cingulum. A small closed basin is present in the valley between the protoconid and the metaconid. The ridges are extending anteriorly and posteriorly from the hypoconid. The posterior ridge reaches the hypoconulid. There are strong cingula along the anterior, the labial and the posterior sides. Of them, the posterior cingulum is especially broad. The anterior cingulum and the labial cingulum is not continuous with the interruption on the lingual base of the protoconid. The folding of enamel is feebly present only on the wall of the labial cingulum and the lingual side of the entoconid.

$\underline{M_3}$: M_3 is represented by two damaged specimens(KSE-1-80, KSE-478-80). They possibly belong to the same individual. The roots are almost lost in both specimens. The antero-lingual part of the crown in KSE-1-80 and the anterior to the antero-lingual parts in KSE-478-80 are also missing. Their cusps are very slightly worn.

The outline of the crown in occlusal view is sub-triangular, which is remarkably constricted between the anterior and the middle lobes, but very slightly constricted between the middle and the posterior lobes. The main cusps are nearly the same as those of M_2 in position and feature. The central transverse valley in the lingual side is deeper than that in the labial side. The remarkable central ridge extends antero-posteriorly from the labial base of the metaconid to the hypoconulid. This ridge divides the posterior lobe into two basins. A shallow and closed basin is distinctly seen between the protoconid and metaconid as that in M_2. The hypoconulid is well developed, and situated at the junction of three ridges such as the central, the labial marginal and lingual marginal ridges. The antero-labial and the antero-lingual faces of the hypoconulid are sharply cut off, but its posterior face is gently sloping. The labial cingulum is strong and continues posteriorly to the labial marginal ridge. It is slightly interrupted at the labial base of the protoconid. The anterior cingulum is also distinct. The enamel folding is present on the walls of the anterior and the labial cingula. It is also present on the labial side of the lingual marginal ridge. The surface of each cusp are rather smooth so that the enamel folding is absent or very faint.

MEASUREMENT:

The method of measurements of I_1 (KSE-4-80) are shown in Text-fig.10. Its dimensions are as follows:

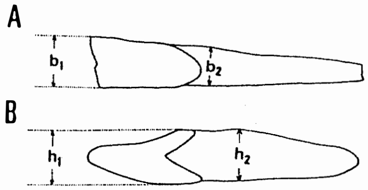
Maximum breadth of crown (b_1) ----------- 5.86 mm

Maximum breadth of root (b_2) ----------- 4.52 mm

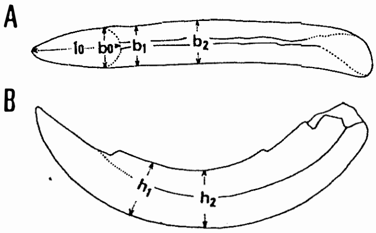
Maximum height of crown (h_1) ----------- 5.72 mm

Maximum height of root (h_2) ----------- 5.84 mm

The method of measurements of the lower canine (KSE-90-80) are shown in Text-fig. 11. Its dimensions are as follows:



Text-fig. 10. Method of measurements of the first lower incisor (KSE-4-80) of Sanitherium sp.



Text-fig. 11. Method of measurements of the lower canine (KSE-99 -80) of Sanitherium sp.

Length of occlusal surface (lo) ---------------------------- 12.3 mm

Breadth of occlusal surface (bo) --------------------------- 5.0 mm

Breadth at the point 20 mm* behind the anterior tip (b_1) ---- 7.7 mm

Breadth at the point 30 mm* behind the anterior tip (b_2) ---- 8.7 mm

Height at the point 20 mm* behind the anterior tip (h_1) ----- 5.4 mm

Height at the point 30 mm* behind the anterior tip (h_2) ----- 5.5 mm

(* measured along lower margin)

The dimensions of the cheek teeth are given in Table 3 and 4.

Table 7 Measurements of the premolar of <u>Sanitherium</u> sp. from Site C of South Kirimun in mm.

	Length	Breadth
P^1 (KSE-181-180)	8.5	3.6
P^2 (KSE-477-80)	6.7	3.6
P_3 (KSE-26-80)	10.5	4.9

Table 8 Measurements of the lower molars of <u>Sanitherium</u> sp. from Site C of South Kirimun in mm.

		Length	Breadth		
			anterior lobe	middle lobe	posterior lobe
M_1	(KSE-3-80)	12.4	7.9	—	8.4
M_2	(KSE-2-80)	15.9	10.8	—	11.0
M_3	(KSE-1-80)	21.4	—	10.4+	—
	(KSE-478-80)	—	—	10.3+	—

DISCUSSION:

The suid remains of the present collection are considerably different from the Upper Miocene to the Pleistocene suids of Africa. The present materials are characterized by their small size. Additionally rather broad outline and well-deveolped labial cingulum are also characteristic in the lower molars.

The following species are listed as the Lower and the Middle Miocene suid of Africa by Cooke & Wilkinson (1978)

Subfamily Hyotheriinae

Hyotherium dartevelli (Hooijer), 1963

H. kijivium Wilkinson, 1976

Subfamily Listriodontinae

Kubanochoerus jeanneli (Arambourg), 1933

K. massai (Arambourg), 1961

K. khinzikebirus Wilkinson, 1976

Listriodon akatikubas Wilkinson, 1976

L. akatidogus Wilkinson, 1976

Lopholistiodon kidogosana Pickford et Wilkinson, 1975

L. moruoroti (Wilkinson), 1976

Subfamily Sanitheriinae

Sanitherium africanus (Stromer), 1926

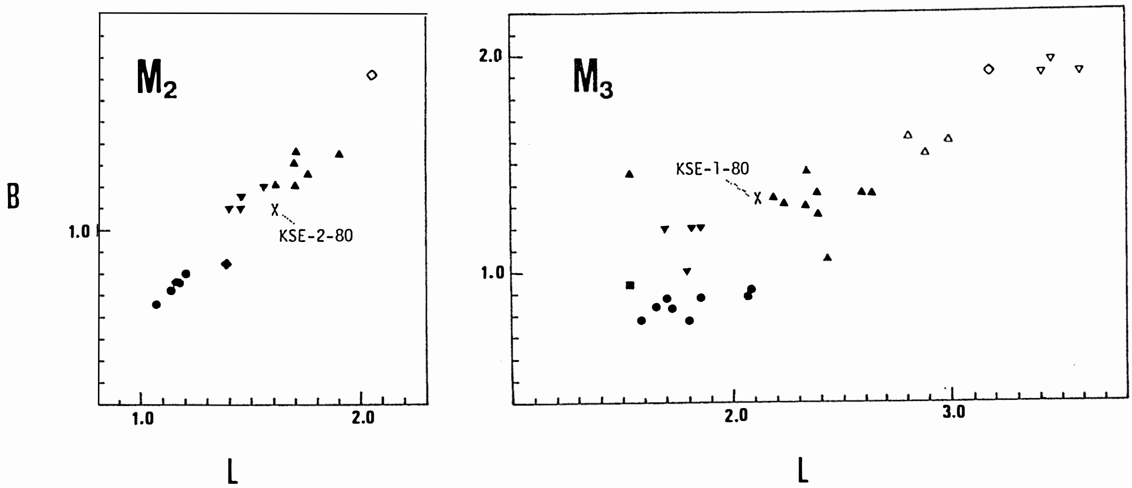
S. nadirum Wilkinson, 1976

In their original list, "*Sanitherium*" *africanus* was assigned to "*Xenochoerus*" *africanus*. The genus *Xenochoerus*, however, had been regarded as the synonymy of *Sanitherium* by several authors (Thenius, 1956).

The present materials are referable to the smaller form among these species (Text-fig. 12). They approximate *Hyotherium dartevelli* and *H. kijivium* in size. These species of *Hyotherium* are distinguishable from the present materials by the absence of the well-developed labial cingulum.

The detailed dental characters of the present materals are consistent with those of the genus Sanitherium in many respects. But the two African species of this genus mentioned above are somewhat different from the present materials. Of them, Sanitherium africanus have the following differences:

1) The size is considerably smaller than the present materials
2) In occlusal view, the outline of the lower molar is more slender and each corner is usually is more round.
3) In M_1 and M_2, the labio-lingual constriction of the middle part of crown is slight or absent.
4) The similar constriction between the middle and the posterior lobes is more distinct in M_3 inversely.



Text-fig. 12. Size distribution of smaller species of African Miocene Suidae. Length (L) and Breadth (B) plots of second and third lower molars. Estimated breadth is shown for M_3 of KSE-1-80. Data other than KSE-1-80 and KSE-2-80 are cited from Wilkinson (1976).

▲ Hyotherium dartevellei
▼ H. kijivium
◇ Kubanochoerus jeanneli
△ Listriodon akatidogas
▽ L. akatikubas
■ Lopholistriodon moruoroti
● Sanitherium africanus
◆ S. nadirum

S. nadirum was described by WILKINSON (1976), based on only one specimen from Ombo of Kenya. This specimen is unerupted M_2. It has the following characters in comparison with the present M_2 (KSE-2-80):

1) The size is smaller.
2) The outline is more elongated in relation to its breadth.
3) The ridges extend anteriorly and posteriorly from the protoconid as well as from the hypoconid. These ridges are absent in the protoconid of KSE-2-80.
4) The folding of enamel is much more remarkable.
5) The labial cingulum is more continuous. In KSE-2-80, however, it is slightly interrupted at the labial base of the protoconid.

Outside of Africa, 4 representative species of Sanitherium are recorded such as S. leobense (Zdarsky) 1909, S. schlagintweiti Meyer 1866, S. jeffreysi Forster Cooper 1913 and S. cingulatum Pilgrim 1926. The first species is known from Europe, and the latter three from Asia. These species seem to be different mainly in size from the present materials. Because the comparison with the African and the Eurasian species is rather inadiquate, the suid in the present collection is provisionally assigned to Sanitherium sp.

Suborder Ruminantia Scopoli, 1777

Infraorder Tragulina Flower, 1888

Superfamily Traguloidea Gill, 1872

Family Tragulidae Milne-Edwards, 1864

Genus Dorcatherium Kaup, 1833

Dorcatherium cf. Pigotti Whitworth, 1958

(Pl. 12, figs. 18-20; Text-fig. 13)

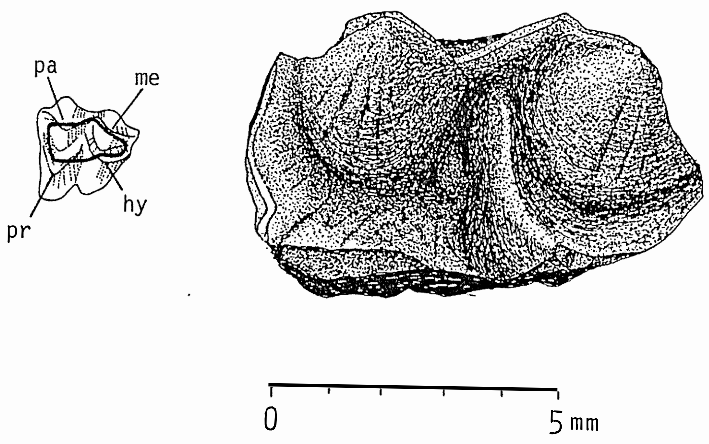
MATERIAL ——— 1 fragmental left M^2 (KSE-33-80)

LOCALITY ——— Site C of South Kirimun

AGE ——— Early or Middle Miocene

DESCRIPTION:

The present material is considerably fragmental, in which the central part of the crown is preserved, whereas all marginal parts including the protocone are lost. The paracone and the metacone are bunoid and conical. The central valley is of W-shaped in general. The anterior part of this valley is broad and extends along the base of the paracone. It projects labially between the metacone and the paracone. The posterior part of this valley surrounding the lingual base of the metacone, is relatively narrow. The crest extending antero-labially from the hypocone reaches the bottom of this valley between the paracone and metacone. The fine vertical grooves are present on the enamel wall of the main cusps.



Text-fig. 13. Dorcatherium cf. pigotti. Occlusal view of the left M^2 (KSE-33-80) from South Kirimun. The area surrounded by a solid line in the left figure indicates the preserved part of the present specimen in the right figure.
pa, paracone: me, metacone: pr, protocone: hy, hypocone

MEASUREMENTS:

The length of the preserved part is 7.78 mm. The length between the apex of the paracone and that of the metacone is 4.38 mm.

DISCUSSION:

This tooth is charecterized by its brachydonty, the bunoid labial cusps and the more crescentic lingual cusps. These features and the size agree with those of Dorcatherium. 5 species of Dorcatherium are known from the African Miocene, which are distinctly different in size (Text-fig.16). The size and the occurrence of these species are summarized as follows in accordance with Gentry (1978):

1). Large sized species.

D. chappuisi Arambourg 1933 -----Kenyan localities (Moruorot, Rusiuga, Mfwanganu, Maboko, Fort Ternan)

D. libiensis Hamilton 1973 ----- Slightly smaller species than *D. chappuisi* from Lybia (Gebel Zelten)

2). Middle sized species.

D. pigotti Whitworth 1958 ----- Kenya (Rusinga, Mfwanganu, Moruorot, Karungu, Ombo) and Uganda (Bukwa)

3). Middle to small sized species

D. songhorensis Whitworth 1958 -----Kenya (Songhor)

4). Small species.

D. parvum Whitworth 1958 ----- Kenya (Rusinga, Karungu, Maboko, Moruorot) and Uganda (Bukwa)

The present material is comparable with *D. pigotti* in size. But it is so fragmental that the detailed discussion is not possible. All species of Dorcatherium in Africa are restricted from the Early to the Middle Miocene in age.

<u>Dorcatherium</u> sp.

(Pl. 12, figs. 7-9, 13-15; Text-fig. 14)

MATERIAL —— 1 left mandeble with M_3 (KSE-28-80), 1 right M_2 (KSE-183-80)

LOCALITY —— Site C of Sorth Kirimun

AGE —— Early or Middle Miocene

DESCRIPTION:

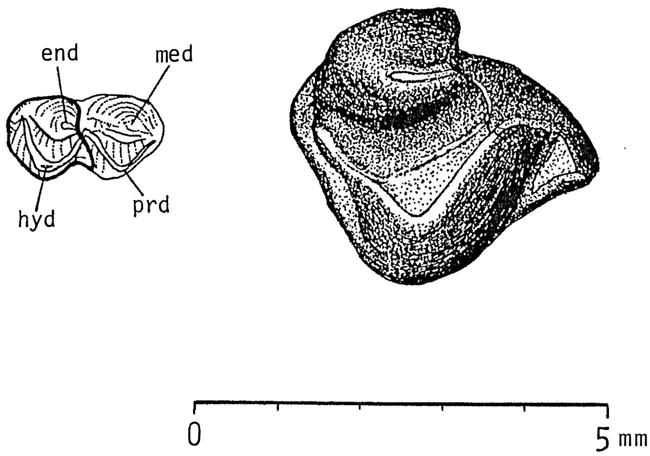
This form may be considerably smaller than <u>Dorcatherium</u> cf. <u>pogotti</u> described in this paper.

<u>Mandible</u>: KSE-28-80 is the badly damaged fragment of mandible beneath M_3. The depth of the horizontal ramus measured beneath the middle lobe of M_3 is ca 9.69 mm along the lingual side, whereas 9.10 mm along the labial side. The horizontal ramus is thin in relation to its depth. Its surface is very smooth. Its lingual side is slighty concave longitudinally.

$\underline{M_2}$: The posterior half of the crown is preserved in KSE-183-80. The entoconid is bunoid and exhibits conical shape elongated antero-posteriorly. The wear plane of the hypoconid is distinctly crescentic. The longitudinal valley extends along the base of the entoconid and opens posteriorly at the postero-lingual corner. The posterior cingulum is well developed which elevates in the central part. The shelf-like cingulum is present at the entrance of the median labial valley. Its labial margin is considerably swelling. The posterior root is preserved. It is stout and thick. It extends straight inferiorly. There is a vertical groove on the posterior surface of the root.

$\underline{M_3}$: KSE-28-80 also represents M_3 as well as the mandible. The tooth is well preserved. The crown is considerably worn. So that the dentine field of each lobe are confluent altogether.

The main cusps are slightly alternating. The lingual cusps are somewhat higher than the labial cusps. The labial valleys are much deeper than the lingual valleys. There is a strong cingulum on the anterior wall of the crown. The small tubercles are present on the shelf-like cingula which are situated at the entrances of the antero-labial and the postelo-labial valleys. The lingual wall between the metaconid and the entoconid is slightly concave, but its surface is smooth so that any enamel folds and cingula are not present. The crest extending anteriorly from the hypoconulid to the hypoconid (not the entoconid) is relatively narrow and has no longitudinal groove. The lingual projection of this crest is very remarkable. The distinct cingulum is present on the lingual base of this crest.



Text-fig. 14. Dorcatherium sp. Occlusal view of the right M_2 (KSE-183-80) from South Kirimun. The area surrounded by a solid line in the left figure indicates the preserved part of the present specimen in the right figure. med, metaconid: end, entoconid: prd, protoconid: hyd, hypoconid.

MEASUREMENTS

Breadth of the posterior lobe in M_2 ---------- 3.52 mm

Length of M_3 -------------------------------- 8.65 mm

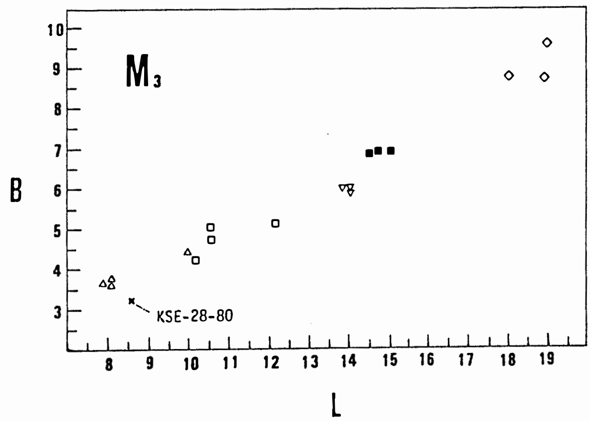
Breadth of the anterior lobe in M_3 ----------- 3.17 mm

Breadth of the middle lobe in M_3 -------------- 3.19 mm

Breadth of the posterior lobe in M_3 ----------- 2.24 mm

DISCUSSION

The present materials are obviously referable to the genus Dorcatherium by their tooth pattern and size. The size is coincident with D. parvam which is the smallest species of this genus (Text-fig. 15). But M_3 of the present materials are somewhat different from that of D. parvum. The former is characterized by its peculiar feature of the posterior lobe, such as the distinct projection of the central crest, the junction of the crest with the hypoconid, and the well-developed lingual cingulum. These characters are not present in D. parvum and other species of Dorcatherium. The specific determination of the present materials is however reserved because of the scarcity of the specimens.



Text-fig. 15. Size distribution of several species of Dorcatherium and Gelocus. Length (L) and breadth (B) plots of third lower molar. Data other than KSE-28-80 are cited from Whitworth (1958) and Hamilton (1973).

◇ Dorcatherium chappuisi

▽ D. pigotti

□ D. songhorensis

△ D. parvum

■ Gelocus whitworthi

Class Reptilia

Order Chelonia Macartney, 1802

Suborder Cryptodira Cope, 1870

Family Testudinidae Gray, 1825

Testudinidae, gen. et sp. indet.

(Pl. 14, figs. 10, 11. 14. 15)

MATERIAL —— 1 neural bone (KIR-1684-80)

LOCALITY —— GR6371

AGE —— Miocene

DESCRIPTION:

The neural bone is square in shape.

Suborder Pleurodira Cope, 1870

Family Pelomedusidae Cope, 1865

Genus Pelusios Wagler, 1830

(Pl. 14, figs. 1-7)

MATERIAL —— 4 mesoplastra (KIR-589-80, KIR-590-80, KIR-597-80, KIR-601-80)

LOCALITY —— Mbagathi

AGE —— Miocene

DESCRIPTION:

The mesoplastron is large. The anterior margin of the mesoplastron has a groove between the pectoral and the abdominal bony plates. It is remarkably worn out.

Order Crocodilia Gmelin, 1788

Suborder Eusuchia Huxley, 1875

Family Crocodylidae Cuvier, 1807

Crocodylidae, gen. et ap. indet.

(Pl. 15, figs. 1-12)

MATERIAL —— 20 dentary fragment (KSE-492-80, KSE-493-80, KSE-519-80, KSE-520-80, KSE-522-80～KSE-526-80, KSE-531-80, KSE-536-80, KSE-539-80, KSE-544-80, KSE-546-80, KSE-549-80, KSE-578-80, KSE-664-80, KSE-673-80, KSE-675-80, KSE-685-80).

LOCALITY —— Site B of South Kirimun

AGE —— Early or Middle Miocene

DESCRIPTION:

The relatively well-preserved dentaries collected from Site B of South Kirimun are described here. The characteristics of them are as follows:

The sympysis is short. The number of the lower teeth is about fifteen.

4. Concluding Remarks

The faunal compositions of the present localities other than South Kirimun are rather obscure, because the collections of these localities are very fragmental or poor in number and variety. In South Kirimun, however, 8 forms of mammals are identifiable as far as specific or generic levels (Table 5). Therefore the authors intend to focus the discussion on the fauna of South Kirimun.

This fauna is characterized by the following points compared with the Late Miocene or the later faunae of East Africa.

1) Thryonomyid and cricetodont rodents are occurred, but cricetid and murid rodents are absent.
2) The small deinothere comparable to *Prodeinotherium* is present.
3) In perissodactyles, equids are absent. The rhinocerotid of this fauna is the Lower Miocene form.
4) The small primitive suid is present.
5) Tragulids exist, but bovids nonexist.

Many fossil localities of the Early and the Middle Miocene are known from East Africa. The faunal lists of the representative localities are shown in Table 5. The compornent of the mammalian fauna of South Kirimun can be devided into the following five groups in comparison with these localities.

1) The same or similar forms are known from the Early Miocene localities.

   -----*Paraphiomys* cf. *pigotti*, *Megapedetes* sp., *Brachypotherium heinzelini*

2) The same or similar forms are known from the Early Miocene and the early Middle Miocene.

   -----*Dorcatherium* cf. *pigotti*

3) The similar forms are known from the Early to the early Late Miocene.

   -----Deinothere

4) The peculiar forms to South Kirimun, but the different species of the same genus are known from the Early Miocane localities.

   -----*Paraphiomys* sp., *Afrocricetodon* sp., *Sanitherium* sp.

5) The peculiar form to South Kirimun.

-----Procaviidae.

It can be concluded that the fauna of South Kirimun is well coincident with those of the Early and the early Middle Miocene localities. On the other hand, it has scarcely common compornents with Ngorora and Fort Ternan which are considered to be the later Middle Miocene.

The faunal list of "Kirimun" offered by Pickford (1981) has several different comporments from the present collections as shown in Table 5.
His "Kirimun" possibly means the localities near Kirimun village, namely the combination of South Kirimun, North Kirimun and Shackleton Kirimun in the sence of the present authors. Therefore "Kirimun" is sense lato equivalent to South Kirimun.
These defferent components of "Kirimun" can be also grouped into 1, 2 and 3 of the above-mentioned classification. Therefore these compornents also indicate the similarity to the Early and the early Middle Miocene faunae.

Pickford (1981) devided the Miocene faunae of western Kenya into 8 faunal sets from the biostratigraphical viewpoint. Set I and II are the Early Miocene, and Set III to V the Middle Miocene in ascending order. He stated, "the fauna of Kirimun is clearly of Set I-II affinities, with emphasis on Set II because of the presence of Dorcatherium parvum and a large pecoran (?Canthumeryx). It is therefore most likely to be between 17.5-18 m.y. old and is unlikely to be as young as late Miocene". The palaeontological results of the present authors on South Kirimun are consistent with the Pickford's conclusion.

Table 5. Mammalian faunal lists of South Kirimun and other representative early to middle Miocene fossil localities in East africa. Palaeontologial and geological data are cited from Bishop (1962), Walker (1969), Madden (1972), Bishop & Pickford (1975), Andrews & Walker (1976), Judith & Van Couvering (1976), Black (1978), Butler (1978a,b), Churcher (1978), Churcher & Richardson (1978), Coock & Wilkinson (1978), Coppens *et al*. (1978), Coryndon (1978), Gentry (1978a,b), Hamilton (1978), Harris (1978), Hooijer (1978), Lavocat (1978), Meyer (1978), Patterson (1978), Savage (1978), Simons et al. (1978), Simons & Pilbeam (1978), Simons & Delson (1978), Walker (1978), Andrews *et al*.(1981), Pickford (1981) and Pickford & Andrews (1981). *: cf.

			Early Miocene								Middle Miocene			
	South Kirimun	Kirimun by Pickford (1981)	Karungu	Mfwangano	Rusinga	Songhor	Koru	Moruarot	Napak	Bukwa	Ombo	Maboko	Fort Ternan	Ngorora
INSECTIVORA														
Protenrec tricuspis					x	x			x					
Geogale aletris					x									
Erythrozootes chamerpes						x	x		x					
Lanthanotherium sp.					x	x								
Galerix africanus					x	x								
Gymnurechinus leakeyi					x									
G. comptolophus					x									
G. songhorensis						x			x					
Amphechinus rusingensis					x	x								
Prochrysochloris miocaenicus						x	x							
Crocidura sp.					x									
Myohyrax oswaldi			x		x		x	x		x				
Rhynchocyon clarki					x	x								
R. rusingae					x	x								
R. sp.													x	

CHIROPTERA												
Taphozous incognita				x		x						
Hipposideros sp.					x							
Propotto leakeyi				x	x							
PRIMATES												
Progalago dorae			x	x	x	x						
P. songhorensis				x	x							
Komba robustus			x	x	x	x						
K. minor				x	x							
Mioeuoticus bishopi				x				x				
M. sp.					x							
Victoriapithecus macinnesi				?						x	x	
V. leakeyi											x	
V. sp.											x	
Limnopithecus legetet				x	x	x		x	x	x	x	x
Dendropithecus macinnesi		x		x			x	x				
Dryopithecus africanus		x	x	x	x	x	x					x
D. nyanzae		x	x	x			x				x	x
D. major	x				x	x	?	x				
D. gordoni			x	x	x							
D. vancouveringi			x	x	x						x	
D. sp.											x	
Ramapithecus wickeri				?							x	x
LAGOMORPHA												
Kenyalagomys rusingae		x		x				x				
K. minor				x								

RODENTIA													
Andrewsimys parvus						x							
Phiomys andrewsi						x	x						
Paraphiomys pigotti		x	x	x	x	x	x	x	x	x			
P. stromeri		x			x	x			x				
P. sp.	x												
Epiphiomys coryndoni						x			x				
Diamantomys leuderitzi		x	x	x	x	x	x		x				
Keniamys mariae				x		x							
Simonimys genovefae				x	x	x	x		x				
S. rarus				x									
S. moreli									x				
Myophiomys arambourgi				x	x	x			x				
Elmerimys woodi					x								
Bathyergoides neotertiarius						x	x		x				
Proheliophobius leakeyi				x	x	?							
Paranomalurus bishopi						x	x		x				
P. soniae				x	x	x	x		x				
P. walkeri				x		x			x				
Zenkerella wintoni						x						x	
Megapedetes pentadactylus					x	x			x	x			
M. sp.	x					x						x	
Afrocricetodon songhori				x		x	x		x				
A. sp.	x												
Protarsomys macinnesi					x								
Notocricetodon petteri					x	x	x						
Leakeymys ternani													x
Vulcanisciurus africanus					x	x	x		x				

CARNIVORA												
Kelba quadaemae			x	x			x					
Teratodon spekei				x	x							
T. enigmae				x								
Anasinopa leakeyi	x	x	x			x				x		
A. sp.			x									
Metasinopa napaki							x					
Dissopsalis pyroclasticus			x							x		
Metapterodon kaiseri	x		x									
M. zadoki			x									
Pterodon africanus	x		x									
Leakitherium hiwegi			x			?						
Hyaenodon andrewsi			x	x		x						
H. matthewi			x	x								
H. pilgrimi			x	x								
Megistotherium osteothalates			x									
Hecubldes euryodon		x	x	x	x		x					
H. macrodon			x									
Afrocyon buroletti												
Mellivora aff. panjabiensis												x
Kichechia zamanae		x	x	x		x	x					
Percrocuta tobieni												x
Afrosmilus africanus	x		x	x								
TUBULIDENTATA												
Myorycteropus africanus		x	x				x					
Orycteropus minutus		x	x	x								
O. chemeldoi											x	x

O. sp. (a)							x							
O. sp. (b)														x
PROBOSCIDEA														
Prodeinotherium hobleyi			x	x	x		x	x		x	x	x	x	x
Gomphotherium angustidens					x	x		x	x		x	x		
G. ngorora														x
Primelephas lepersonnei			?									*		
HYRACOIDEA														
Pachyhyrax championi			x	x	x	x		x	x	x		x		
P. cf. pygmaeus			x		x									
Moroehyrax bateae					x					x				
Parapliohyrax sp.														x
Prohyrax sp.								x						
PERISSODACTYLA														
Chalicotherium rusingense			x	x	x	x	x		x					
Brachypotherium heinzelini	x		x		x				x		x	x		
B. sp.														x
Aceratherium acutirostratum		x	x		x			x	x		?			
Dicerorhinus leakeyi			x		x	x			x		x			
D. sp.								?		x		?		
Aceratherium or Dicerorhinus														x
Chilotheridium pattersoni		x			x					x		?		x
Paradiceros mukirii													x	
Hipparion primigeneum														x

ARTIODACTYLA														
Mastritherium aequitorialis			x		x			x	x	x				
Brachyodus africanus			x		x					?		x		
B. cf. moneli					x						x			
Hyotherium dartevelli			x	x	x	x		x	x					
H. kijivium				x	x	x	x		x					
Bunolistriodon jeanneli					x	x			x			x		
B. khinzikebirus												x		
Listriodon akatikubas												x		
L. akatidogus					x									
L. sp.													x	
Lopholistriodon kidogosana														x
L. moruoroti								x						
Sanitherium africanus			x	x	x	x				x				
S. nadirum											x			
S. sp.	x													
Dorcatherium chappuisi				x	x			x				x		
D. pigotti	*		x	x	x			x	x	x	x	x		
D. songhorensis						x			x					
D. parvum		x	x		x			x		x		x		
D. sp. A													x	
D. sp. B	x													
Gelocus whitworthi					x									
Propalaeoryx nyanzae					x			x						
Canthumeryx sirtensis			?		x			x				?		
C. sp.		?												
Climacoceras africanus												x		
Palaeotragus primaevus					?			x				x	x	
P. sp.														x

Samotherium africanus											x	
? S. sp.												x
Zalapha zelteni						x						
Protragocerus labidotus											x	
P. sp.												x
Walangania africanus	?		x	x		x	x					
Eotragus sp.			?							?		
Gazella sp.										?	x	x
Oioceros tanyceros											x	
Pseudotragus potwaricus											x	x

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