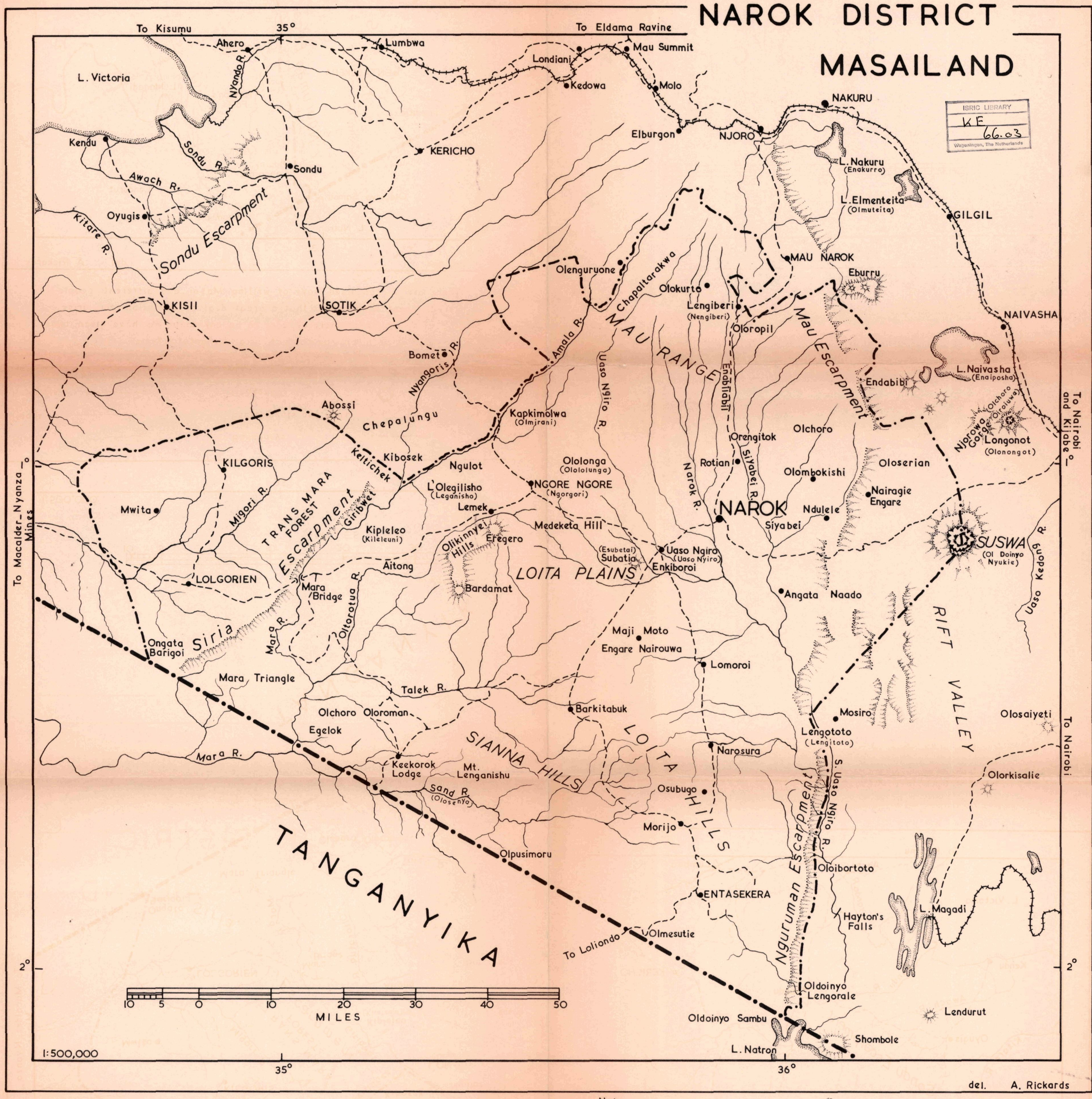
NAROK DISTRICT
MASAILAND



Rivers
Roads
Railways
Boundarys
Escarpments and Hills
Craters

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AN ECOLOGICAL SURVEY OF THE NAROK DISTRICT OF KENYA MASAILAND

1961 - 1965

PART I

by

P.E. Glover

with

Geology by L.A.J. Williams

Instigated by Dr. F. Fraser Darling
and conducted under the auspices of the
Conservation Foundation of New York

1966

The author wishes to acknowledge with thanks the help of the Director, E.A.A.F.R.O. and his staff, in the production of this paper.

In particular he is indebted to the Librarian, Mrs. L.D. Rogerson and her staff as well as Mrs. D. Wilson and Mrs. M. May.

Finally thanks are due to Mrs. A. Rickards of the Kenya Veterinary Department for her work on the maps and diagrams, and to Mrs. B. Fumerton for the arduous work of the original typescript.

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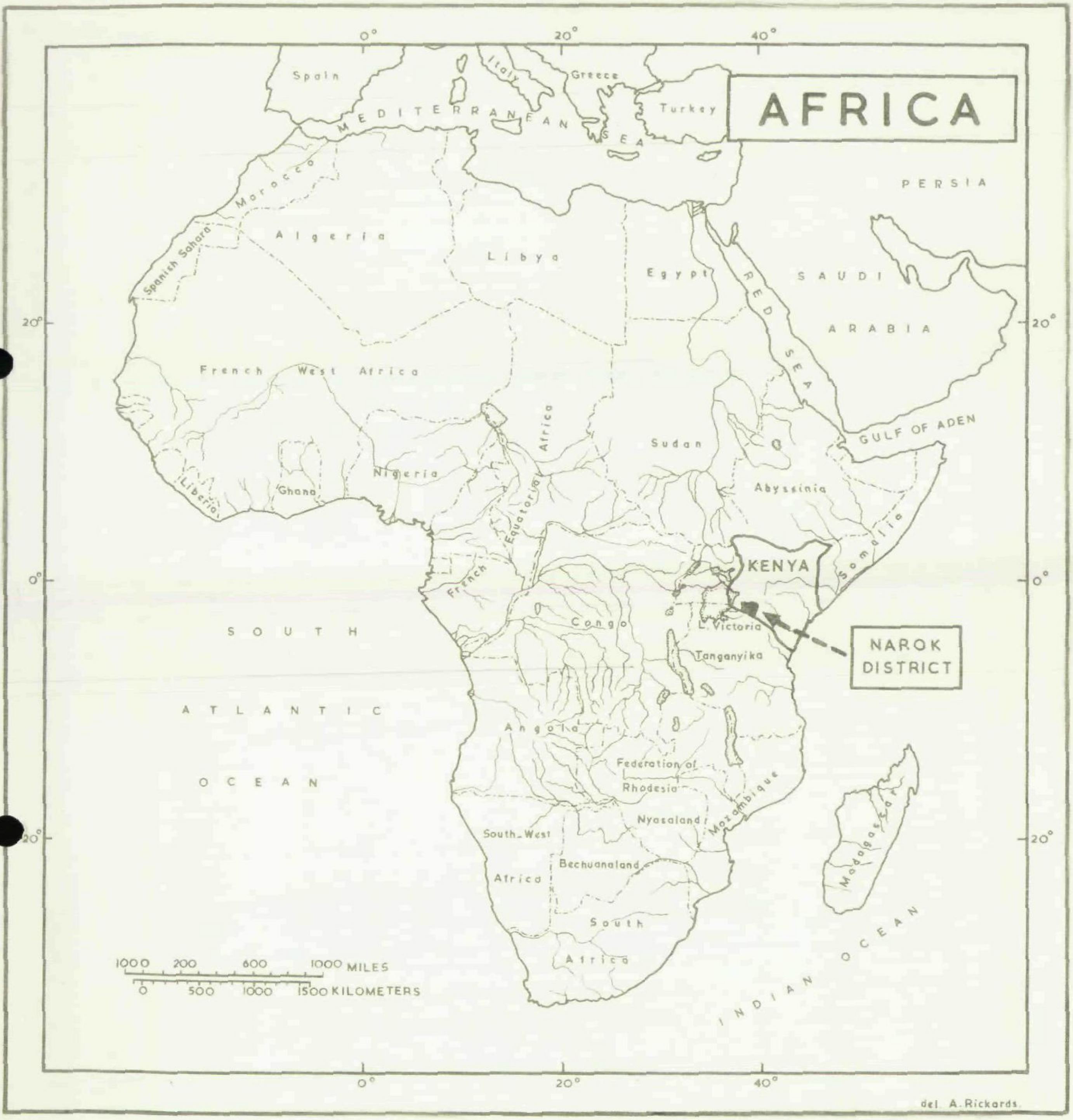

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French West Africa
Africa
GULF OF ADEN
Sudan
Nigeria
Liberia
Ghana
Equatoria
Abyssinia
KENYA
Somalia
French
Congo
L. Victoria
NAROK DISTRICT
Tanganyika
SOUTH ATLANTIC OCEAN
Angola
Federation of Rhodesia
Nyasaland
Mozambique
Madagascar
South-West Africa
Bechuanaland
South Africa
INDIAN OCEAN
100 0 200 600 1000 MILES
0 500 1000 1500 KILOMETERS
del. A. Rickards.

AN ECOLOGICAL SURVEY OF THE
NAROK DISTRICT OF KENYA MASAILAND

by

P.E. GLOVER

for

The Conservation Foundation of America

INTRODUCTION

The Masai are a pastoral people who do not hunt game but they play a very important role in the ecology of the country they live in because they roam about from season to season, seeking grazing for their herds of cattle, sheep and goats. They burn the grass and bush as frequently as possible to open up the country and to obtain fresh green pasture. They build "manyattas" * which are surrounded by circular enclosures of thorn bush known as "bomas", in which the cattle

Footnote: * circular groups of huts

are kept at night. The "manyattas" are usually sited near water, so that the country round about soon becomes denuded and a network of radiating paths develops. In recent years, the Masai have tended to remain longer and longer in one place, with the result that many parts of their country are now severely overgrazed and eroded and the woody vegetation is fast disappearing. Large portions of the Mau forest, particularly around its edges, are in an advanced state of destruction and in certain places in the south towards Tanganyika, the situation is desperate. If mal-use of the habitat continues at the present rate, it is inevitable that the vegetation of this entire area and the animals which inhabit it will be non-existant within a few decades unless proper methods of conservation and management are introduced very soon.

In spite of this destruction, parts of the Narok district, such as the Mara river area, are some of the last remaining big game sanctuaries in Africa.

Because of the grave danger that this country, with all its scenic beauty and its game, may disappear in the not-too-distant future, the Conservation Foundation of America has financed and sponsored this survey, which was begun in March 1961.

Most of the region constituting an "ecological unit" * falls within the Narok district of Kenya Masailand, but it also includes that part of the Rift Valley stretching from the

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Footnote: * An ecological unit is a region which, except for man's influence, consists of an integrated set of ecological factors more or less in balance and capable of indefinite perpetuation without habitat deterioration.

northern end of Lake Natron, on the Tanganyika border, to Lake Nakuru and thence westwards to the Mau summit and from there south and south-westwards to the Tanganyika border again.

The survey included the collection of more than 4,500 plant specimens in collaboration with Dr.M.D.Gwynne and Mr.S. Paulo, Mr.H.Tucker, Mr.L.E.D.Wateridge and many other people, which have been identified by the East African Herbarium and Kew. Notes have been made on their distribution, ecology, value as food plants, medicinal properties, etc., together with their Masai and Kipsigis names. Plant collections were also made in a number of inaccessible places with the assistance of helicopters of the Army 8th Independent Reconnaissance Unit.

An ecological map showing the major vegetation communities of the area has been constructed by Mr.E.C.Trump, assisted by Mrs.A.Rickards.

A detailed geological survey of the area was specifically made by Mr.L.A.J.Williams of the Kenya Department of Mines and Geology, with maps and sections.

Soil samples and plant specimens were collected with the help of Mr.H.Tucker and Mr.L.E.D.Wateridge, Mr.P.Napier Bax and my son, E.C.Glover, from different parts of the country. These were analysed by Mr.M.T.Friend of the East African Agriculture and Forestry Research Organisation and Mr.E.Bellis of the Scott Laboratories, Kenya Department of Agriculture. From the data obtained, a soil map has been prepared.

A special study was also made of the hydrology, rainfall and meteorology of the region in collaboration with Miss M.Lindlay of the Hydrological Branch of the Ministry of Works and the East African Meteorological Department.

A list of all the animals known to occur in the area, with notes on their ecology, etc., has been prepared in collaboration with the staff of the Coryndon Museum, officers of the Kenya Veterinary Department and Messrs.D.Ker and S.Downey, who have made "safaris" in this part of the country for many years. Notes on Masai animal folk lore, made by Mr.D.Round-Turner who was District Officer at Narok, have also been included.

Vegetation counts were made in areas which are being denuded by elephant, in order to discover the proportion of the plants damaged or destroyed and whether the elephant have preferences for certain trees.

In some parts of the area, it was observed that giraffe also are damaging their habitat. The browsing patterns of giraffe appear to vary in different vegetation communities and species. In some areas they are killing certain plants such as Balanites.

Studies were made in various parts of the area to discover the reason for, and the rate of soil erosion. Both wild and domestic animals cause erosion around water holes and aggravate the erosion already taking place in gullies and particularly ledges, by trampling and digging the lower levels of the soil with their hooves and horns to obtain salt. In some places, the erosion ledges or terraces are the result of trampling only and not of water run-off, for progressive erosion was observed in 10 of these during the dry season of 1961/62 but no further damage occurred in the very heavy rains when the Masai stock had moved away.

Collections of snails, butterflies, termites and other insects were made in collaboration with Dr.M.D.Gwynne and identified by officers of the Coryndon Museum, the East African Herbarium and the East African Agriculture and Forestry Organisation.

Collections of stone implements and other artefacts were made with the assistance of Mr.Tucker, Mr.Wateridge and E.C.Glover, in order to learn something of the pre-history of the area. These were identified by Mr.Glynn Isaac, Deputy Director of the Centre for Prehistory and Palaeontology and Mr.R.Clarke at the Coryndon Museum.

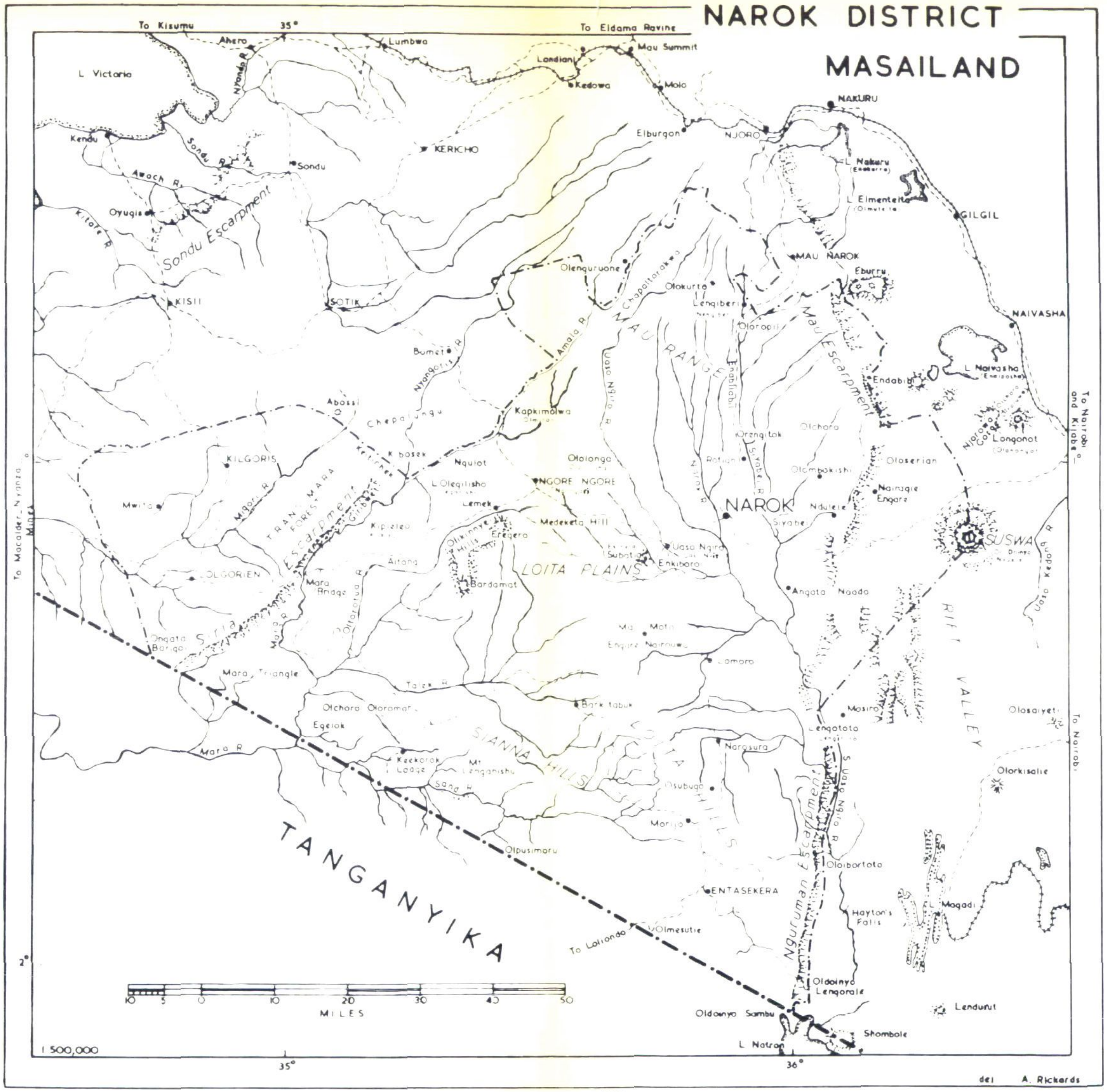
In order to place as much information as possible on record, it has been necessary to enlist the help and co-operation of many people and departments, whose names and contributions to the work will be acknowledged in the detailed sections that follow. At this stage, I must point out that while my own share of the work has been most generously financed by a far-seeing and appreciative American organisation, the value of the help and co-operation of existing Government departments and officials is incalculable. Without their willing and generous assistance, the survey could not have been accomplished. This fact emphasises the great modern tragedy of waste in Africa; the waste of priceless unrecorded knowledge and experience.

This work is the fulfilment of a resolution passed at the Kenya Wild Life Society's Annual General Meeting in 1959, when it was proposed that scientific personnel in Government departments might volunteer to help in recording and directing knowledge of the wild life (plant and animal) of East Africa.

In conclusion, special mention must be made of my gratitude to the Conservation Foundation in New York for so kindly making this work possible and for their patience and trust in me, for it has taken much longer to accomplish than was at first envisaged. Finally, I am deeply indebted to Dr.Frank Fraser Darling, whose interest and guidance provided the inspiration to achieve the results obtained.

P.E. GLOVER

NAIROBI, Kenya.
June 1965



Rivers		Boundarys	
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CHAPTER

I

GEOLOGY *

By L.A.J. Williams

Department of Mines and Geology

The following convenient sub-division of the rocks exposed in the Narok district is adopted for descriptive purposes:-

(7) Quaternary sediments
(6) Quaternary volcanic rocks
(5) Tertiary volcanic rocks
(4) Bukoban System (late Precambrian)
(3) Precambrian intrusive rocks
(2) Nyanzian and Kavirondian Systems
(1) Basement System

Footnote: * Summarised from "The Geology of the Narok district". Read at the First Symposium of the East African Academy and published by Messrs.Longman's Green and Company with the permission of the Commissioner of Mines and Geology, Kenya. This paper was originally written as part of this survey.

(1) Basement System (Precambrian)

Large areas of the central and southern parts of the Narok district are immediately underlain by intensely metamorphosed sediments of the Basement System. Quartzites, gneisses, schists, amphibolites, migmatites, mylonites and pegmatites are exposed between the western scarps of the Rift Valley (the Nguruman escarpment, west of the Mara river). Occurrences of mylonites along the length of the Siria escarpment mark a major thrust zone separating Basement System rocks from those of the Nyanzian and Kavirondian Systems. Quartzites, derived from original sandstones and grits, dominate the local Basement System succession and feature prominently in the Loita and Sianna hills and in the hills around Lemek. Although no crystalline limestones have been encountered in the district, metamorphosed impure calcareous sediments are represented by hornblende-and-epidote-rich rocks. Gneisses and schists of pelitic and semipelitic origin are widespread.

(2) Nyanzian and Kavirondian Systems (Precambrian)

Low-grade metomorphic rocks of the Nyanzian and Kavirondian Systems occur in the western parts of the district, above the Siria escarpment. Basic and andesitic lavas, greywackes and shales constitute the Nyanzian System. Coarse conglomerates with subordinate shales, grits and andesites are the local representatives of the Kavirondian System.

(3) Precambrian Intrusive Rocks

The post-Nyanzian intrusives are mainly granites, granodiorites, dolerites and quartz porphyries. An important phase of gold, silver and copper mineralisation was associated with the granite, porphyries, porphyrites, felsites and dolerites.

(4) Bukoban System (late Precambrian)

Rocks of the Bukoban System (Kisii Series) rest with marked unconformity on folded representatives of the Nyanzian and Kavirondian Systems and associated intrusives. Basalts are overlain by quartzites that are, in turn, followed by felsites, andesites, dacites and rhyolites with intercalated tuffs and conglomerates.

(5) Tertiary Volcanic Rocks

If any rocks were formed between Precambrian and middle Tertiary times, they were subsequently removed by erosion, so that Miocene volcanic rocks and rare sediments rest directly on a peneplained Precambrian surface. The oldest volcanic rocks are melanephelinites exposed at several localities between the confluence of the Siyabei and Uaso Ngyiro rivers and the Tanganyika border, close to the western scarps of the Rift Valley. These lavas are overlain by phonolites that flowed southwards and south-westwards from the Mau. The phonolites cover much of the country between the Loita plains and the Siria escarpment, where the lavas were upfaulted to the west along the Siria fault, probably in late Miocene times.

Lavas of probable Pliocene age, known as the Kirikiti Basalts, rest against a pre-existing fault scarp of Basement System rocks along the Nguruman escarpment. Faulting during the lower Pleistocene and after extrusion of lavas of the Plateau Trachyte Series, caused the Kirikiti Basalts to be downthrown some 2,000 feet to the east into the floor of the Rift Valley, though a ledge of the basalts capped by trachytes remains on the lower part of the escarpment. South and south-east of Narok, tuffs and water-laid ashes rest on Miocene melanephelinites and phonolites and on Pliocene Kirikiti Basalts. They are locally overlain by alkali basalts. Northwards, the alkali basalts are in turn overlain by Pliocene tuffs, agglomerates and welded tuffs which, together with a thick cover of Pleistocene ashes, form the Mau range.

(6) Quaternary volcanic rocks

In upper Pliocene or lower Pleistocene times, trachyte flows (constituting the Plateau Trachyte Series) were extruded in the vicinity of the present Rift Valley. These lavas now form the floor of the Rift south of Suswa, having been downfaulted against the older Kirikiti Basalts during the lower Pleistocene. Ol Doinyo Sambu volcano was probably active during middle Pleistocene times and pyroclastic rocks are interbedded with basalts and nephelinites near the Tanganyika border. Upper Pleistocene basalts, rhyolites, comendites, trachytes, phonolites and pyroclastic rocks occur in the Rift Valley at and near Suswa. Some trachytes on Suswa mountain may be of Recent age. Quaternary pyroclastic rocks attain a maximum thickness of some 800 feet in the Mau range; the ashes rest on Pliocene welded tuffs, and locally on Miocene phonolites and Basement System gneisses.

(7) Quaternary Sediments

Pleistocene sediments are confined to the floor of the Rift Valley. Silts and gravels (the Oloronga Beds) and fluviatile pebble beds and sands, that occur in the extreme south-eastern corner of the district, accumulated in lower Pleistocene times. A middle to upper Pleistocene age is assigned to lacustrine sediments of the Naivasha basin north of Suswa. Silty clays of the Natron basin were deposited during the upper Pleistocene, when the lake surface stood some 50 to 100 feet above its present level.

Structure

In rocks of the Basement System, isoclinal and recumbent N.E. - S.W. structures were subsequently refolded along N.W. - S.E. axes. Intense folding about W.N.W. - E.S.E. axes characterises rocks of the Nyanzian and Kavirondian Systems, but only gentle folding has been recognised in overlying volcanics and sediments of the Bukoban System.

Faults affecting Basement System rocks are generally parallel to the Siria escarpment and the axial trend of earlier folds. Strike faults are prevalent in Nyanzian and Kavirondian System rocks. A fault along the Nguruman escarpment, which resulted in Basement System rocks being downthrown some 3,000 feet to the east in mid-Tertiary times, represents the earliest recognised movement leading to the formation of the adjacent portion of the Rift Valley. After extrusion of Miocene melanephelinites and phonolites, further major movements occurred on faults near the

Nguruman escarpment during the lower Pleistocene caused further downthrow to the east of about 2,000 feet. In middle Pleistocene times, the main episode of grid-faulting in the Rift Valley was accompanied by movements on the Nguruman and Mau faults.

Erosion Surfaces

Phonolitic lavas in the western half of the Narok district rest on an erosion surface which has been dated as the sub-Miocene bevel by occurrences of fossiliferous sediments in neighbouring areas.

West of the Siria escarpment, this surface slopes towards lake Victoria at about 35 feet per mile. It has been downthrown some 900 feet to the east by the Siria fault and, between the Loita plains and the Mara river, the sub-lava surface slopes at 35 feet per mile to the south-west. Immediately west of the Loita hills, the sub-Miocene surface is inclined at about 22 feet per mile to the west-south-west; at Narosura, the same surface slopes nearly eastwards at 80 feet per mile; and in the extreme south-eastern corner of the district, the slope is about 17 feet per mile to the south-east. The main warping or doming of the sub-Miocene surface in the Narok district, which occurred chiefly along a north-south axis parallel to the Rift Valley, preceded extrusion of Miocene lavas.

Above the sub-Miocene surface, and everywhere approximately parallel to it, are relics of earlier erosion surfaces. A bevel at about 1,300 feet above the sub-Miocene is tentatively correlated with the end-Cretaceous peneplain, remnants of this surface being preserved west of Kilgoris and in the Lemek, Sianna and Loita hills. Several intermediate bevels between the sub-Miocene and the end-Cretaceous surfaces have been recognised.

Local bevels and river terraces lying about 250 feet below the sub-Miocene surface at the southern end of the Loita hills and a surface overlain by gravels, west of Lolgorien, 200 - 350 feet below the sub-Miocene bevel, are correlated with the end-Tertiary peneplain of other parts of Kenya.

BIBLIOGRAPHY

BAKER, B.H. (1958). Geology of the Magadi area. Report No.42, Geol.Surv.Kenya.

-do- Geology of the area south of Magadi. Report No.61, Geol.Surv.Kenya (at the press).

GREGORY, J.W. (1921). The Rift valleys and geology of East Africa. Seeley, Service & Co.Ltd., London.

HUDDLESTON, A. (1951). Geology of the Kisii district. Report No.18, Geol.Surv.Kenya.

JENNINGS, D.J. Geology of the Molo area. Report, Geol.Surv. Kenya (in preparation).

PULFREY, W. (1960). Shape of the sub-Miocene erosion bevel in Kenya. Bulletin No.3, Geol.Surv.Kenya.

SAGGERSON, E.P. Geology of the Loita hills area. Report, Geol.Surv.Kenya (awaiting publication).

SAGGERSON, E.P. et al (1960). Cross-folding and refolding in the Basement System of Kenya Colony. Report, Int. Geol.Cong., XXI, Copenhagen, Part XVIII, 335-346.

SCHOEMAN, J.J. (1949). Geology of the Sotik district. Report No.16, Geol.Surv.Kenya.

SHACKLETON, R.M. (1946). Geology of the Migori gold belt and adjoining areas. Report No.10, Geol.Surv.Kenya.

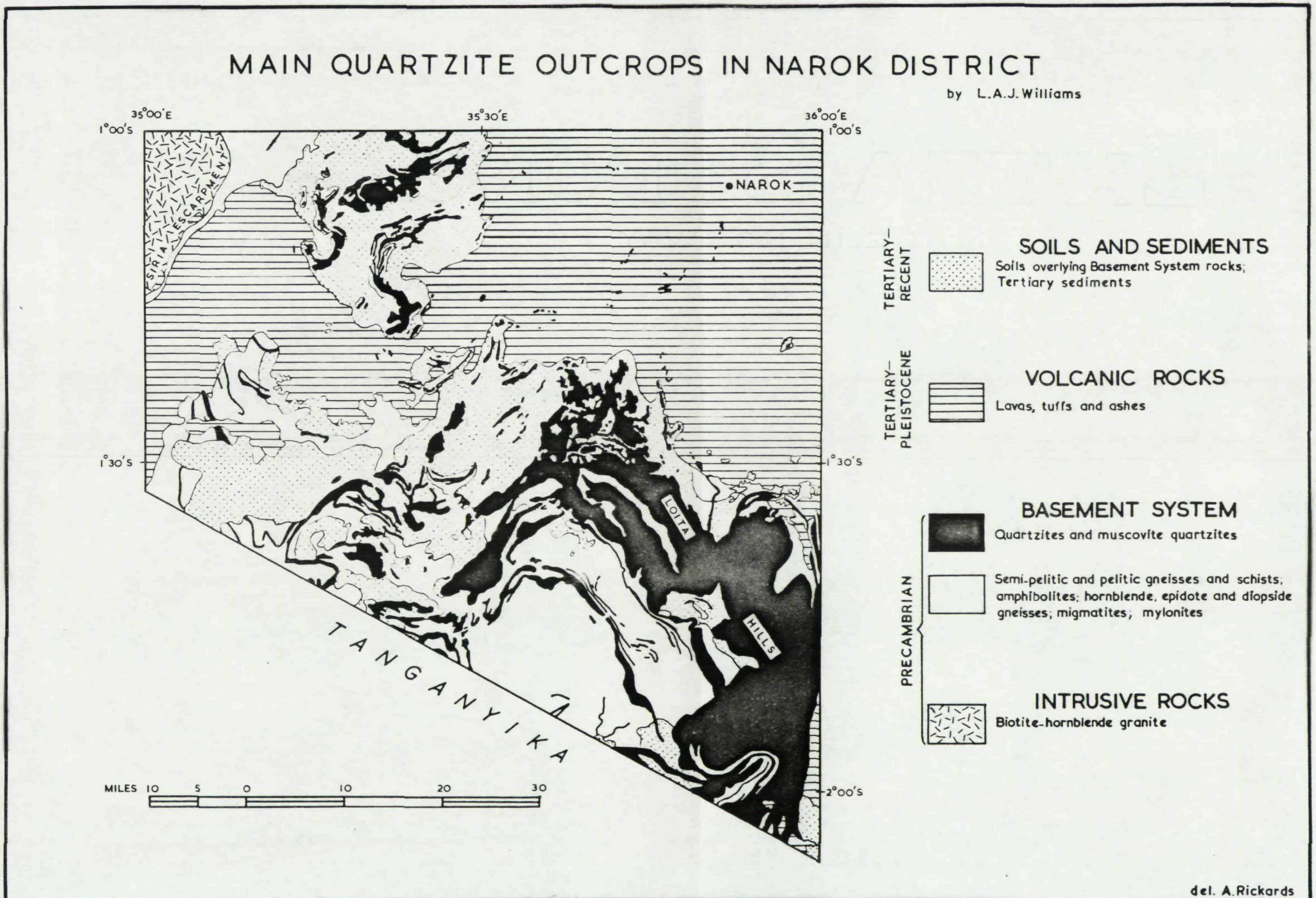
THOMPSON, A.O. and DODSON, R.G. Geology of the Naivasha area. Report No.55, Geol.Surv.Kenya (at the press).

WILLIAMS, L.A.J. (1963). Geology of the Narok district. Proceedings of the East African Academy: First Symposium, 37-49.

-do- Geology of the Mara river - Sianna area. Report No.66, Geol.Surv.Kenya (at the press).

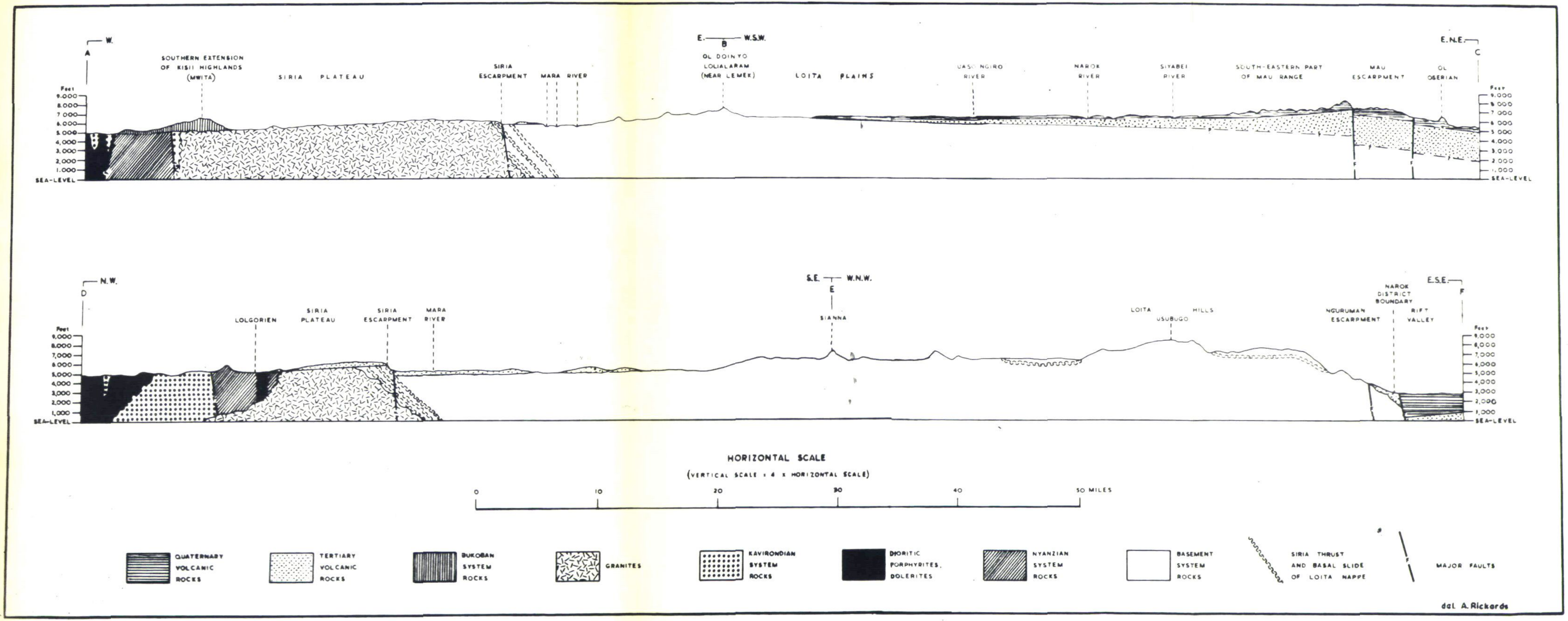
-do- Geology of the Mau area. Report, Geol.Surv. Kenya (in preparation).

WRIGHT, J.B. Geology of the Narok area. Report, Geol.Surv. Kenya (awaiting publication).

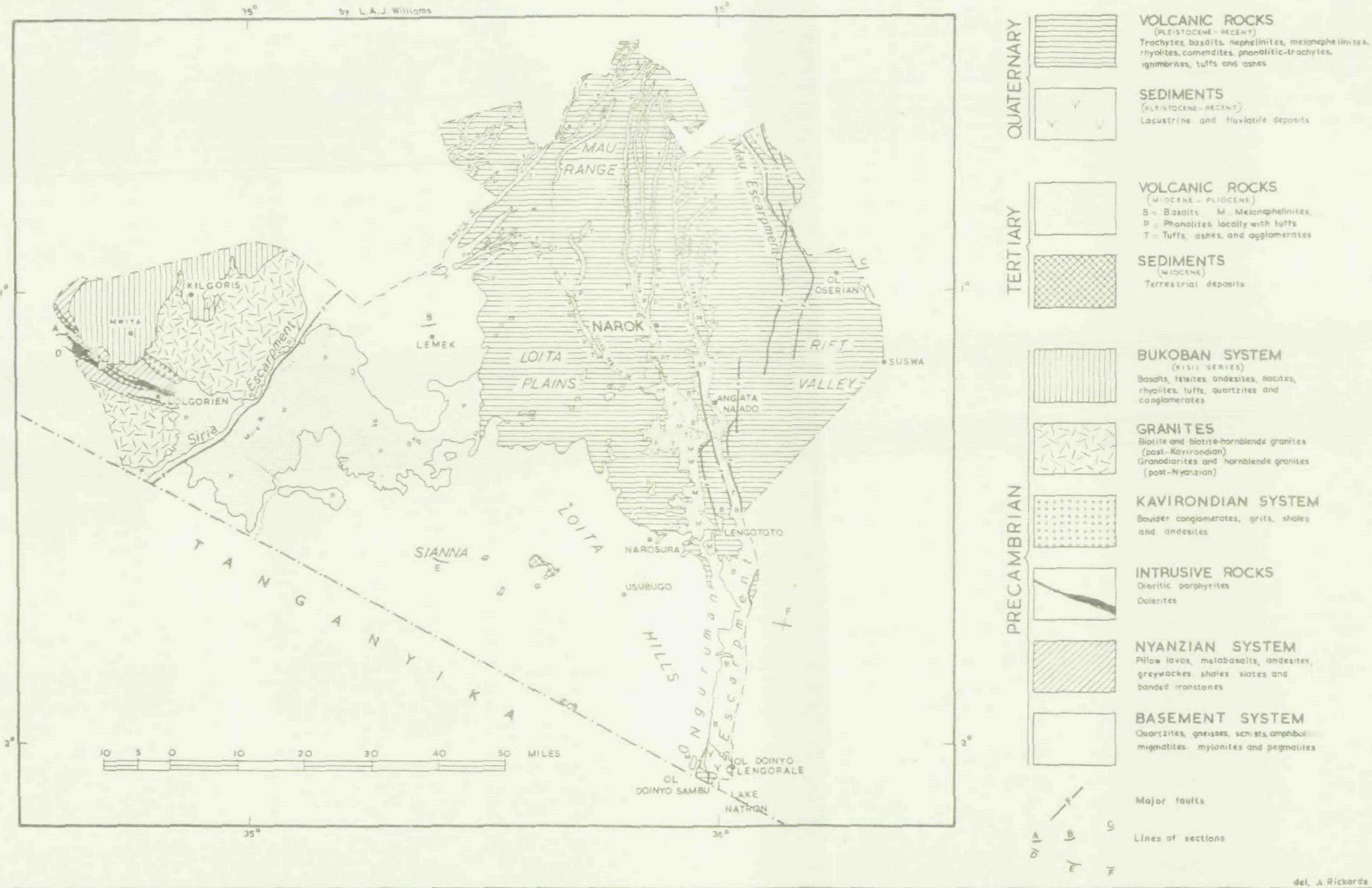

MAIN QUARTZITE OUTCROPS IN NAROK DISTRICT
by L.A.J. Williams
35°00'E
35°30'E
36°00'E
1°00'S
1°30'S
2°00'S
NAROK
SIRIA ESCARPMENT
LOITA
HILLS
TANGANYIKA
MILES 10 5 0 10 20 30
TERTIARY–RECENT
SOILS AND SEDIMENTS
Soils overlying Basement System rocks; Tertiary sediments
TERTIARY–PLEISTOCENE
VOLCANIC ROCKS
Lavas, tuffs and ashes
BASEMENT SYSTEM
Quartzites and muscovite quartzites
Semi-pelitic and pelitic gneisses and schists; amphibolites; hornblende, epidote and diopside gneisses; migmatites, mylonites
PRECAMBRIAN
INTRUSIVE ROCKS
Biotite-hornblende granite
del. A.Rickards

SECTIONS ACROSS THE NAROK DISTRICT

by L.A.J. Williams



GEOLOGICAL MAP OF NAROK DISTRICT



CHAPTER

II

TOPOGRAPHY

The Narok district of Kenya Masailand covers an area of about 7,000 square miles (the ecological unit is about 9,000 square miles). It lies between latitudes $0^{\circ}30'$ - 2° south and longitudes $34^{\circ}30'$ - $36^{\circ}15'$ east. The Mau massif, rising to over 10,000 feet in the north - one of the largest forested regions in Kenya, is a dominant feature within this region.

The Siria plateau and escarpment, over 6,000 feet high and sloping westwards with the Mara river at its eastern foot, forms a break roughly down the western side of the district. Rising above the Siria plateau to about 6,500 feet at Mwita, are ridges of hills forming the northern extension of the Karri highlands.

From Narok southwards the country is flat, consisting mainly of the open Loita plains sloping southwards from an altitude of about 6,300 feet, flanked to the north and east by the Uaso Ngyiro river and dissected by shallow water courses which become heavily wooded to the south and east. To the south-westwards, the Loita plains merge into other plains falling steadily towards the Mara river and the Tanganyika border where, at an altitude of 5,200 feet, they represent a continuation of the vast Serengeti plains. Further west in the Sianna range, some peaks reach altitudes of 7,400 feet. The Loita plains are bounded to the west and north-west by the Lewele hills, which attain a height of 7,400 feet. Also to the north, the plains are fringed by the forested lower slopes of the Mau range. To the south-east lie the Loita hills, which attain a height of more than 8,500 feet and beyond them lies the Nguruman escarpment. Both of these regions are extensively forested.

The eastern parts of the district fall within the Rift Valley, sloping southwards from about 6,000 feet at the foot of the Kijabe escarpment to 2,000 feet at Lake Natron, only the upper end of which falls within the Kenya boundary where the Uaso Ngyiro river enters its northern swamps.

A little further to the north of Natron in the Rift Valley, lies lake Magadi and about 50 miles to the north of it is mount Suswa, a dormant volcanic caldera 7 miles across and rising to nearly 8,000 feet at its summit. Ten miles to the north again is mount Longonot, another volcano reaching to 9,000 feet in height.

Still further northwards in the Rift Valley at the foot of the Masai escarpment is Eburru mountain, more than 8,000 feet high. To the east and north of it lie lakes Naivasha, Elmenteita and Nakuru. To the west of Nakuru, on the edge of the Mau, are the small towns of Molo, Londiani and Kericho.

The Narok district is bounded to the east by Kikuyu country, to the west by the Kipsigis and Kisii reserves and in the extreme south-west, near the shores of lake Victoria, by the Luo country of South Nyanza. All these tribes are agricultural and the areas they occupy are intensively cultivated.

BIBLIOGRAPHY

BUTLER, R.K. (1959). Atlas of Kenya. Nairobi: Survey of Kenya.

PHYSICAL FEATURES — NAROK DISTRICT

C H A P T E R

III

C L I M A T E

Rainfall Meteorological records have been kept at Narok for more than 51 years and for a long time at several peripheral stations such as Sotik, Kericho, Molo, Londiani, Nakuru, Naivasha and Magadi.

Rainfall records have also been kept for shorter periods at Lolgorien, Kilgoris, Aitong, Kipleleo, Gelegele, Kapkimulwa, Kibosek, Narosura, Olenguruone and Entasekera but no information exists for the central part of the region. Nevertheless, it has been possible to construct a rainfall map from the records that are available.

Reference to this maps shows that there is a variation in annual rainfall from less than 15 inches to the south-east in the Rift Valley at the foot of the Nguruman escarpment and around Magadi, to more than 70 inches in the north-west corner of the Mau (at Olenguruone the average rainfall over twenty three years is 75.06 inches).

In the Mau area in the north, there is never a month without rain and this applies to all areas on the plateau west of the Rift Valley, including the Mara, the Loita plains and Narok. The wettest months in the region are usually from February to May but November and December can have more rain than the preceding months. Usually, the driest period is from July to October.

The highest annual rainfall recorded at Narok over a period of 36 years was 53.74 inches (1963) and the lowest 11.81 (1933). The highest annual rainfall at Magadi over a period of 24 years was 34.53 (1930) and the lowest 6.03 inches (1948).

According to M.Lindley (1963), analysis of records at Narok shows that the wet period for the nine years 1954-62, when the mean annual rainfall was 35.9 inches or 27 per cent above average, was preceded by a four-year period of varying rainfall. Before that, there was a 17-year spell of generally below-average rainfall, 24.0 inches a year or 15 per cent below the long-term average. During this time a considerable deficit of rainfall built up, which may have affected those springs on which the influence of rainfall in previous seasons is felt. The recent period of above-average rainfall may conversely have resulted in increased discharges from deep-sourced springs and the vegetation of the area may also have benefited from the wetter climate. Miss Lindley demonstrates with a probability plot that there is a 10 per cent chance of annual rainfall at Narok being less than 16 inches or more than 41 inches. Drought conditions for longer periods do not appear to match well in theory and practice, a fall of 12 inches in practice comparing with only 8 inches in theory for two years in 100. A high value of 49 inches appears probable for the same frequency. Data for the period of overlap with Kipleleo, where records were kept for 8 years up to the end of

1963, gives a line almost parallel but 3-4 inches higher than that for the full period. A similar short period plot for Kipleleo indicates a wider range of rainfall figures than at Narok. An eight-year period is, however, too short to allow probability figures of any real value.

Cloud cover at Narok at 08.30 hours varies between 5.6 tenths in January and 8.7 tenths in May; at 14.30 hours, it ranges between 6.8 tenths in September and 7.8 tenths in November.

Relative humidity At Narok, the mean monthly relative humidity at 08.30 hours varies between 86 per cent in May and 69 per cent in October; at 14.30 hours, it ranges between 58 per cent in May and 33 per cent in February. The mean maximum relative humidity at Narok is 100 per cent for all months, but the mean minimum relative humidity varies between 56 per cent in May and 30 per cent in February.

At Magadi, the mean maximum relative humidity ranges between 74 per cent in April and 56 per cent in September and the mean minimum relative humidity varies between 24 per cent in February and 40 per cent in May.

At Egerton College, near Njoro, on the northern slopes of the Mau, where records have been kept for 10 years, the relative humidity is high in April, May, July and August, varying between 62 and 77 per cent. It is low from January to March, varying between 45 and 49 per cent at 15.00 hours East African time (See charts and tables).

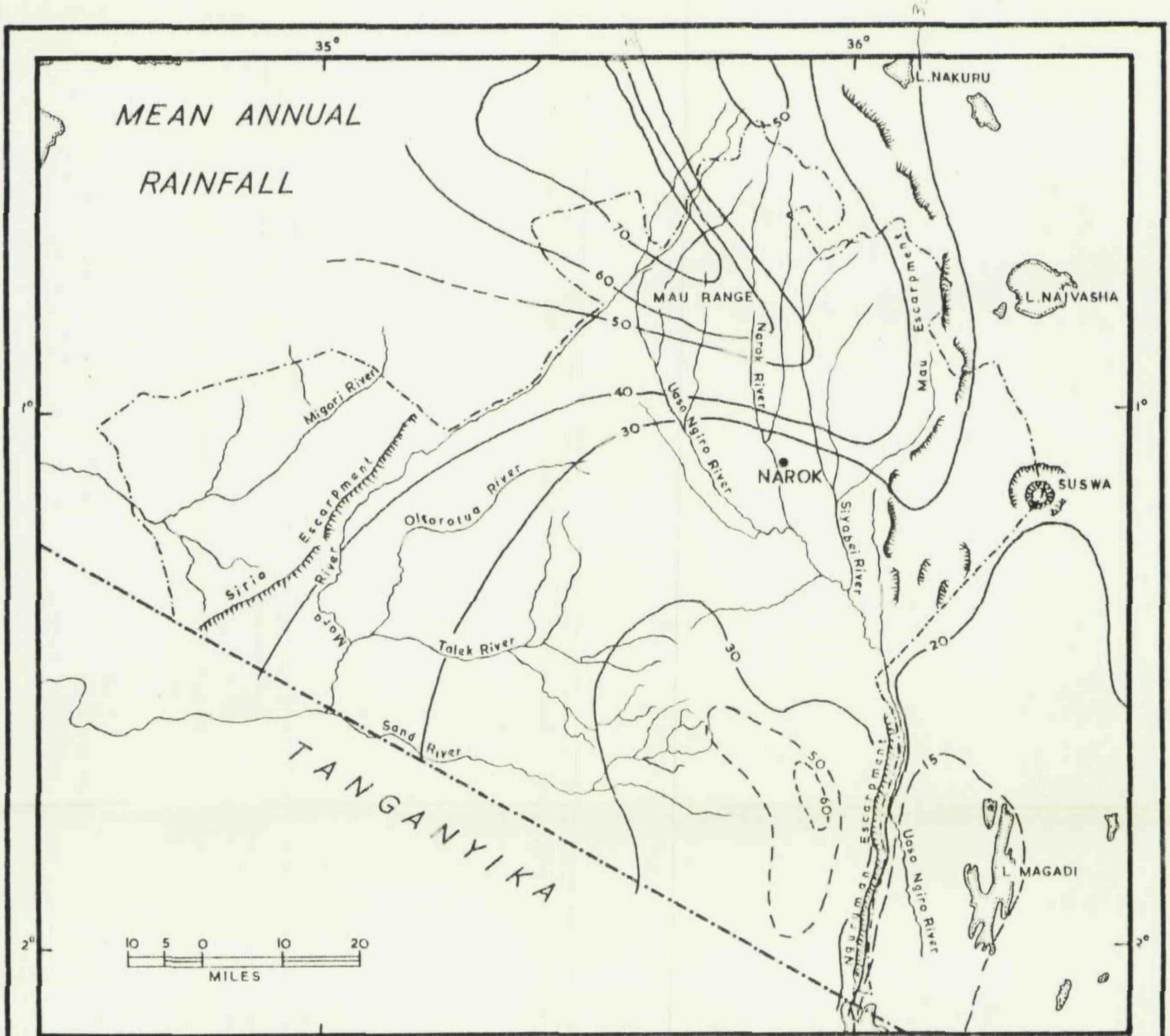
Temperature The highest mean maximum temperature for Narok is 81.2°F (27.3°C) in February and the mean minimum for the same month is 46.1°F (7.8°C). The lowest mean maximum temperature 70.3°F (20.2°C) occurs in July and the lowest mean minimum 48.8°F (7.3°C) in September.

At Magadi, the highest mean maximum temperature of 37.5°C also occurs in February and the mean minimum for the same month is 22.9°C. The lowest mean maximum temperature of 31.0°C occurs in July and the lowest mean minimum of 20.6°C is also in July.

At Egerton College, the mean maximum temperature is highest from January to March, varying between 72.5°F (22.4°C) and 74.6°F (23.5°C). The highest mean minimum temperature of 48.6°F (9.0°C) occurs in April and the lowest, 44.9°F (7.1°C), in September (See charts and tables).

Wind At Narok, winds are high in October, when at 08.30 hours 11 per cent of the velocity is from 13-24 miles/h (21-39 km/h) and 73 per cent at 14.30 hours. Another windy month is May but the least wind blows in December when 47 per cent of the velocity is only up to 3 miles/h (5 km/h) at 08.30 hours and 53 per cent is 13-24 miles/h at 14.30 hours.

At Magadi, the most windy period is from August to October, when 86 to 91 per cent of the wind speed is between 4 and 12 miles/h at 08.30 hours and 95 to 98 per cent at 14.30 hours, but the months with highest wind speeds are November and December and the lowest of 7 per cent, in November at 14.30 hours.

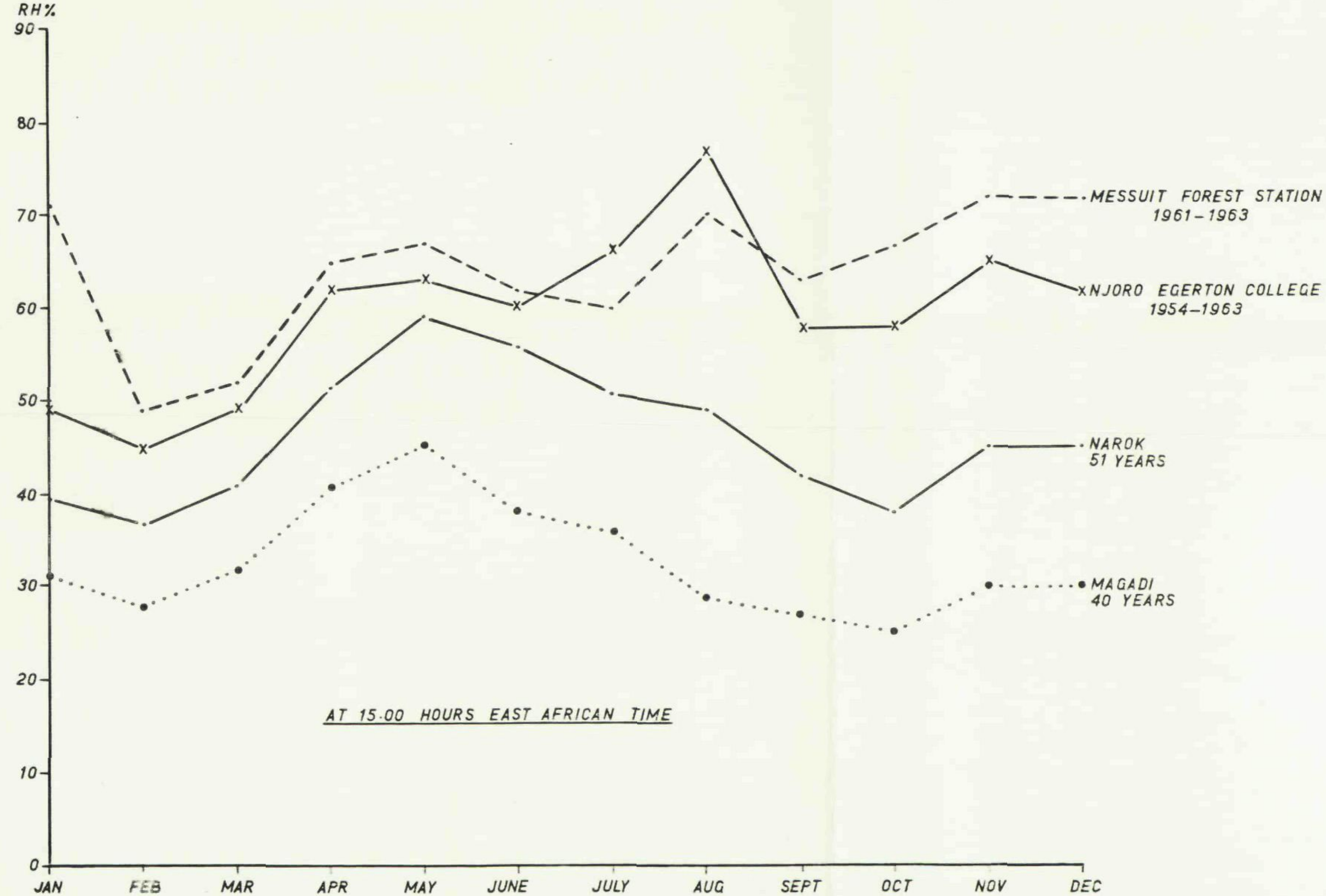


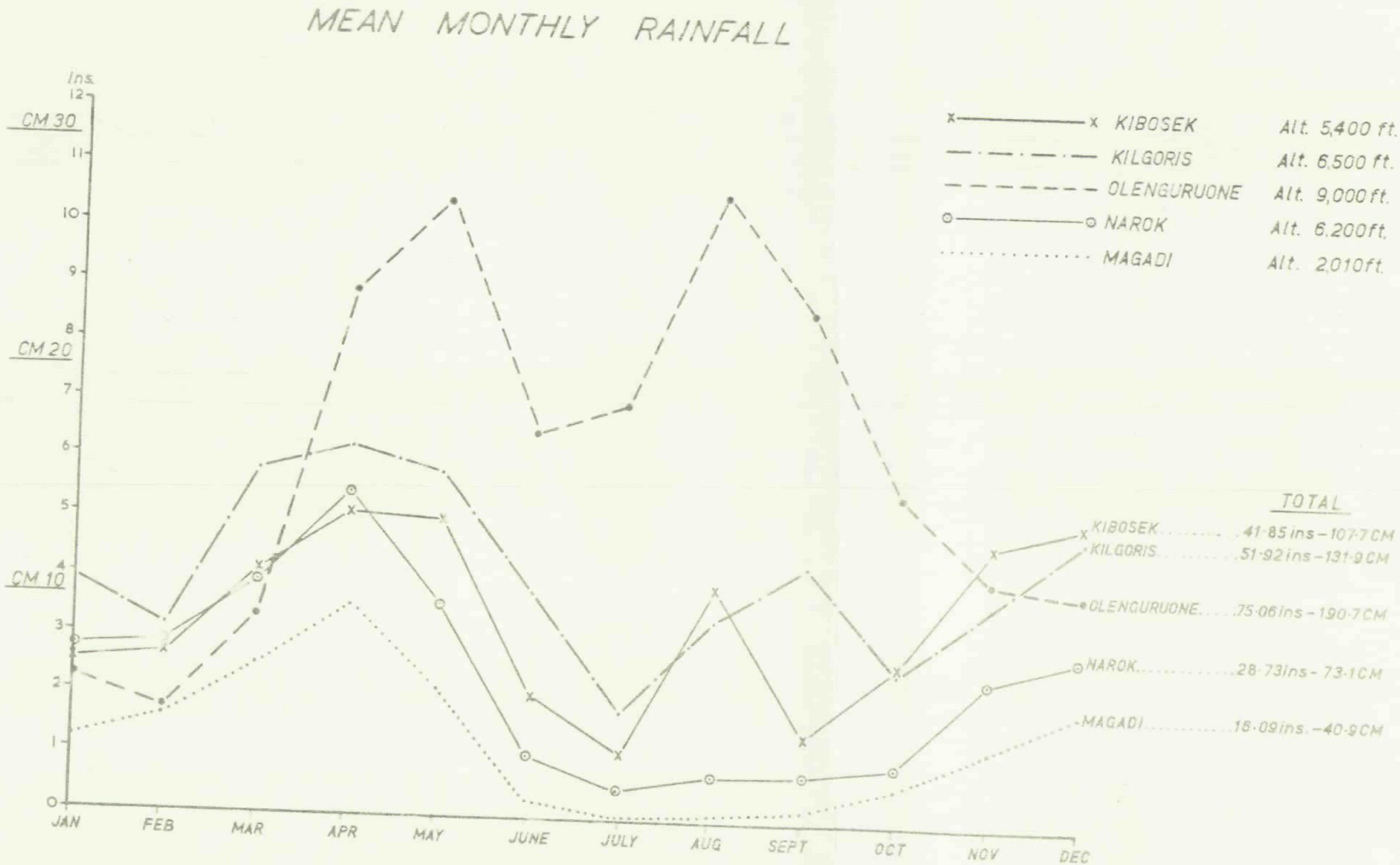
Compiled from:
1. The Climate of Kenya Masailand. By J. F. Griffiths, E. A. Meteorological Department, Nairobi, and M. D. Gwynne, E. A. Agriculture and Forestry Research Organization.
2. A Map produced by J. Glover, M.S.
3. Rainfall Map of East Africa (Based on all available data at 1955)
4. Information from the E. A. Meteorological Department, Nairobi.

1963

del. A. Rickards

MEAN MONTHLY RELATIVE HUMIDITY

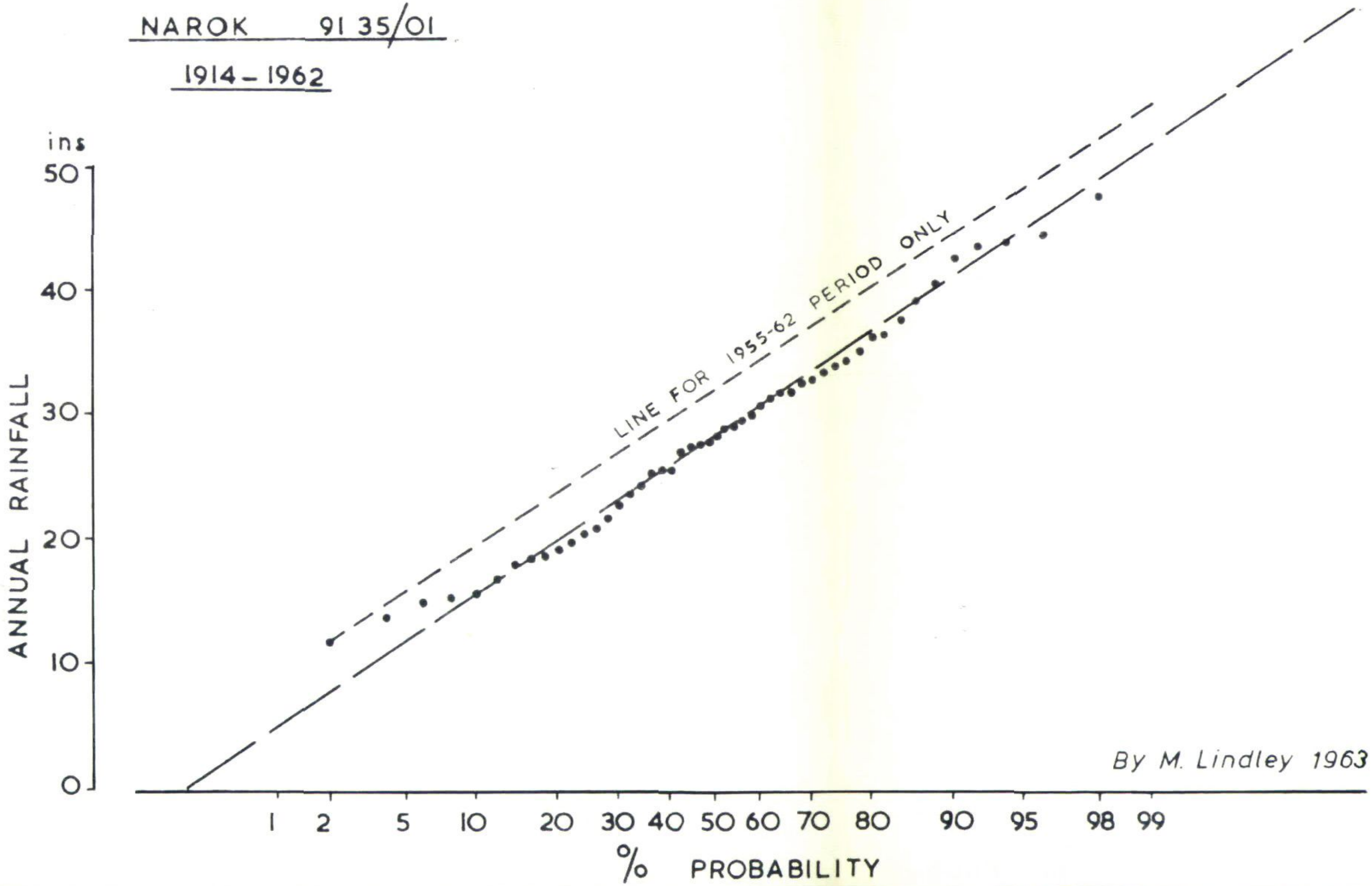


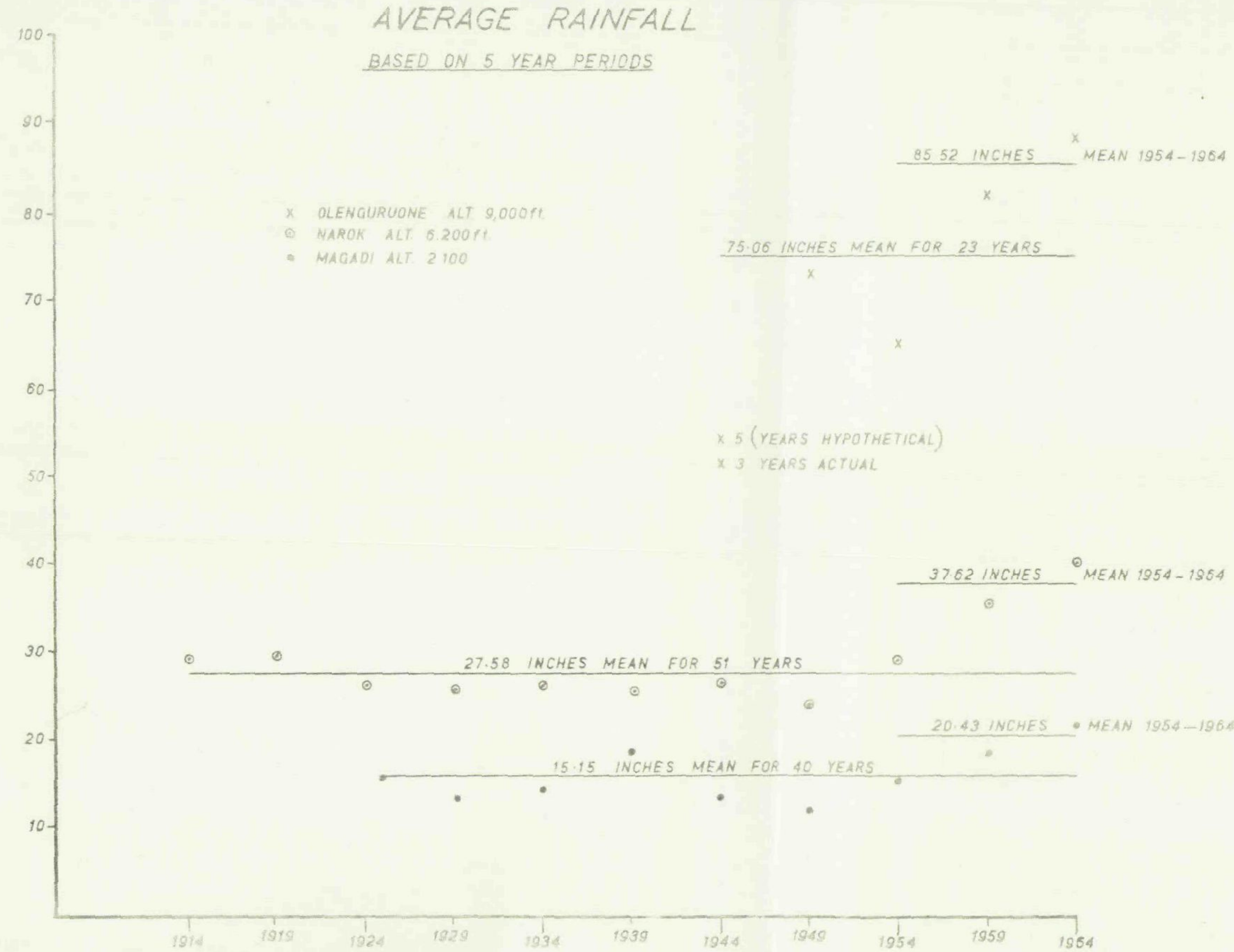


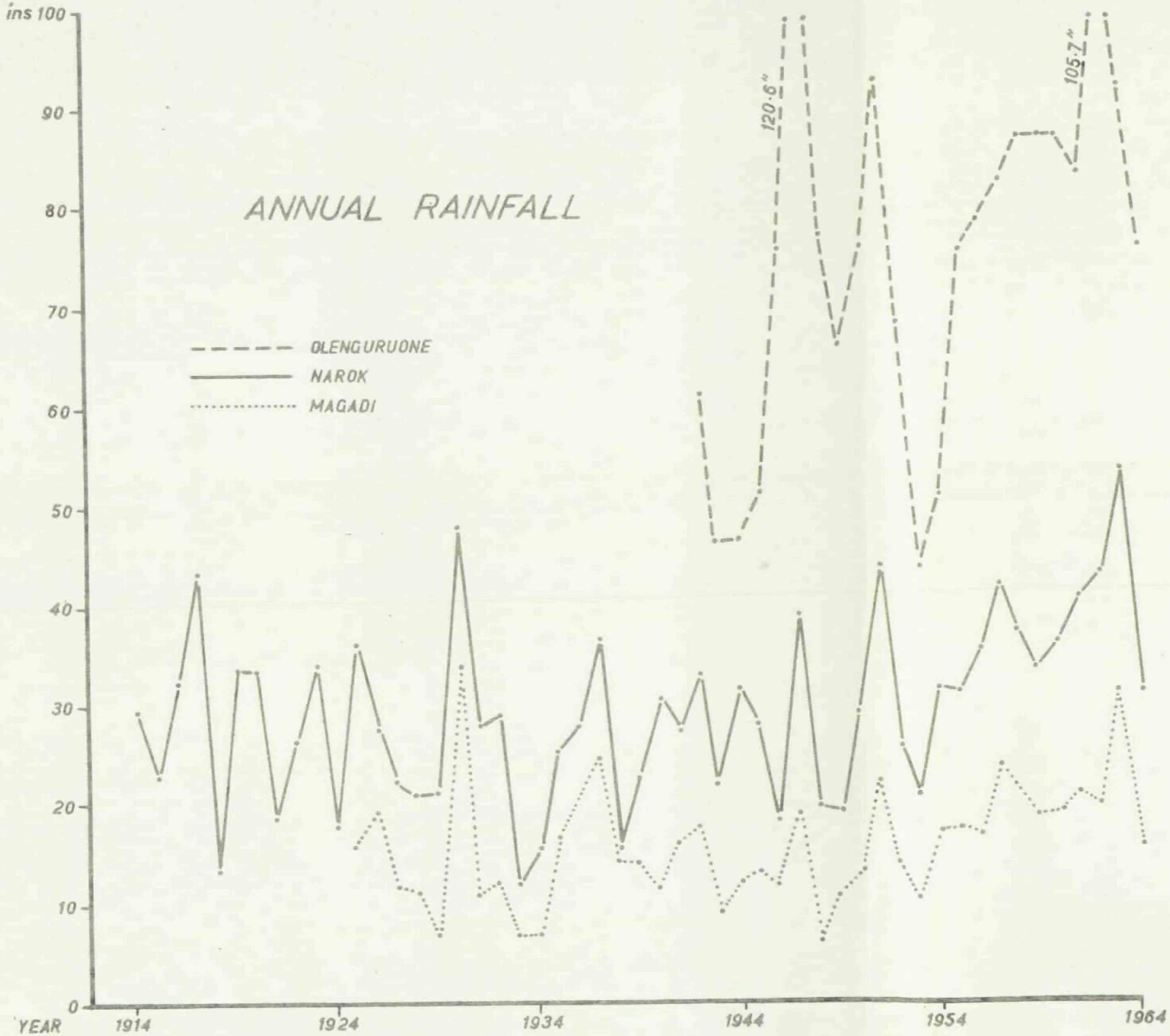
MEAN MONTHLY RAINFALL
Ins.
CM 30
CM 20
CM 10
KIBOSEK Alt. 5,400 ft.
KILGORIS Alt. 6,500 ft.
OLENGURUONE Alt. 9,000 ft.
NAROK Alt. 6.200 ft.
MAGADI Alt. 2,010 ft.
TOTAL
KIBOSEK 41·85 ins – 107·7 CM
KILGORIS 51·92 ins – 131·9 CM
OLENGURUONE 75·06 ins – 190·7 CM
NAROK 28·73 ins – 73·1 CM
MAGADI 16·09 ins. – 40·9 CM
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC

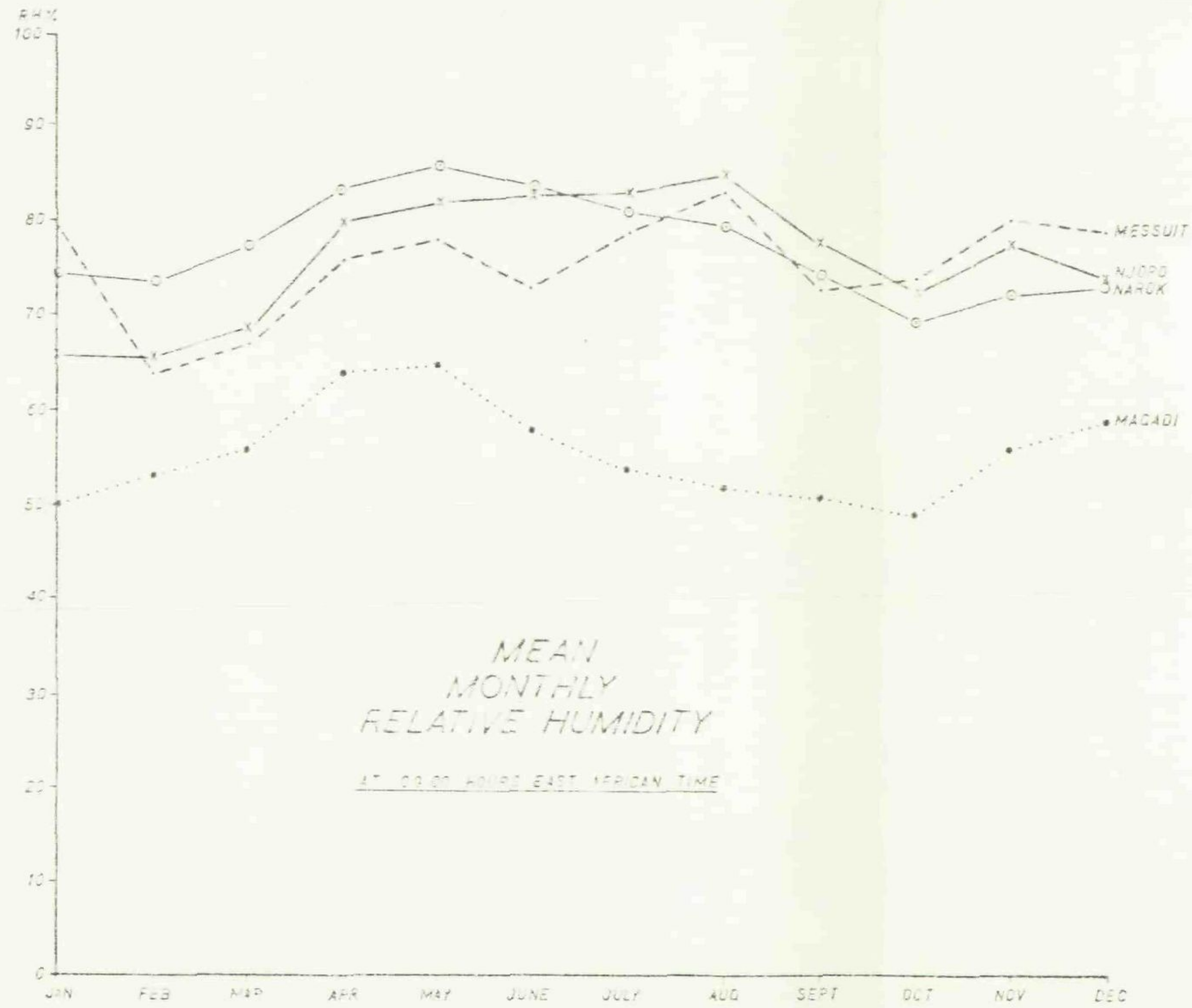
FIG 2.

PROBABILITY OF ANNUAL RAINFALL



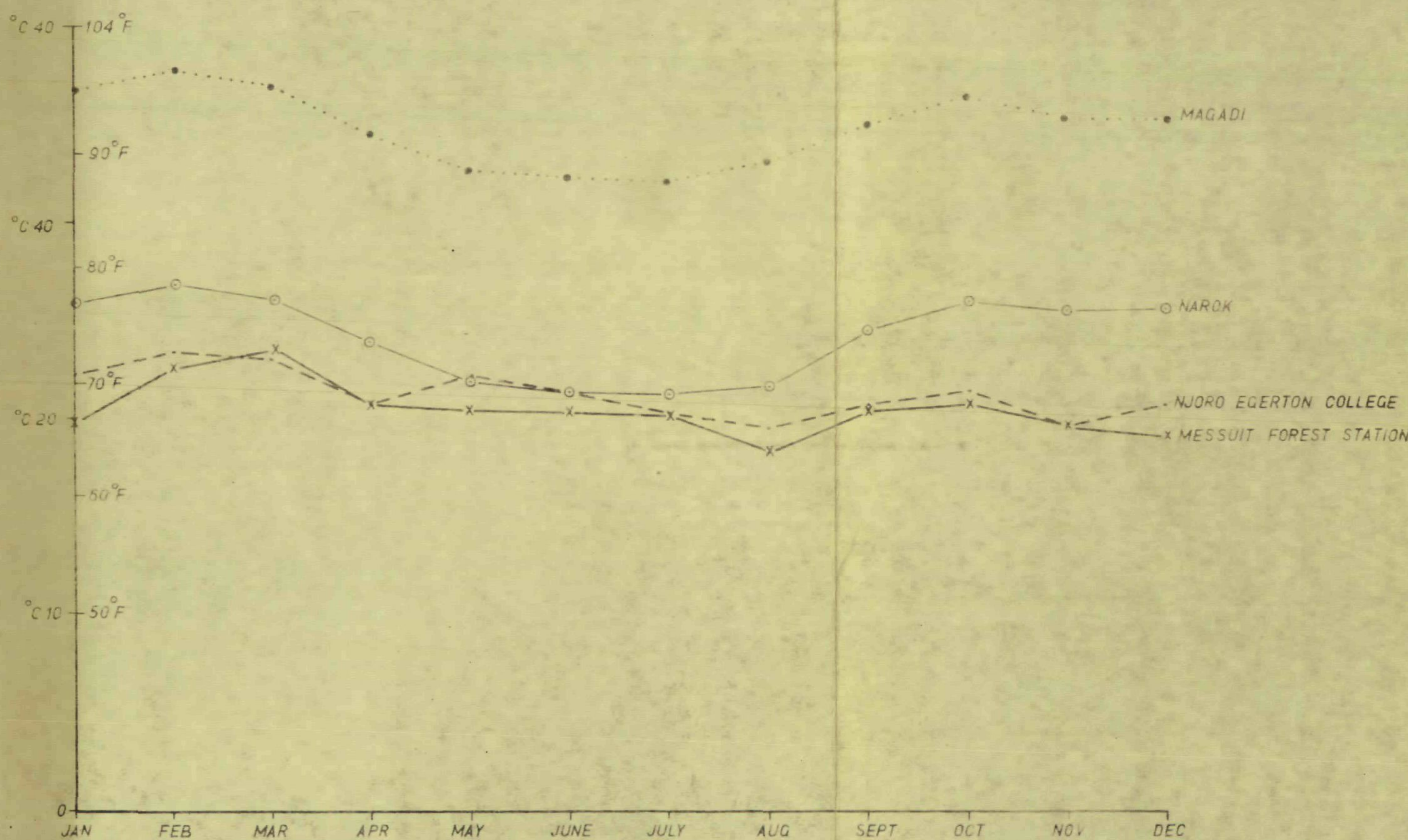

AVERAGE RAINFALL
BASED ON 5 YEAR PERIODS
x OLENGURUONE ALT 9,000 ft.
⊙ NAROK ALT 6,200 ft.
• MAGADI ALT 2100
85.52 INCHES MEAN 1954 – 1964
75.06 INCHES MEAN FOR 23 YEARS
x 5 (YEARS HYPOTHETICAL)
x 3 YEARS ACTUAL
37.62 INCHES MEAN 1954 – 1964
27.58 INCHES MEAN FOR 51 YEARS
20.43 INCHES MEAN 1954 – 1964
15.15 INCHES MEAN FOR 40 YEARS
100
90
80
70
60
50
40
30
20
10
1914
1919
1924
1929
1934
1939
1944
1949
1954
1959
1964

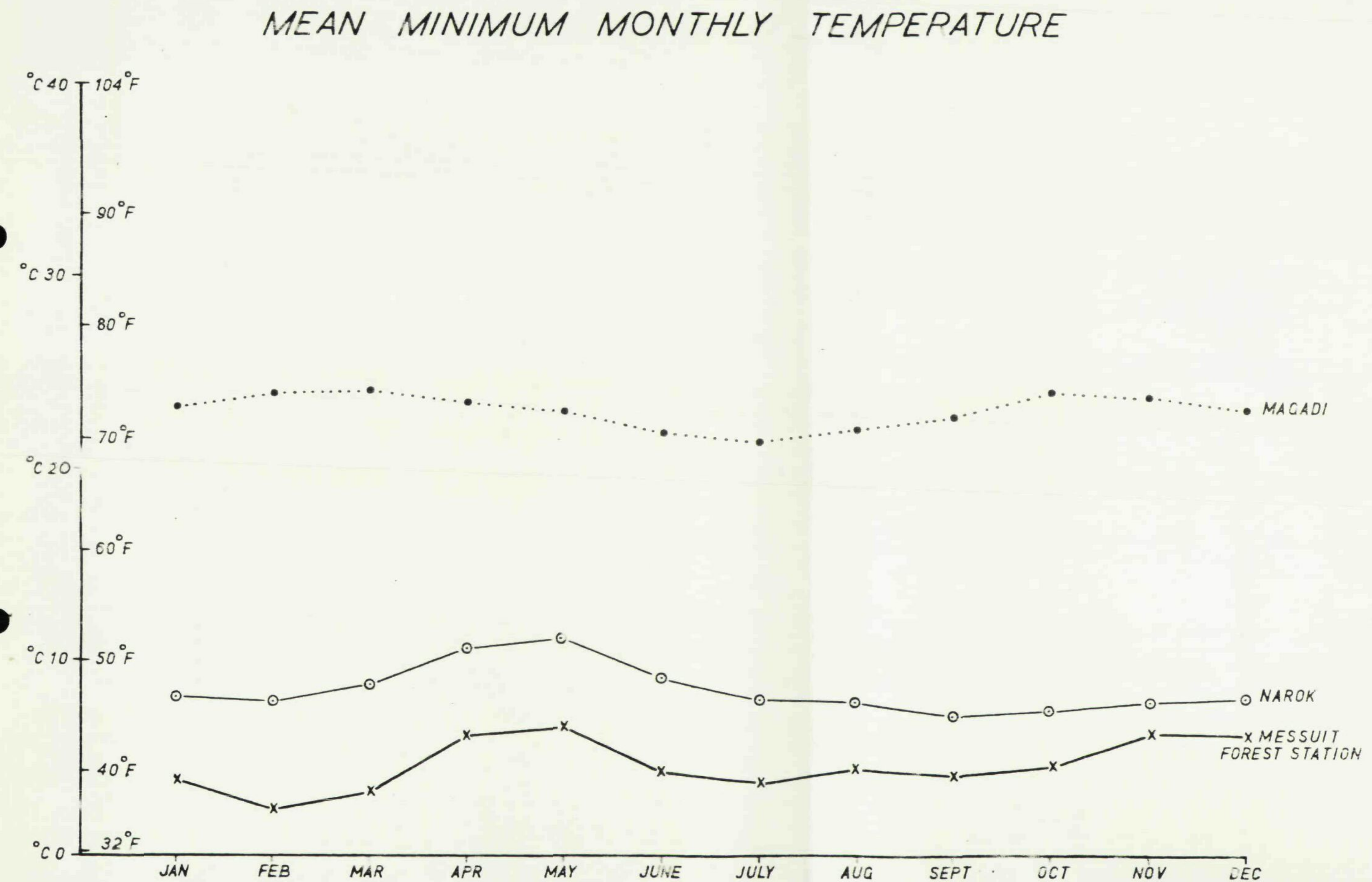

ANNUAL RAINFALL
OLENGURUONE
NAROK
MAGADI
ins 100
90
80
70
60
50
40
30
20
10
0
YEAR
1914
1924
1934
1944
1954
1964
120·6"
105·7"



AT 09.00 HOURS EAST AFRICAN TIME

MEAN MAXIMUM MONTHLY TEMPERATURE




MEAN MINIMUM MONTHLY TEMPERATURE
°C 40
104°F
90°F
°C 30
80°F
70°F
°C 20
60°F
°C 10
50°F
40°F
°C 0
32°F
MAGADI
NAROK
MESSUIT FOREST STATION
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC

CHAPTER

IV

HYDROLOGY

Reference to map 1 shows that there are three main river systems draining the Narok district. These are:-

1. The Uaso Ngyiro which has its head waters in the high Mau, rising to the north of Olokurto on the escarpment above Njoro and flowing south-eastwards over the edge of the Nguruman escarpment into the Rift Valley where it hugs the foot of the Rift wall as far as Oloibortoto. There it turns slightly eastwards and eventually spreads out into an extensive swamp lying to the north of lake Natron. The Uaso Ngyiro is fed by several main tributaries, such as the Narok and Siyabei rivers, the head waters of which also rise in the Mau escarpment.

2. The Mara which has its source near that of the Uaso Ngyiro in the Mau. It flows south-south-westwards as far as its junction with the Nyangoris, a permanent stream which flows through the Chepalungu region of trans-Mara Kipsigis country. From there, the Mara follows the Siria escarpment for several miles to Mara Bridge, where it swings south-eastwards to form the "Mara Triangle" - a piece of game country which lies between it and the Siria escarpment to as far as the Tanganyika border. At the Tanganyika border, where it is joined by the semi-permanent Sand river, the Mara swings westwards, eventually to flow into

lake Victoria Nyanza near Musoma. The main seasonal tributaries of the Mara are the Oltorotua, which rises on the edge of the Loita plains near Lemek; the Talek, which drains the Loita plains and the western side of the Loita hills; and the Sand river, which rises in the Loita hills, flowing westwards along the southern foot of the Sianna hills until it reaches the Tanganyika border near Keekorok before it joins the Mara.

3. <u>The Migori</u> which rises near Abossi and drains the trans-Mara plateau, flowing south and then westwards to join the Kuja at Macalder Mines near the Tanganyika border before flowing into lake Victoria.

Two peripheral rivers of importance to the Narok ec-system are: (a) the Sondu, the main tributaries of which also rise in the Mau near Elburgon and Londiani. This river flows westwards through the forested areas of Kericho, Sotik and the Kisii highlands. It has its mouth in the eastern end of the Kavirondo gulf of lake Victoria; (b) the Uaso Kedong, which rises at the foot of the Kikuyu escarpment to the north-east of mount Suswa, flowing southwards along the base of Suswa to disappear in one of the many fault trenches of the Rift Valley.

To the north of the Mau, drainage is into lakes Nakuru, Elmenteita and Naivasha.

A paper on the hydrology of the Narok district, together with a hydrological map, was provided by M.Lindley (1963) as part of this survey and some of her information is incorporated here. She indicated that records of stream flow are scarce and regular gauging stations are found only on the two main dry season tributaries of the Mara river - the Nyangoris near Bomet and the Amala at the bridge near Kapkimulwa. There are also gauges at Migori, on the Migori river outside the Masai region, on the Oltanki at Kilgoris - a tributary of the Migori, on the Masampoli spring near Nairagie Engare, on the Uaso Ngyiro at the Game Department check post, at Narok township on the Narok river and at the Mission on the Siyabei river. Stream flow has only been recorded at the first three stations for any length of time, so that it is not yet possible to enable a gauge-height relationship to be drawn up for the other streams. Poor communications and absence of competent recording are further difficulties which have not yet been overcome.

All the permanent streams in the area, except the Uaso Kedong, derive their water from the Mau catchment.

Evaporation Evaporation data from the pan at Narok is available for a 48-month period, 1959-64, which is really too short for any but the most tentative conclusions to be drawn. Lindley (1963) indicated that total annual evaporation is in the 50 - 70 inch range if no pan factor is used, or the 40 - 56 inch range applying the 0.8 factor which is often adopted. The pattern of evaporation through the year fluctuates much less than that of rainfall, with highest figures (about 10 per cent of the annual total) in October and March and lowest values (7 - 7.5 per cent) in May, June, July and November. Actual pan figures vary between 3 and 8 inches per month. At lower altitudes near the Tanganyika border and in the Rift Valley, potential evaporation may be expected to exceed the Narok figures.

Water balance effects The application of hydrological information to the natural vegetation of the area and potential crops, varies with the plants concerned and the moisture storage ability of the soils. However, an average year's rainfall only supplies some 45 per cent to 60 per cent of the potential moisture requirements of a region. Only during the periods March to May and November to December, in the whole area, plus possibly August and September in the wetter regions, does the average rainfall approach the potential evapo-transpiration rate for the month. Under these conditions, a continuous vegetation cover on a deep soil leaves no excess moisture for a streamflow replenishment of aquifers. Nevertheless, it has been shown by soil moisture penetration studies, (Glover 1950) and (Glover, Glover and Gwynne 1962) that penetration is greatly assisted by vegetation cover.

The hydrology of the Sambret and Lagan areas in the tea-growing region of the Kericho district on the western edge of the Mau, was studied by members of the East African Agriculture and Forestry Organisation between 1957 and 1962.

Kerfoot (1962) indicated that the Lagan and most of the Sambret areas were covered with "mature moist montane evergreen high forest", or secondary growth derived from it. Above 7,500 feet at Sambret, the forest was replaced by Montane bamboo forest which, however, contained evergreen forest elements scattered through the matrix. These areas are, therefore, representative of most of the higher rainfall parts of the Mau (Chapter VI).

When Lagg and Pratt (1962) investigated the relation of storm flow to incident rainfall in the Sambret and Lagan catchments between November 1957 and October 1958, these areas were still under complete forest cover. The storm flow, expressed as a percentage of total flow, showed a remarkable similarity in the behaviour of the two catchments (8.60 per cent for Lagan and 8.92 per cent for Sambret).

At first, felling and clearing the trees did not seriously change the pattern of runoff at Sambret in the early part of 1960. But by June the effects of clearing and clean weeding for planting caused a marked change in the storm flow response and very much more runoff was measured than was predicted.

The results obtained from these experiments showed that a continuous cover of tall forest is a highly effective regulator of stream flow, as the total storm flow in the forest areas amounted to only 1.3 per cent of the rainfall. The most severe storm, in which 4.6 inches of rain fell in 50 minutes, produced a runoff of only 2.56 per cent, with a peak flow of 18.5 cusecs (9 cusecs per square mile). Dagg and Pratt conclude by saying: "In comparison with the rate of 373 cusecs per square mile delivered by the 600 acres of developed area (which had been cleared of forest) the flood control capacity of the forest cover is excellent."

Pereira et al (1962) showed that the water used by the high forest in transpiration was almost constant at 60 inches for the three years studied. Therefore, the catchment "water yields" varied from 15 per cent for a year with 72 inches of rain, to 28 per cent for a year with 85 inches of rain.

The ratio of evapo-transpiration to open water evaporation for the forested catchment was consistently $E_t / E_o = 1.0$ (Dagg & Waweru 1965).

In spite of the very low storm flow from the forests, the ratio of maximum to minimum monthly stream flow was quite large, being in the order of 10:1 for the years 1957/58 and 1959/60 and 5.6:1 for 1958/59.

The above information stresses the importance of preserving the vegetation cover of the Mau and other forested areas in the region, especially that in the humid zone (Chapter VI).

A C K N O W L E D G E M E N T S

I am greatly indebted to the Director of the East African Meteorological Department for all the records and help his department has given me.

I am particularly grateful to Miss Jessie Tomsett for all the trouble she took to find obscure records from the departmental files, to Miss Jeanne Ossent for kindly letting me have copies of the available records published by her department and to Dr.H.T.Mörth for reading and checking the script.

BIBLIOGRAPHY

BUTLER, R.K. (1959). Atlas of Kenya. Nairobi: Survey of Kenya.

DAGG, M. and PRATT, M.A.C. (1962). Relation of storm flow to incident rainfall. E.Afr.agric.for.J., 27, 31-35.

DAGG, M. and WAWERU (1965). Climatic classification of rangeland in East Africa. Report of the East African Range Classification Committee. E.A.A.F.R.O.

GRIFFITHS, J.F. and GWYNNE, M.D. (1962). The climate of Kenya Masailand. E.Afr.agric.for.J., 28, 1-6.

KERFOOT, O. (1962). The vegetation of the Sambret and Lagan experimental catchments. E.Afr.agric.for.J., 27, 23-24.

LINDLEY, M. (1963). Notes on the hydrology of the Mara Narok area. Proceedings of the East African Academy: First Symposium, 51-55.

MÖRTH, H.T. (1965). Investigations into the meteorological aspects of the variations in the level of Lake Victoria. East African Meteorological Department. Progress Report (February 1965).

MÖRTH, H.T. and LUMB, F.E. (1965). Investigations into the meteorological aspects of the variations in the level of Lake Victoria. East African Meteorological Department. Progress Report (March 1965).

PEREIRA, H.C., DAGG, M. and HOSEGOOD, P.H. (1962). The water balance of both treated and control valleys. E.Afr.agric.for.J. 27, 36-41.

EAST AFRICAN METEOROLOGICAL DEPARTMENT (1964). Collected climatological statistics for East African stations. East African Common Services Organisation, Nairobi.

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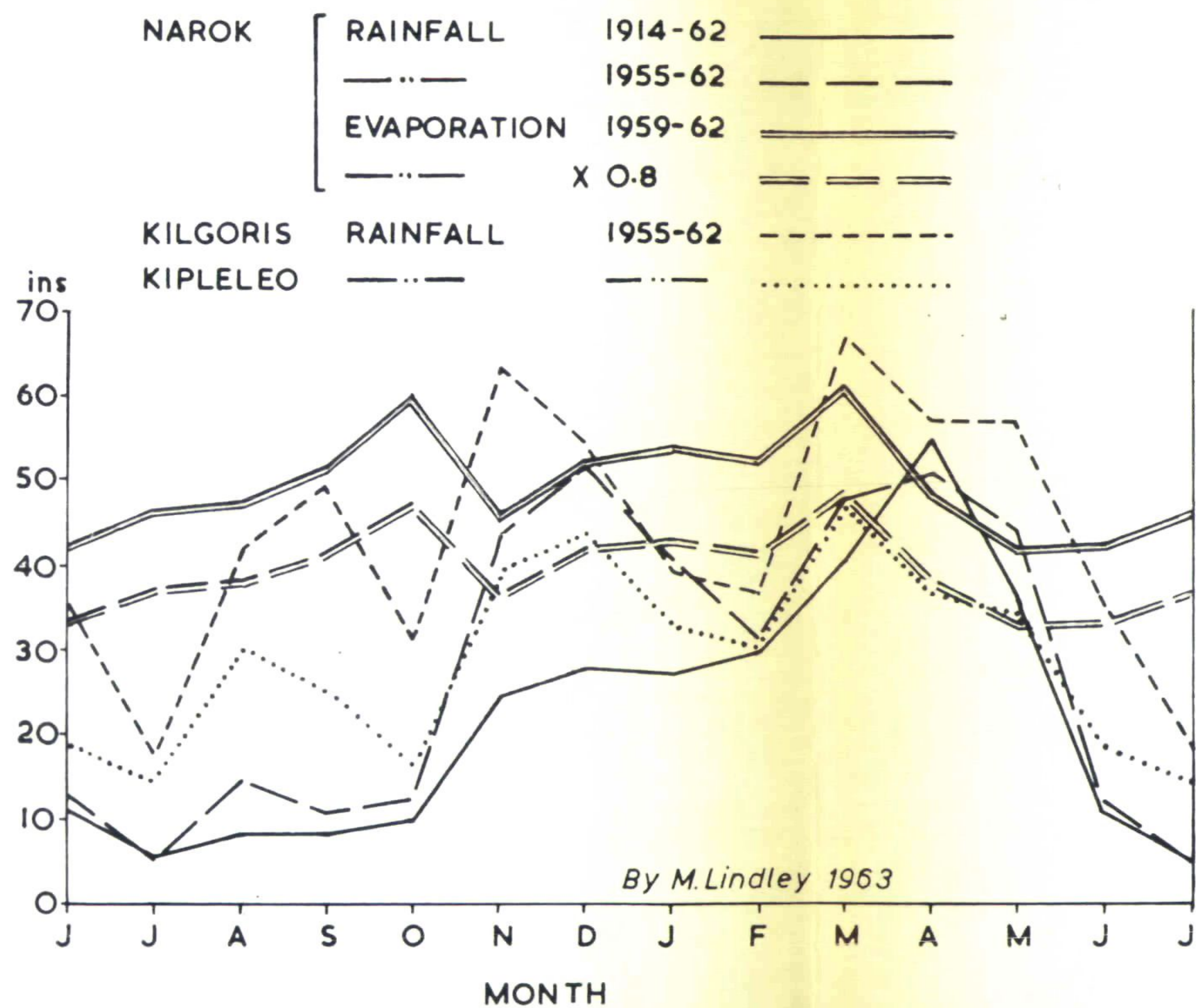
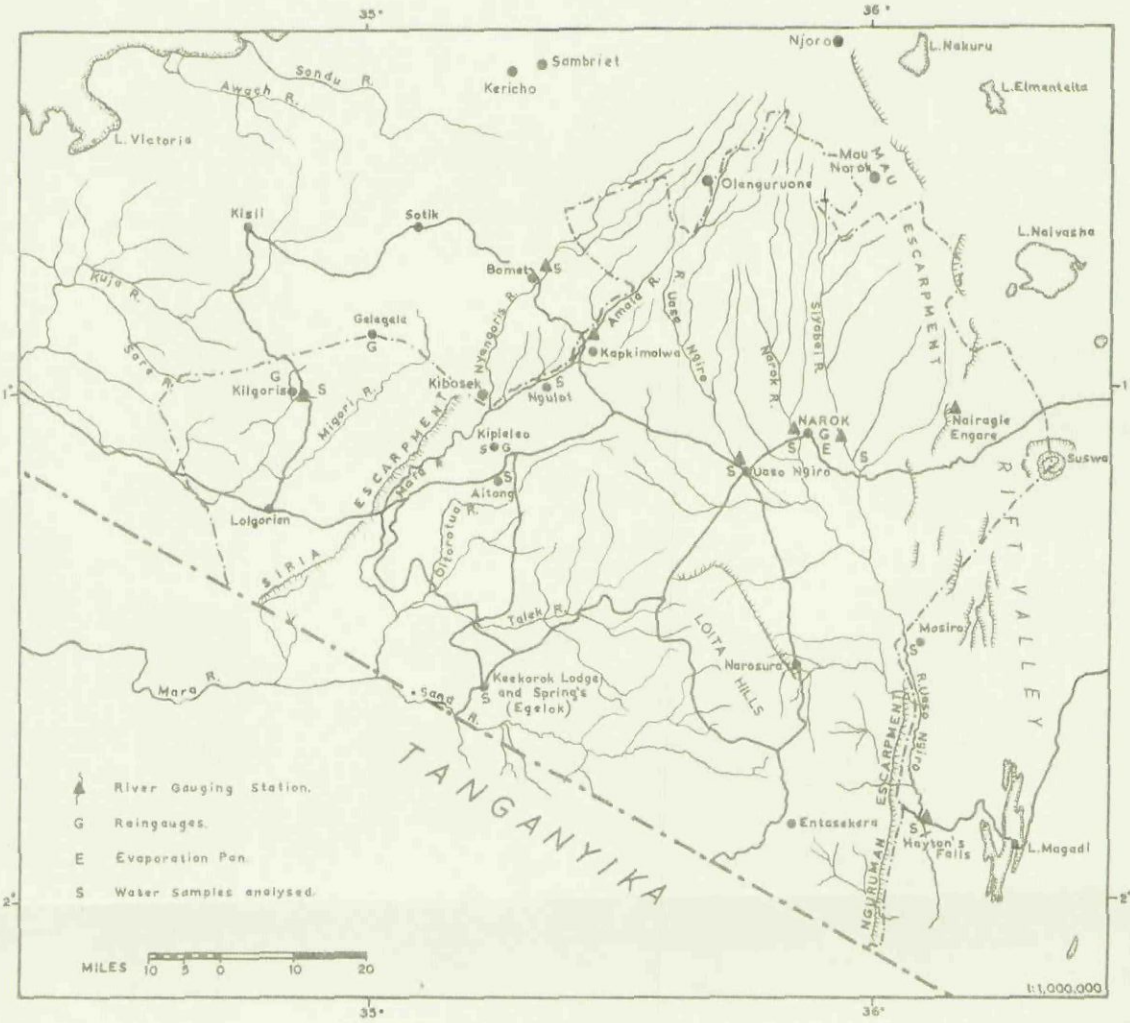
FIG 4.

MEAN MONTHLY RAINFALL AND PAN EVAPORATION





MARA NAROK AREA
HYDROLOGICAL FEATURES

by M. Lindley 29.4.1963

del. A. Rickards

CHAPTER V

SOILS

The three most important factors influencing soil formation in tropical regions are:- geology, topography and climate. To these, Scott (1962) adds living organisms and time.

In the humid areas of the high Mau, the surface horizon of the soil is very much influenced by climate and vegetation. In parts of the Talek area where the black clay soils are primarily derived from underlying phonolite, topography exerts an influence, as these soils are poorly drained.

Milne (1947), in Tanzania, noted that in rolling country, a sequence of soil types occurred between the crests and valley bottoms and that under similar topographical conditions, similar sequences were found. These he called "soil catenas". The same phenomenon exists in this region but it is not so easy to discern because of the recent tectonic and volcanic activity but this correlation in southern Tanzania is classic.

On the Loita hills in the south-east of the region, the soils are shallow and derived from Basement System rocks, so that their chemical composition and physical structure are different from those of the Mau, but in the forested areas of both regions there is a close similarity in the surface horizons of the soils.

Except for the forested areas, most of the soils of the Narok district are truncated. In many places, the top soil and even the subsoil has gone, leaving hard compacted concretionary pavements.

Over a large part of the region, the upper layers of the soil consist of fine lava dust or other pyroclastic material such as pumice granules. Sometimes this material may be more than 20 feet deep, consisting of a succession of layers of varying texture. (Good examples are to be seen on the road between Suswa and Narok).

In order to determine the chemical and other qualities of the soils, 96 profiles were dug in various parts of the country from which 290 samples were collected. This was done by digging a pit to a depth at which the soil became too hard to proceed, because it was indurated or because of the presence of stone. Frequently it was shallow and country rock or "caliche" concretions were struck near the surface, but one pit at Aitong reached a depth of 14 feet..

Altogether, 14 different important soil types are recognised in the area surveyed (Scott 1962) but it was not possible to collect samples from all of them.

The classification used below is that of Scott (1962). Reference to the soil map shows that the different soil types do not fall neatly into the three climatic zones. There is a considerable amount of overlapping, which is inevitable when geology, topography and man are taken into account. In turn, these factors greatly complicate the vegetation patterns.

WELL DRAINED SOILS

HUMID ZONE

Rainfall above 50 inches per annum

Strong brown to dark brown loams (Ando-like soils)
Scott (1962) - Types 1 and 2

These soils vary in colour from dark brown to black to dark grey, depending on whether they occur on a "highly dissected" or "gently rolling" topography, both of which occur in the Mau region; the lighter coloured soils occupying the steeper, better drained places. The "A" horizon has a high humic content (5 - 10 per cent carbon) overlying a "strong brown weakly crumbly to structureless, or weakly subangular blocky loam derived from volcanic ash". There may also be a series of buried soils below, sometimes with pumice horizons present.

In the relatively undisturbed forest regions of the Mau massif where little truncation has taken place, there is a very high humic content in the "A" horizon (5 - 17 per cent carbon). The soil samples collected from the surface horizon in this region were neutral or only slightly acidic - pH 6.0 to 7.2 - but in one patch of trampled bamboo thicket near Mau Narok, the pH dropped to 5.5. An unexpected feature was that sometimes there appeared to be a drop in pH in the middle zones between the depths of 6 inches and 2 feet with a subsequent rise with greater depth. In one grassy glade, the pH was as low as 5.5 in the surface horizon although the carbon content was quite high (3.30 per cent C). Unfortunately, sufficient evidence is not available to prove this point conclusively and further investigations may be rewarding, particularly as the following examples do sh w significant differences:-

1. Keltichek, Trans-Mara "half mile strip" in grassland derived from evergreen forest cleared 15 years previously, with no history of overgrazing or trampling :
   Surface horizon depth 0 - 3 inches, carbon content 4.85 per cent, pH 7.9

   Middle horizon depth 10 - 26 inches, C ± 1.0 per cent, pH 5.4

   Lower horizon depth 58 - 64 inches, C 0.34 per cent, pH 8.2

2. Mara River Prison area in grassland derived from evergreen forest cleared 12 years previously, with no history of overgrazing or trampling :

   Surface horizon depth 0 - 3 inches, C 7.86 per cent, pH 7.2

   Middle horizon depth 10 - 13 inches, C 0.68 per cent, pH 5.4

   Lower horizon depth 28 - 31 inches, C 0.53 per cent, pH 7.5

The sodium and potassium values in these forest soils are low to normal but they sometimes increase with depth. The nitrogen content is usually highest in the top 3 inches of the surface horizon, decreasing with depth because the nitrogen content is a function of the organic composition. Thus forest soils are singularly susceptible to denudation as this nitrogen content may take hundreds of years to build up again.

Dark red friable clays (latosilic soils)

Scott (1962) - Type 5

The "A" horizon is dark reddish brown with a high humic content (3 - 7 per cent carbon) overlying "a dark red clay with clay skins". These soils are derived from both volcanic and granitic Basement System rocks and they occur on an undulating ridge topography in the western part of the region in the Kilgoris and Sotik areas.

Three profiles were dug here, one in open grassland, another at the base of a thicket clump and the third in a patch of forest. The deepest soil was that at the base of the thicket clump, which reached 3 feet. The organic content was highest in the forest top soil (7.26 per cent carbon) and the lowest in the grassland (1.70 per cent carbon). The pH was highest in the forest top soil (8.0) and lowest in the grassland (6.0).

The sodium and potassium values for these soils are fairly low; Na less than 0.4 m.e. 100 g, and K less than 4.0 m.e. 100 g.

The nitrogen values are highest in the top three inches of soil in the forest and at the base of the thicket clump (0.80 and 0.66 per cent) but lowest in the grassland (0.13 per cent).

All these soils have a high gravel and sand content and are too shallow to be of great agricultural value. Where they are derived from Basement System rocks, a stone line usually occurs. These soils are extremely vulnerable to any type of exploitation and must be treated with great care.

SUB-HUMID ZONE

Rainfall between 30 and 50 inches per annum

Red friable clays (latosolic soils)

Scott (1962) - Type 6

A dark reddish brown humic "A" horizon overlies a red weak subangular blocky friable clay. These soils are derived from both volcanic and Basement System rocks (sometimes with stone lines associated with the latter). They occur on undulating ridge topography between 5,200 and 7,500 feet and are to be found in the south and south-eastern parts of the region.

In the forested areas of the Loita hills, the humic layer has a carbon content of between 5 and 7 per cent and a nitrogen value of 0.5 to .07 per cent but in the truncated soils of the grasslands, the carbon content of the humic layer drops to less than 2 per cent and the nitrogen content below 0.2 per cent. Most of the soils are either neutral or slightly acidic but sometimes the pH rises with depth, as at Moricho Loita where it is 7.0 in the top soil and 8.7 at a depth of 30 - 35 inches. The potassium values are low for the normal growth of plants because of leaching but the Na content may become high with depth, as at Moricho Loita where it was 0.52 m.e. 100 g in the top soil and 3.75 m.e. 100 g at a depth of 30 - 35 inches.

Red to yellow-red sandy clay loams (latosolic soils)

Scott (1962) - Type 8

According to Scott, these soils range in colour from red to yellow to grey. They are derived from granite and are usually associated with inselbergs. The "A" horizon, which has a humic content of 1.5 to 3.5 per cent carbon, overlies a red to yellow-red weak sub-angular blocky gritty sandy clay loam derived from coarse-grained siliceous rocks. The pH is usually low to neutral (4.5 to 7). No samples of this soil were collected as it occurs only in a small area in the south-western part of the region near the Tanzania border.

SEMI-ARID ZONE

Rainfall less than 30 inches per annum

Brown to dark-brown calcareous loams (chestnut soils)

Scott (1962) - Type 10

Soils vary in colour from dark grey to dark brown. They have a low humic "A" horizon (1 - 2 per cent carbon) which overlies a brown to dark brown weak sub-angular blocky clay loam with calcareous concretions. They are derived from volcanic ash and cover the central part of the region including the Narok area, the Loita plains and parts of the Rift Valley. They are normally truncated, with a compacted surface and are often composed of layers of varying hardness, producing a step pavement or terrace effect in eroded areas. The variation in induration may be the result of different periods of volcanic activity but the deposition of colloids and salts leached from upper layers may have also played a part.

The organic content of the top soil appears to be influenced by the degree of truncation. Certainly, sheet erosion plays an important part in reducing the depth of the humic "A" horizon. In grassland, however, biological and chemical processes are much more rapid than they are on the cool shaded floor of the forest, so that the oxidation and hence reduction of the carbon content in the surface horizon in grassland is more rapid. For example, samples taken from a patch of thicket at Rotian, 7 miles north of Narok, showed an 8.37 per cent carbon content in the top soil, yet a few yards away in open grassland there was only 2.03 carbon content in the top soil. On the Loita plains from 5 separate profiles, the carbon content ranged between 2.37 and 1.20 per cent in the first 3 inches of the top soil. This fact is most important from a conservation and range management point of view.

In some parts of this region, the calcareous concretions vary in size with depth; the smallest pea-like ones being in the upper layers. In eroded areas, such as the top of the Siyabei plateau, large lumps as big as a man's fist are strewn over the surface of the soil.

The pH of the upper layers is normally more or less neutral, sometimes becoming basic at the surface in the termite patterns on the Loita plains (Glover et al, 1964). Usually the pH increases with depth. A good example of this phenomenon came from a profile at Sigarrar, 33 miles from Aitong on the way to Kapkimulwa, where the pH of the top 5 inches of soil was 6.7, increasing to 8.5 at a depth of 23 inches.

Another phenomenon observed in these soils is the presence of alkali concentrations at various horizons in the profile which usually are, but may not be, related to depth. The amount of alkali in the soil influences the dispersal of clay, which causes changes in texture, hardness and solubility. This fact may be largely responsible for the erosion pavements mentioned earlier which are common in many parts of the plains.

A further interesting point is the fact observed by Dr.H.W.Dougall that there is a direct correlation between pH and the sodium content of these soils, which is illustrated in the following table. The significance of this fact in relation to plant growth is very important.

Correlation between pH and Na (m.e. 100 g)

pH	Na (me/100g)	Depth of sample (inches)	
7.5	1.19	0-7.6	Loita plains
7.7	2.89	17.8-71.2	
6.7	.29	0-7.6	Olengeri
6.2	.19	30.5-40.7	
6.9	3.24	68.6-76.2	
7.1	4.34	0-10.2	*Pennisetum*, low mound, Olengeri
7.2	1.69	38.2-48.3	
6.4	.74	89-99	
6.4	.10	0-7.6	*Harpachne* zone, Olengeri
6.4	.44	25.4-38.2	
7.2	1.87	61.0-68.6	
6.3	.39	0-9	Musiara, between Talek river and Mara river. (Badly drained)
6.7	1.24	9-16.5	
7.2	2.14	16.5-25.4	
7.7	2.19	33.0-43.2	
8.5	3.34	56.0-64.8	
6.8	.69	0-7.6	Between Aitong and Mara river - Ololoma
7.5	3.74	12.7-23.0	
8.7	6.59	35.6-50.8	
8.9	7.74	61.0-71.2	

Cont....

Correlation between pH and Na (m.e. 100 g) (Cont.)

	pH	Na (me/100g)	Depth of sample (inches)	
	6.8	.15	0-7.6)	*Olea-Dombeya* forest Oloropil, Mau Narok
	6.8	.10	15.3-25.4)	
	5.9	.15	56-63.5)	
23 Σ	163.5	45.44		
Mean	7.1	1.98		

	pH	Na	pHxNa
Sum of Squares	1176.09	186.4012	354.265
Correction	1162.27	89.7736	323.019
Corrected sum of squares	13.82	96.6276	31.246

Analysis of Variance

Regression	1	70.64)	F = 57.0 ***
Error	21	25.99)	r^2 = .731
Total	22	96.63	Regression coeficient 2.26

Regression equation:

$$Na(me/100g) = 2.26 \times pH - 14.07$$

SOILS WITH SLIGHT SEASONALLY IMPEDED DRAINAGE

Light yellow-brown sandy loams
Scott (1962) - Type 17

They vary in colour with a dark grey to dark greyish-brown humic "A" horizon (1 - 2 per cent carbon) overlying a light yellowish-brown to reddish-yellow structureless gritty sandy clay loam sometimes with mottling and iron concentrations which may become massive with depth. They are derived from coarse-grained siliceous rocks and occur only in the extreme south-western corner of the region on middle and lower slopes at altitudes between 5,000 and 6,000 feet. The pH is normally acidic, varying from 4.5 to 6, and the annual rainfall is between 30 and 50 inches. No samples were collected.

Red to dark red friable clays - with a laterite horizon
Scott (1962) - Type 18

The upper humic layers of these soils vary from dark brown to dark reddish-brown, with a humic content of 0.5 - 3 per cent carbon in the "A" horizon, overlying a red to dark red sub-angular friable clay with rounded iron concretions which become massive with depth. These soils are derived from both volcanic and Basement System rocks and occur on flat ridge tops or upper slopes of gently sloping pediments. They are also found in the extreme south-western corner of the region. The annual rainfall varies between 30 and 50 inches. The pH is acidic, ranging from 5 to 6. No samples were taken.

SOILS WITH IMPEDED DRAINAGE

Black to dark grey clays (grumosolic soils) - popularly called "black cotton" soils.

Scott (1962) - Type 22

They include calcareous variants and are mainly derived from colluvium and volcanic ash occurring on broad depressions ranging in altitude from 5,000 to 7,000 feet with an annual rainfall between 20 and 50 inches. pH ranges from 6 to 9. They occur extensively in the southern and south-western parts of the region and are the result of weathering of minerals brought about by intense tropical conditions during the rains. They usually occur on a flat or depressed topography. The clay minerals in these soils are known as "Beidellite" and "Montmorillonite".

A profile dug at Musiara in "black cotton" soil populated by grass and Acacia drepanolobium Harms ex Sjöstedt between the Mara and Talek rivers, had a carbon content of 2.92 per cent in the first 3 inches of the surface horizon, dropping to 0.46 at a depth of 25 inches. The clay content was 16.5 per cent, rising to 57.8 per cent at a depth of 6 - 10 inches and dropping again to 29.1 per cent at 22 - 25 inches. The pH was 6.3 in the top soil, rising to 8.5 at a depth of 22 - 25 inches. The potassium content was 1.95 m.e. 100 g in the first 3 inches of the surface horizon, rising to 3.10 at a depth of 22 - 25 inches. The sodium content was 0.39 m.e. 100 g in the top soil, rising to 3.34 at a depth of 22 - 25 inches.

Another profile, in similar soil, in the plains underlain by phonolite at Ololomei, between Aitong and the Mara river, had a pH of 6.8 in the first 3 inches of the surface horizon, rising to 8.9 at a depth of 24 - 28 inches; the clay content in the top soil was 16.0

per cent, rising to 54.4 per cent at a depth of 5 - 9 inches and dropping again to 26.8 at 24 - 28 inches below the surface. The potassium content in the first 3 inches of the surface horizon was 2.90 m.e. 100 g, rising to 6.65 at a depth of 24 - 28 inches; the sodium content was 0.69 m.e. 100 g in the top soil, rising to 7.74 at 24 - 28 inches. The rainfall of this region probably exceeds 30 inches per annum for most years.

<u>Dark brown clays</u> (grumosolic soils)
Scott (1962) - Type 23

"Self mulching dark brown clay loams merging into angular block calcareous clay", mainly derived from colluvium and volcanic ash in low lying bottom lands. The pH varies between 7 and 9 and they have much in common with type 22, the "black clays". They occur in the western part of the region.

Two profiles dug at Keltichek, in the half mile strip of cleared forest land, showed a similar pattern with a fairly high organic content in the surface horizon (3.82 and 4.85 per cent carbon respectively). They also showed a similar increase in clay content in the middle horizons to the black clays in type 22 and both showed a reduction in pH from about 8 in the top soil to 6 in the first profile at a depth of 9 - 12 inches, and 5.40 in the second profile at 10 - 14 inches. Unfortunately, the first profile was only 1 foot deep, but the second showed a steady increase again in pH at greater depth until, at 64 inches, it was 8.2. The potassium content in the first profile dropped from 2.70 m.e. 100 g in the surface horizon to 1.35 m.e. 100 g at a depth of 3 inches, but rose again to 2.10 m.e. 100 g at a depth of a foot. In the second, the potassium content dropped from 3.95 m.e. 100 g in the top soil to 2.00 m.e. 100 g at a depth of 2 - 4 inches. Then it rose again until it reached 6.20 m.e.100 g at a depth of 64 inches.

The sodium content was low in the surface horizon layers of both profiles, i.e. 0.39 and 0.36 m.e. 100 g but at a depth of about a foot it began to rise and at 64 inches in the second profile it had reached 2.89 m.e. 100 g.

POORLY DRAINED SOILS

Grey-brown mottled clays (vlei soils)
Scott (1962) - Type 26

In these soils the humic "A" horizon varies in colour from very dark grey to greyish-brown with a 2 - 3 per cent carbon content. It overlies an angular blocky mottled clay. They are derived from colluvium in low-lying bottom lands. Again, they occur in the extreme south-western corner of the region at altitudes ranging between 5,000 and 6,000 feet. pH values vary between 5 and 6.5. No samples were collected.

Dark grey to greyish-brown compacted loamy sands (solodised solonetzic soils)
Scott (1962) - Type 27

Dark grey to greyish-brown sands with a cemented flocculated clay in the "B" horizon. At depth, a black angular blocky clay is usually present. They are derived from colluvium and occur on level to gently sloping ground, usually adjacent to the black clays. They are found at altitudes of 5,500 - 6,000 feet to the south-west of Narok, associated to some extent with the brown calcareous loams (type 10) and with an annual rainfall of 30 - 45 inches.

REGOSOLS AND LITHOSOLS

Ash and pumice soils

Scott (1962) - Type 33

They show no profile development other than a more humic surface layer with a 2 per cent or less carbon content. They have a dark greyish-brown silt loam surface layer overlying brown loamy fine sand; there may be pumice bands or bands of differentiated particle size. The pH in the surface horizon and upper layers may be neutral or slightly acid, becoming basic with depth and saline or sodic concentrations may occur in the form of visible white deposits.

Two profiles, one at the northern foot of mount Suswa in the Rift Valley at an altitude of 5,200 feet, and the other near the outer rim of the caldera at an altitude of 6,000 feet, closely resembled each other. Both were truncated, as they had been severely overgrazed and trampled. According to Bellis (1963), they comprised a "loamy, fine sand surface soil overlying pumice". In both profiles, the surface was brown, neutral and of low organic content (0.62 and 0.68 per cent), the subsoils were distinctly yellowish, highly alkaline (pH 10.3 at 8 inches in the first and 9.8 at 2 feet in the second) and dominated by sodium (6.0 m.e. 100 g at 18 inches in the first and 5.0 at 1 foot in the second). They were both rich in calcium and phosphorus (phosphate).

Regosols occur mainly in the Rift Valley at altitudes between 5,000 and 9,000 feet, with an annual rainfall ranging from 20 to 60 inches.

Lava boulders

Scott (1962) - Type 34

In the volcanic areas, lava boulders may be a dominant feature of the land surface, such as a continuous boulder cover as on blocky lava flows with small pockets of dark soil, to shallow soils with boulders in a matrix of dark brown to yellow-red clay loam. They occur mainly in the Rift Valley.

Shallow stony soils with rock outcrops

Scott (1962) - Type 35

"Variously developed soils which have been subjected to geological and recent accelerated erosion and have lost their original characteristics", usually associated with escarpments and hill tops and well represented in the Loita hills on the Nguruman and Siria escarpments and in the southern part of the Rift Valley towards Magadi.

Alluvium, recent lacustrine deposits

Scott (1962) - Type 30

Including old and present day sediments deposited in river flood plains, such as the Uaso Ngyiro swamp to the north of lake Natron, and lake deposits of geologically recent origin, including peaty swamps which are subjected to a seasonal permanent water table, such as those which occur around the shores of lakes Naivasha, Elmenteita and Nakuru.

A C K N O W L E D G E M E N T S

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BIBLIOGRAPHY

ANDERSON, G.D. (1963). Some weakly developed soils of the eastern Serengeti plains, Tanganyika. Afr.Soils, 8, 339-47.

ANDERSON, G.D. and TALBOT, L.M. (1965). Soil factors affecting the distribution of the grassland types and their utilisation by wild animals on the Serengeti plains, Tanganyika. J.Ecol., 53, 33-56.

BELLIS, E. (1963). Remarks on analysis sheet. MS.

BUTLER, R.K. (1959). Atlas of Kenya. Nairobi: Survey of Kenya.

KERFOOT, O. (1963). Report on investigation of the soils of the Serengeti plains. East African Agriculture & Forestry Research Organisation. Departmental Report.

MELICH, A., BELLIS, E. and GITAU, J.K. (1963). Fertilizing and liming in relation to soil chemical properties. Scott Laboratories, Department of Agriculture, Kenya, Departmental Report.

MILNE, G. (1939). A report on a journey to parts of the West Indies and the United States for the study of soils. East African Agricultural Research Station, Amani, Tanganyika Territory.

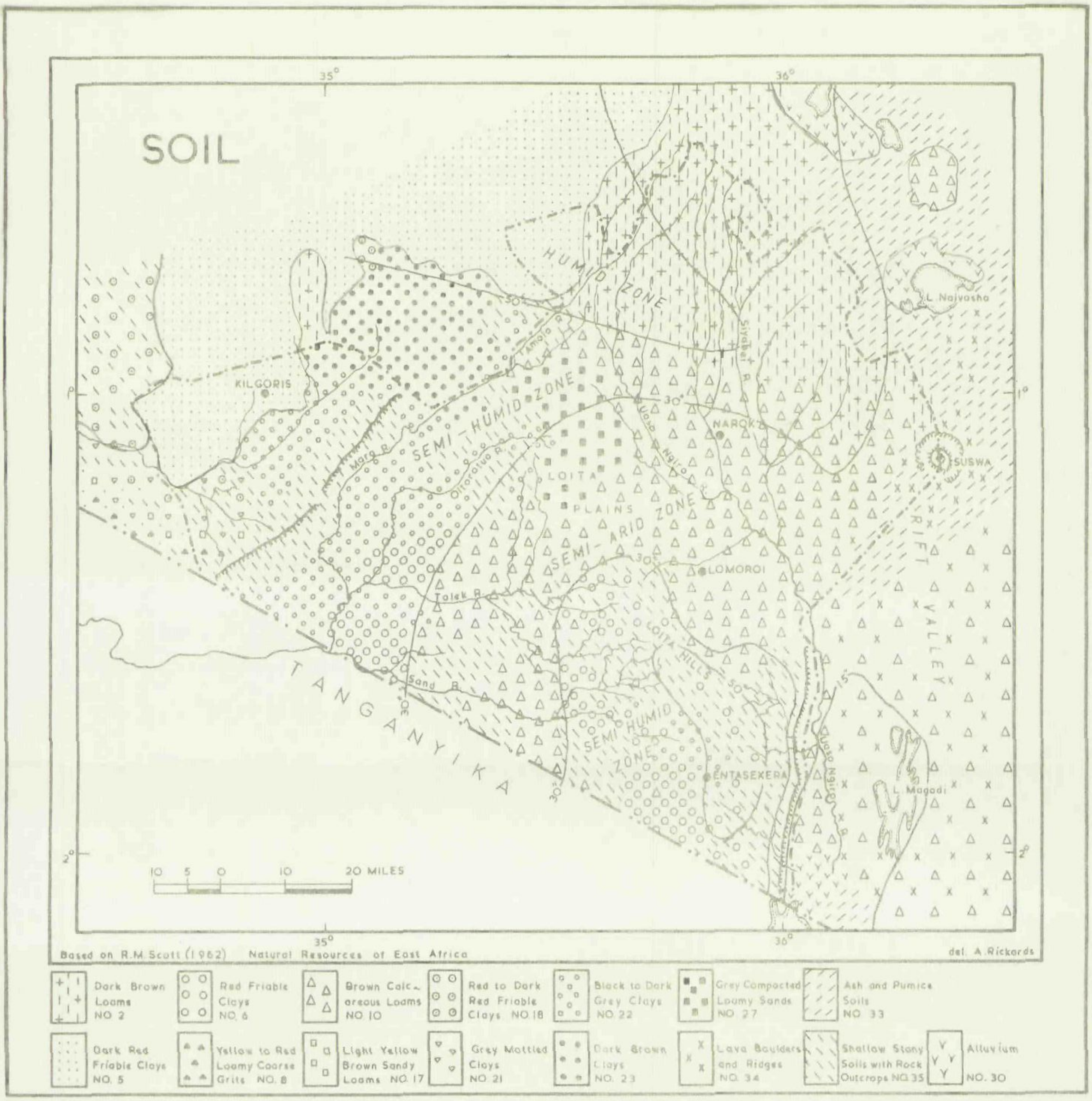
-do- (1947). A soil reconnaissance journey through parts of Tanganyika Territory, December 1935 to February 1936. J.Ecol., 35.

RUSSELL, E.J. (1952). Soil conditions and plant growth. London: Longmans Green.

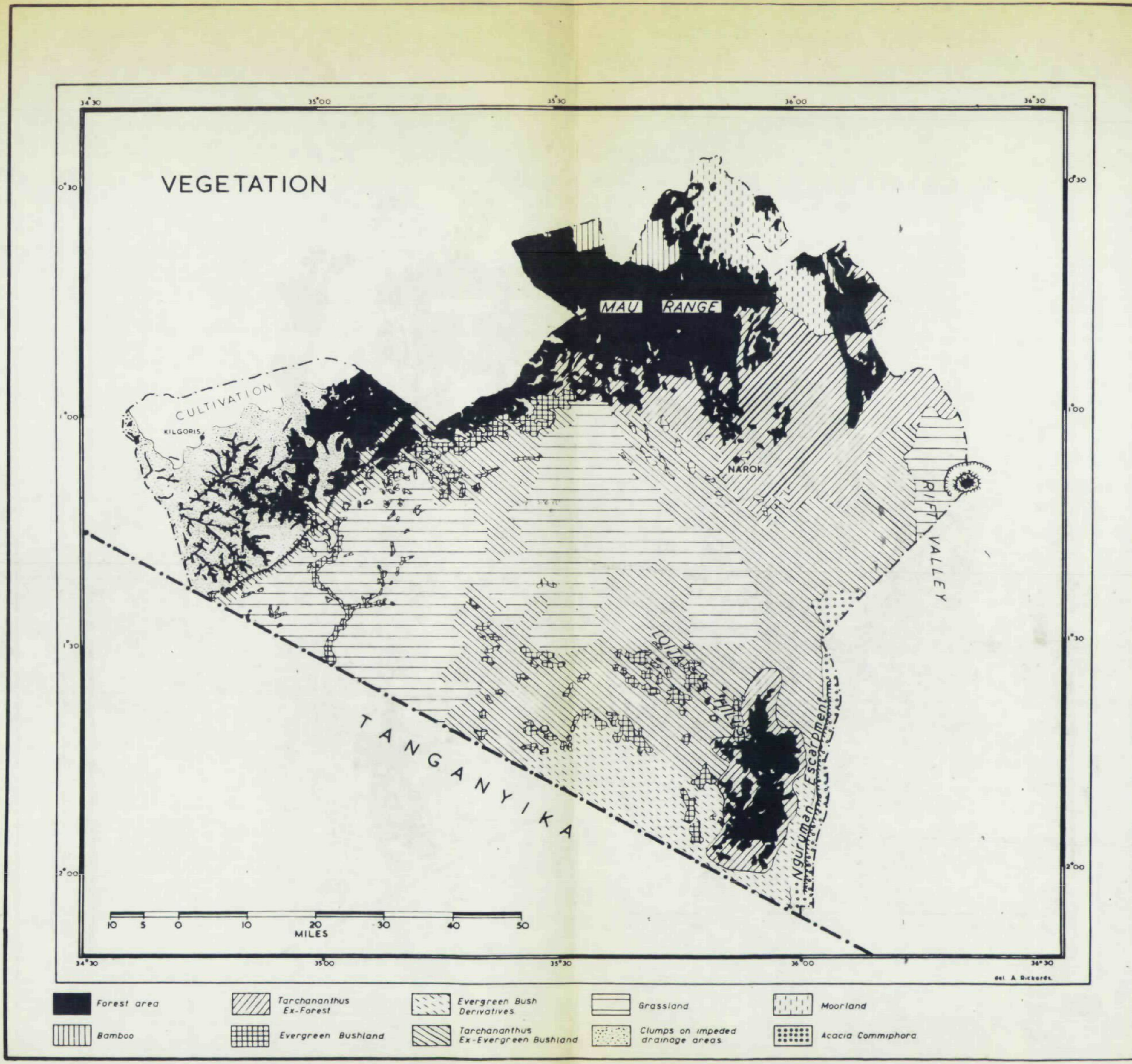
-do- (1962). The natural resources of East Africa. Nairobi. D.A.Hawkins in association with the East African Literature Bureau.

SCOTT, R.M. (1962). The soils of East Africa. In The Natural Resources of East Africa. Nairobi. D.A.Hawkins in association with the East African Literature Bureau.

VAGELER, P. (1933). An introduction to tropical soils. Macmillan & Co.Limited, London.



SOIL
KILGORIS
HUMID ZONE
SEMI-HUMID ZONE
SEMI-ARID ZONE
LOITA PLAINS
LOITA HILLS
NAROK
LOMOROI
ENTASEKERA
SUSWA
L. Naivasha
L. Magadi
RIFT VALLEY
TANGANYIKA
Mara R.
Amala R.
Siyabei R.
Uaso Ngiro
Oloraitua R.
Talek R.
Sand R.
35°
36°
1°
2°
10 5 0 10 20 MILES
Based on R.M. Scott (1962) Natural Resources of East Africa
del. A. Rickards
Dark Brown Loams NO. 2
Red Friable Clays NO. 6
Brown Calcareous Loams NO. 10
Red to Dark Red Friable Clays NO. 18
Black to Dark Grey Clays NO. 22
Grey Compacted Loamy Sands NO. 27
Ash and Pumice Soils NO. 33
Dark Red Friable Clays NO. 5
Yellow to Red Loamy Coarse Grits NO. 8
Light Yellow Brown Sandy Loams NO. 17
Grey Mottled Clays NO. 21
Dark Brown Clays NO. 23
Lava Boulders and Ridges NO. 34
Shallow Stony Soils with Rock Outcrops NO. 35
Alluvium NO. 30


VEGETATION
MAU RANGE
CULTIVATION
KILGORIS
NAROK
RIFT VALLEY
LOITA HILLS
Nguruman Escarpment
TANGANYIKA
MILES
10 5 0 10 20 30 40 50
34°30
35°00
35°30
36°00
36°30
0°30
1°00
1°30
2°00
del. A. Rickards.
Forest area
Tarchananthus Ex-Forest
Evergreen Bush Derivatives
Grassland
Moorland
Bamboo
Evergreen Bushland
Tarchananthus Ex-Evergreen Bushland
Clumps on impeded drainage areas
Acacia Commiphora

ANALYTICAL METHODS

The constituents determined were organic carbon and organic matter; organic nitrogen; coarse sand (2 - 0.2 mm); fine sand (0.2 - 0.02 mm); silt (0.02 - 0.002 mm) and clay (10.002 mm); the pH of a 1:5 soil:water suspension and the exchangeable sodium and potassium, extracted by neutral normal ammonium acetate. A few analyses done at the Scott Laboratories included calcium, magnesium, phosphorus and biological tests.

Organic matter (C)

1. The carbon figure % C W-Black does not take into account elemental carbon (i.e.charcoal), so that the carbon content given is only really the organic carbon.

2. C/N is the ratio of carbon nitrogen in the soil.

Both carbon and nitrogen are expressed as total percentages.

Sodium (Na) - These values are expressed as milli-equivalents per 100 grammes:

less than	0.2 m.e. 100 g is	low
	0.4 " " " " "	normal
	2.0 " " " " "	high alkaline
	50-80 " " " "	very high saline

Potassium (K) - Expressed as milli-equivalents per 100 grammes:

2.0 m.e. 100 g	- typical of Kenya soils
4.0 " " " "	- normal
14+ " " " "	- very high saline-alkaline

Where a surface soil has less than K 0.5 m.e. 100 g, it is deficient in potassium but even if the K content is higher than 0.5 m.e. 100 g, if the Ca/Mg ratio is less than 1:2.5, the soil is deficient in K.

If the K/Ca ratio is less than 1:8, K is deficient.

<u>Calcium (Ca)</u> - Expressed as milli-equivalents per 100 grammes.

If the Ca content is less than 5.0 m.e. 100 g, it is deficient.

More than 20 m.e. 100 g is excessive.

Ratios of Ca/Mg larger than 4:1 represent an excessive Ca situation.

<u>Magnesium (Mg)</u> - Expressed as m.e. 100 g.

Deficient < 1.0 m.e.
Excessive > 3

<u>Manganese (Mn)</u> - Expressed as m.e. 100 g

Deficient < 0.1 (not recorded so far in Kenya soils)
> 2 may be toxic in acid soil

<u>Phosphorus (P)</u> - Expressed in parts per million - p.p.m.

Deficient 0 - 20 p.p.m.
Excessive > 80 p.p.m.

<u>Nitrogen (N)</u> - Expressed as a weight percentage of the total nitrogen in the soil % n.

Not all N is available for immediate plant use, i.e. this represents the total reservoir of soil nitrogen.

Hydrogen Ion Potential (pH) -

values of	6.0 or less	-	acid
	7.0	-	neutral
	7.5 - 8.5	-	moderately basic
	8.5 +	-	alkaline

Biological Tests :- (Cunninghamella) per cent of plus all

	Deficient	Sufficient	High
Nitrogen N	0 - 20	20 - 60	60
Phosphate P	0 - 50	50 - 100	100
Sulphur S	0 - 60	60 - 100	100

This is a guide - there can be no hard and fast rules for such a complex system as soil.

Biological tests are especially tricky and the N is most unreliable. Acid soils tend to give too high a figure for N.

For S ----> $\leq$ 60, means merely that there is a possibility that S is deficient.

SOIL ANALYSES

HUMID ZONE

(Analyised by M.T.Friend, East African Agriculture and Forestry Organisation)

DARK BROWN LOAMS Scott (1962) - Type 2

Locality and Vegetation type	Sample No.	Depth in inches	% C W-Black uncorrected	% N	C/N	% Organic matter	% Coarse sand	% Fine sand	% Silt	% Clay	pH	K m.e. 100g	Na m.e. 100g
Forest 18 miles from	88	0-3	13.48	1.285	14.0	27.0	4.3	37.3	17.9	13.5	7.2	4.50	0.39
Olokurto on the way	89	3-6	6.40	0.680	12.5	12.8	7.9	35.1	28.8	15.4	7.5	3.35	0.14
to Elburgon.	90	12-16	2.48	0.235	14.0	5.0	8.5	22.1	31.9	32.5	7.5	3.80	0.19
Podocarpus dominant -	91	24-27	0.96	0.130	9.8	1.9	9.0	20.8	22.2	46.1	7.4	6.45	0.14
Altitude 9,600 ft.	Carbon content and N high in top soil. K content high, especially at depth												
Olenguruone area	96	0-4	5.35	0.595	12.0	10.7	9.6	33.5	37.4	8.8	6.2	1.75	0.14
about 30 miles from	97	4-8	3.46	0.395	11.6	6.9	4.8	36.6	38.7	13.0	6.2	1.30	0.10
Olokurto in bamboo	98	24-28	1.23	0.160	10.2	2.5	7.2	20.8	23.8	45.7	5.8	2.00	0.10
thicket above a small	99	45-49	0.42	0.065	8.6	0.8	9.1	19.8	25.0	45.3	6.0	2.10	0.10
stream -													
Altitude ± 7,900 ft.	Carbon content and N lower than in true forest; pH also lower												
Olenguruone area.	105	0-3	3.30	0.240	18.3	6.6	9.9	40.6	17.0	25.9	5.5	1.05	0.10
Open grassy slope on	106	3-7	3.57	0.265	17.9	7.1	12.7	37.7	18.8	23.7	5.4	0.75	0.10
the Masai side of the	107	10-14	1.68	0.170	13.2	3.4	15.8	24.4	23.1	33.3	5.6	0.60	0.10
Amala river. *Digitaria*,	108	22-25	0.49	0.065	10.0	1.0	15.2	21.2	26.2	36.4	6.0	0.67	0.10
Microchloa, *Eragrostis* -	109	43-47	0.16	0.035	6.1	0.3	8.2	14.4	15.8	61.3	6.1	1.12	0.24
Altitude ± 8,600 ft.	Carbon content, N and pH lower than in the true forest												

Cont.....

HUMID ZONE

DARK BROWN LOAMS Cont....

Locality and Vegetation type	Sample No.	Depth in inches	% C W-Black uncorrected	% N	C/N	% Organic matter	% Coarse sand	% Fine sand	% Silt	% Clay	pH	K m.e. 100g	Na m.e. 100g
Oloropil near Mau	129	0-3	8.44	0.745	15.0	16.9	13.3	32.3	17.8	19.7	6.8	2.65	0.15
Narok in Olea, Dombeya,	130	6-10	3.94	0.335	15.6	7.9	18.6	30.2	30.5	12.8	6.8	2.20	0.10
Lasiosiphon forest -	131	22-25	2.02	0.155	17.3	4.0	9.7	25.5	28.4	32.4	5.9	1.60	0.15
Altitude 9,500 ft.	pH decreasing with depth												
Doboti, N.E.Mau near	132	0-3	6.45	0.720	11.9	12.9	4.1	43.4	17.7	21.9	5.5	1.95	0.15
Mau Narok, in bamboo	133	12-16	4.22	0.510	11.0	8.4	5.7	37.6	26.5	21.8	5.5	1.95	0.20
thicket -	134	26-30	2.98	0.340	11.6	6.0	7.0	29.9	42.9	14.2	6.0	1.95	0.10
Altitude 9,800 ft.	pH lower than in the true forest												
Melelo in the S.W. Mau,													
about 15 miles N. of	146	0-3	1.82	0.195	12.4	3.6	10.1	26.5	34.5	25.3	6.3	0.75	0.15
Ololunga. Truncated													
soil in open grassy glade -	147	12-15	0.50	0.065	10.2	1.0	17.6	25.8	23.0	32.6	6.7	1.65	0.40
Themeda, Microchloa,													
Sporobolus, etc. -	Truncated - carbon content and N low in the top soil												
Altitude 7,200 ft.													
Melelo - inside a	148	0-4	12.64	1.140	14.8	25.3	4.5	57.5	1.5	11.2	6.7	1.90	0.45
Trichocladus thicket	149	5-8	2.46	0.270	12.1	4.9	9.1	31.7	33.2	21.1	6.2	0.90	0.25
on raised ground -	150	20-23	0.61	0.075	10.8	1.2	13.9	22.9	22.8	39.2	5.8	1.65	0.50
Altitude 7,200 ft.	Carbon content and N high in the top soil similar to the true forest												

Cont....

SUB-HUMID ZONE

DARK RED FRIABLE CLAYS   Scott (1962) - Type 5

Locality and Vegetation type	Sample No.	Depth in inches	% C W-Black uncorrected	% N	C/N	% Organic matter	% Coarse sand	% Fine sand	% Silt	% Clay	pH	K m.e. 100g	Na m.e. 100g
Endama, trans-Mara, about 4½ miles towards	157	0-3	7.26	0.660	14.6	14.5	45.4	27.3	4.4	8.4	8.0	1.60	0.33
Kilgoris from Migore bridge. Forest:	158	7-10	1.38	0.140	13.1	2.8	55.3	22.3	9.4	10.2	8.3	1.10	0.13
Warburgia, Cassine, Diospyros.	159	16-22	0.65	0.065	13.3	1.2	58.1	17.2	11.1	12.4	8.1	1.90	0.15
Altitude 5,400 ft.	pH high, particularly as K is not high and Na is low. Carbon and N contents fairly high.												
Olosendo, trans-Mara, about 1½ miles from	151	0-4	4.40	0.395	14.8	8.8	45.9	25.2	9.8	10.3	6.9	1.55	0.20
Migore bridge towards Kilgoris, base of a	152	12-15	0.77	0.080	12.8	1.5	60.2	21.6	9.6	7.1	6.5	1.10	0.13
thicket clump Olea and Euclea -	153	33-36	0.40	0.055	9.7	1.8	57.1	15.9	7.5	18.7	6.9	0.83	0.13
Altitude 5,118 ft.	Carbon content and N in top soil higher than in the grasslands.												
Endama, trans-Mara, about 4½ miles from	153A	0-3	1.70	0.130	17.4	3.4	56.1	18.3	9.9	12.3	6.0	0.40	0.10
Migore bridge. Grassland between thickets, Themeda,	154	3-6	1.48	0.115	17.1	3.0	46.6	28.9	8.2	13.3	5.6	0.35	0.13
Pennisetum, Clandestinum -	156	7-10	1.60	0.115	18.5	3.2	50.0	25.5	8.0	13.3	5.7	0.35	0.10
Altitude 5,400 ft.	Carbon content and N low												

Cont....

SUB-HUMID ZONE

DARK RED FRIABLE CLAYS Cont...

Locality and Vegetation type	Sample No.	Depth in inches	% C W-Black uncorrected	% N	C/N	% Organic matter	% Coarse sand	% Fine sand	% Silt	% Clay	pH	K m.e. 100g	Na m.e. 100g
Trans-Mara Plateau, 10 miles from Lolgorien towards Mara bridge.	30	0-3	1.35	0.130	13.8	2.7	18.3	31.6	21.2	26.2	6.2	0.80	0.52
Grassland between thicket	31	12-15	0.85	0.085	13.3	1.7	17.0	31.1	18.9	31.3	6.3	0.45	0.74
clumps. *Hyparrhenia*,	32	20-23	0.31	0.065	6.3	0.6	14.7	33.2	20.0	31.5	6.4	0.65	0.64
Themeda, etc.	33	32-36	0.32	0.045	9.4	0.6	27.4	29.1	25.5	17.4	6.7	1.75	1.19
Altitude ± 6,600 ft.	Carbon content and N low												

RED FRIABLE CLAYS Scott (1962) - Type 6

Locality and Vegetation type	Sample No.	Depth in inches	% C W-Black uncorrected	% N	C/N	% Organic matter	% Coarse sand	% Fine sand	% Silt	% Clay	pH	K m.e. 100g	Na m.e. 100g
Entasekera in the Loita hills. Riverine	162	0-3	7.04	0.680	13.8	14.1	32.3	29.2	3.0	21.4	7.8	1.75	0.30
bushland, *Rhus*, *Lippia*,	163	12-15	1.37	0.140	13.0	2.7	31.8	20.1	9.8	35.6	7.5	1.55	0.20
etc. -	164	24-27	1.27	0.110	15.3	2.5	28.8	18.6	8.0	42.1	6.8	1.65	0.33
Altitude 6,400 ft.	Carbon content and pH high in the top soil												
Moricho Loita, near Entasekera in the	165	0-3	1.76	0.195	12.0	3.5	29.2	21.0	7.3	39.0	7.0	1.15	0.52
Loita hills.	166	12-15	0.91	0.105	11.5	1.8	22.2	20.6	9.2	46.2	7.7	0.83	2.13
Grassland, *Themeda*,	167	30.35	0.95	0.085	14.9	1.9	22.0	22.9	6.9	46.3	8.7	0.75	3.75
Eragrostis, Kikuyu. Altitude 7,300 ft.	Carbon content low in top soil. pH neutral, becoming basic with depth in contrast to profile above; heavily overgrazed and truncated; salinity increases with depth.												

Cont....

SUB-HUMID ZONE

RED FRIABLE CLAYS Cont....

Locality and Vegetation type	Sample No.	Depth in inches	% C W-Black uncorrected	% N	C/N	% Organic matter	% Coarse sand	% Fine sand	% Silt	% Clay	pH	K m.e. 100g	Na m.e. 100g
Olodungoro near													
Entasekera in the Loita	171	0-3	5.10	0.500	13.6	10.2	29.8	29.4	2.0	28.6	6.8	3.20	0.40
hills. Forest:	172	12-15	2.38	0.225	14.1	4.8	29.0	19.9	5.9	40.4	6.6	1.37	0.25
Podocarpus, _Juniperus_,	173	32-34	1.70	0.105	22.5	3.4	24.8	19.5	5.1	47.2	6.5	0.90	0.25
Warburgia, _Olea_.													
Altitude 7,300 ft.	Similar to profile 162 - 164 above												
Matei near Entasekera													
in the Loita hills.	168	0-3	1.60	0.165	12.9	3.2	36.1	22.4	15.5	22.8	7.5	2.00	0.25
Grassland on a hill slope.	169	12-15	0.76	0.95	10.6	1.5	29.10	22.7	13.2	33.6	6.9	1.37	0.25
Themeda, _Eragrostis_,	170	24-27	0.46	0.070	8.8	0.9	24.6	24.9	13.8	35.8	7.1	2.20	0.30
Andropogon, etc.	Similar to profile 165-167 but not as basic in the subsoil. Heavily grazed and truncated.												
Altitude 7,300 ft.													

SEMI-ARID ZONE

BROWN TO DARK BROWN CALCAREOUS LOAMS Scott (1962) - Type 10

Locality and Vegetation type	Sample No.	Depth in inches	% C W-Black uncorrected	% N	C/N	% Organic matter	% Coarse sand	% Fine sand	% Silt	% Clay	pH	K m.e. 100g	Na m.e. 100g
Loita plains about 3													
miles S. of Gorengore.	46	0-3	1.20	0.130	12.2	2.4	5.7	32.7	28.4	30.8	7.5	3.70	1.19
Grassland, _Microchloa_,													
Sporobolus, _Cynodon_,	47-49	7-28	1.04	0.115	12.0	2.1	11.4	28.2	29.2	29.1	7.7	3.90	2.89
ecium.													
Altitude 6,200 ft.	Truncated soil with a compacted surface												

Cont....

SEMI-ARID ZONE

BROWN TO DARK BROWN CALCAREOUS LOAMS Cont...

Locality and Vegetation type	Sample No.	Depth in inches	% C W-Black uncorrected	% N	C/N	% Organic matter	% Coarse sand	% Fine sand	% Silt	% Clay	pH	K m.e. 100g	Na m.e. 100g
Loita plains - Olengeri about 4 miles S.E. of Gorengore. Pennisetum schimperi, Themeda, etc. Zone of a termite pattern. Altitude 6,200 ft.	79	0-3	2.37	0.210	15.0	4.7	3.4	36.9	33.7	21.3	6.7	1.90	0.29
	80	12-16	0.93	0.095	13.0	1.9	4.3	37.0	26.4	30.4	6.2	3.00	0.19
	81	27-30	0.26	0.045	7.7	0.5	4.5	29.7	50.6	14.7	6.9	4.30	3.24
	The grass was grazed short and the surface of the soil compacted but the carbon content is higher in the top soil than in 46 above. The K and Na contents increase with depth.												
Loita plains - Olengeri as above. In the Harpachne short grass zone of a termite pattern	85	0-3	1.70	0.175	12.9	3.4	3.2	41.6	27.5	24.5	6.4	2.30	0.10
	86	10-15	1.08	0.105	13.7	2.1	5.4	29.4	24.9	38.2	6.4	1.93	0.44
	87	24-27	0.27	0.060	6.0	0.5	4.1	54.9	25.7	14.8	7.2	3.52	1.87
	The surface of this soil was compacted, the carbon content in the top layer is low and the K and Na contents increase with depth, as does the pH.												
Loita plains - Olengeri as above. In the middle of a termite pattern with termite activity. Clumps of Justicia elliotii.	82	0-4	1.89	0.200	12.6	3.8	5.7	32.4	25.0	33.1	7.1	3.85	4.34
	83	15-19	1.37	0.145	12.5	2.7	3.6	34.0	26.3	33.4	7.2	2.55	1.69
	84	35-39	0.89	0.110	10.8	1.8	3.2	35.1	26.8	33.1	7.2	2.36	0.74
	The middle zones of this profile were riddled with termite holes and termite gardens and there is a marked decrease in Na in the lower zones												

Cont.....

SEMI-ARID ZONE

BROWN TO DARK BROWN CALCAREOUS LOAMS Cont....

Locality and Vegetation type	Sample No.	Depth in inches	% C W-Black uncorrected	% N	C/N	% Organic matter	% Coarse sand	% Fine sand	% Silt	% Clay	pH	K m.e. 100g	Na m.e. 100g
Rotian about 7 miles	139	0-4	2.03	0.180	15.0	4.0	6.3	32.8	27.5	29.4	6.3	1.30	0.15
N. of Narok in grassland	140	16-20	1.46	1.115	16.9	2.9	8.5	32.1	29.0	27.5	6.3	0.37	0.70
on eroded ground -	141	39-42	0.82	0.095	11.5	1.6	6.9	28.9	24.9	37.7	6.9	5.50	5.02
Altitude 6,800 ft.	142	45-50	0.36	0.051	9.4	0.7	7.9	37.6	27.6	26.2	8.4	4.60	4.20

Although this was in a severely eroded area, the carbon content of the top soil is higher than would be expected; the pH, K and Na contents all increase with depth.

SOILS WITH IMPEDED DRAINAGE

BLACK TO DARK GREY CLAYS ("Black cotton soils") Scott (1962) - Type 22

Locality and Vegetation type	Sample No.	Depth in inches	% C W-Black uncorrected	% N	C/N	% Organic matter	% Coarse sand	% Fine sand	% Silt	% Clay	pH	K m.e. 100g	Na m.e. 100g
Ololomei plains	37	0-3	3.13	0.225	18.5	6.3	14.9	36.0	26.8	16.0	6.8	2.90	0.69
between Aitong and	38	5-9	1.46	0.150	12.9	2.9	5.7	25.7	11.3	54.4	7.5	5.65	3.74
Mara river on phonolite	39	14-20	0.91	0.115	10.5	1.8	3.4	27.1	26.9	40.8	8.7	6.25	6.59
Themeda grassland -	40	24-28	0.49	0.070	9.3	1.0	4.4	29.9	37.9	26.8	8.9	6.65	7.74
Altitude ± 5,500 ft.													

There is a sudden rise in the clay content at a depth of 5-9 inches and then a decrease with depth. The pH, K and Na contents rise steadily until high levels are reached at depth.

Locality and Vegetation type	Sample No.	Depth in inches	% C W-Black uncorrected	% N	C/N	% Organic matter	% Coarse sand	% Fine sand	% Silt	% Clay	pH	K m.e. 100g	Na m.e. 100g
Musiara between	41	0-3½	2.92	0.245	15.8	5.8	27.7	31.1	1.89	16.5	6.3	1.95	0.39
Talek and Mara	42	3½-6½	2.23	0.200	14.8	4.5	24.2	23.8	9.0	38.5	6.7	2.30	1.24
rivers in *Acacia*	43	6½-10	1.62	0.140	15.3	3.2	12.7	25.9	0.4	57.8	7.2	2.80	2.14
drepanolobium	44	13-17	1.60	0.135	15.7	3.2	14.5	24.7	3.8	53.8	7.7	2.80	2.19
community		22-25½	0.46	0.080	9.2	0.9	26.6	20.1	10.7	41.7	8.5	3.10	3.34

This soil is similar to the one above but the K and Na values do not rise so high

Cont.....

REGOSOLS AND LITHOSOLS

ASH AND PUMICE SOILS

Locality and Vegetation type	Sample No.	Depth in inches	Texture	Colour	% C	% N	P p.p.m.	Mn m.e. 100g	Mg m.e. 100g	Ca m.e. 100g	pH	K m.e. 100g	Na m.e. 100g
Suswa - N. foot in Sporobolus grassland - Altitude 5,200 ft.	7A	0-3	Loamy fine sand with pumice.	Brown	0.62	0.05	18	0.2	0.8	2.4	6.9	2.5	0.3
	B	18-21		Yellow Brown	0.36	0.03	31	0.2	1.0	5.4	10.3	4.1	6.0
	C	36-39	Pumice grits	Brown Yellow	0.09	0.01	30	0.2	1.2	9.0	9.6	4.7	5.0
	D	48-51	Pumice	Light grey	0.16	0.01	2	0.01	1.4	33.6	10.0	2.0	3.6
	Top soil low in carbon content, subsoil lightly alkaline and dominated by sodium. The underlying pumice is strongly calcareous												
Suswa - N. outer rim of the caldera in grassland - Cynodon, Harpachne, Aristida - Altitude 6,000 ft.	11A	0-3	Loamy fine sand	Brown	0.68	0.07	17	0.3	1.3	6.1	6.0	3.0	1.3
	B	12-15	Pumice - gravelly	Brown Yellow	0.07	0.02	33	0.2	1.6	6.7	9.6	5.3	5.0
	C	24-27	Loamy fine pumice	Yellow Brown	0.06	0.01	17	0.03	2.0	18.0	9.8	3.1	4.0
	D	30-33	Gravel	Yellow	0.09	0.01	14	0.02	1.2	20.0	9.7	3.8	9.6
	Similar to the profile above but solid lava was struck at 30 in. and the calcium content is high in the top soil.												

Cont....

SHALLOW STONY SOILS Scott (1962) - Type 35

Localty and Vegetation type	Sample No.	Depth in inches	% C W-Black uncorrected	% N	C/N	% Organic matter	% Coarse sand	% Fine sand	% Silt	% Clay	pH	K m.e. 100g	Na m.e. 100g
itong hillside in cacia nilotica, rchonanthus, mbretum bushed rassland - Eragrostis porobolus, Cynodon - ltitude 5,700 ft.	54	0-4	4.00	0.370	14.3	8.0	33.6	30.4	15.3	12.7	6.7	2.30	0.30
	Greyish friable with no subsoil, only quartzite stone and gravel												
itong hillside in roton, Sansevieria, acia brevispica hicket.	55	0-3	5.08	0.545	12.3	10.2	20.7	30.8	25.5	12.8	7.2	2.35	0.29
	Dark grey and friable - no subsoil, only quartzitic stone and gravel												
ara river area near he old iron bridge n Croton, Euclea, lea, Grewia thicket - ltitude ± 5,200 ft.	56	0-4	7.75	0.720	14.3	15.5	10.1	36.1	9.7	28.6	7.5	3.60	0.64
	Dark grey, light in texture and friable, the carbon content K and pH are higher than in the two previous soils												
ara river area near he old iron bridge in hemeda, Bothriochloa, agrostis wooded rassland - about 3 arge Cassine trees to he acre - ltitude ± 5,200 ft.	57	0-4	2.56	0.240	14.2	5.1	17.7	34.6	17.7	24.9	7.0	2.95	0.34
	Light grey, truncated - surface soil compacted, overlying lava												

Cont....

SHALLOW STONY SOILS Cont.....

Locality and Vegetation type	Sample No.	Depth in inches	% C W-Black uncorrected	% N	C/N	% Organic matter	% Coarse sand	% Fine sand	% Silt	% Clay	pH	K m.e. 100g	Na m.e. 100g
Oldebesi Lemoko, 45 miles N. of Aitong in the Kapkimulwa hills in bracken, <u>Tarchonanthus</u> and burnt <u>Juniperus</u> scrub - Altitude 6,800 ft.	58	0-4	3.02	0.250	16.1	6.0	20.3	32.7	15.9	25.1	6.2	1.10	0.09
	Dark reddish-grey, loamy and friable. Taken from the top of a quartzitic hill												
Ngerendei near Mara river between Aitong and Kipleleo - associated with <u>Schrebera</u>, <u>Obetia</u>, <u>Chloris gayana</u> - Altitude 5,400 ft.	22	0-4	9.78	0.930	14.0	19.6	8.5	41.5	21.4	9.0	8.1	4.85	0.54
	Stony volcanic hillside; no subsoil; carbon content and pH higher than any of those above												

(Analysed by E.Bellis, Scott Agricultural Laboratories, Kenya Department of Agriculture)

SOME MORE DETAILED CHEMICAL ANALYSES

(Collected by L.E.D.Wateridge, Kenya Veterinary Department)

Locality and Vegetation type	Sample No.	Texture	Colour	Depth in inches	% C W-Black	% N	P p.p.m.	Mn m.e. 100g	Mg m.e. 100g	Ca m.e. 100g	pH	K m.e. 100g	Na m.e. 100g
	5958	Coarse granular loam	Very dark grey brown	0-4	3.74	0.38	214	0.9	4.4	19.2	7.0	2.0	0.1
Kibosek, Trans-Mara area in grassland occupied by <u>Euclea</u>, <u>Cassine</u>, <u>Olea</u>, etc. forest 15 years previously. (Dark brown clays, Type No.23 - Scott 1962)	5959	Weathered rock fragments & quartz gravel		4-8	1.31	0.15	90	1.8	2.8	13.3	6.9	1.5	0.1
	5960	Granular loam	Very dark grey	8-12	-	-	92	1.4	3.5	21.2	7.0	1.4	0.1
	5961	Hard coarse granular clay	Dark brown	12-24	-	-	23	0.5	3.0	10.4	6.3	2.8	0.1
	5962	Weathered ash mixed with clay	Very dark grey and strong brown	24-42	-	-	21	0.8	5.1	6.3	6.7	2.5	0.1
	5963	Variegated red strong brown and very pale brown	Weathering ash	42-51	-	-	40	0.7	4.4	12.9			0.1
	5964		Soft weathering ash with sanadine crystals	51-113	-	-	53	0.7	3.8	7.8	7.5	1.0	0.5

Cont.....

SOME MORE DETAILED

CHEMICAL ANALYSES (Cont.)

Locality and Vegetation type	Sample No.	Texture	Colour	Depth in inches	% C W-Black	% N	P p.p.m.	Mn m.e. 100g	Mg m.e. 100g	Ca m.e. 100g	pH	K m.e. 100g	Na m.e. 100g
.ibosek, Trans-Mara .rea (Cont..)	This is a shallow, dark-coloured, truncated former forest soil which has been buried by an 8 inch deposit of hill wash or alluvial material. It has a high manganex content with a few mangiferous weathered rock fragments in the 8-12 inch sample. The calcium content is very high, particularly in the upper layers. The lower layers are composed of weathering volcanic ash. Water seeped into the pit when the depth of 113 inches was reached.												
At the foot of a hill .n Cis-Mara area 300 .ards west of the .itong cross roads; in grassland. (Black, .ark grey clays - Type No.22(Scott 1962))	5965	Hard coarse sandy loam	Dark grey brown	0-3	1.17	0.10	40	0.9	3.4	5.6	6.2	1.5	0.4
	5966	Very hard sandy clay loam	Grey brown	3-6	0.58	0.07	46	0.8	3.0	9.6	7.2	2.0	2.0
	5967	-do-	-do-	6-10	0.50	0.06	55	0.8	3.3	12.9	7.4	2.3	1.7
	A truncated soil from the footslopes of the hill affected by sodium in the subsoil; there is also an increase in the pH and calcium content with depth												
Same area as above but from the top of the hill; in grassland. (Shallow stony soil - Type No.35 (Scott 1962))	5968	Friable loam with occasional quartz grits	Dark grey	0-4	2.63	0.24	250	1.2	3.6	17.7	6.3	1.5	0.3
	5969			4-7	2.28	0.22	250	1.1	3.6	20.0	6.2	1.4	0.1
	A shallow, slightly acidic soil underlain by quartzitic rock embedded with flakes of mica; the phosphate and calcium contents are high. A good example of Type 35 (Scott 1962)												

Cont.....

SOME MORE DETAILED

CHEMICAL ANALYSES (Cont.)

Locality and Vegetation type	Sample No.	Texture	Colour	Depth in inches	% C W-Black	% N	P p.p.m.	Mn m.e. 100g	Mg m.e. 100g	Ca m.e. 100g	pH	K m.e. 100g	Na m.e. 100g
..	5990	Friable granular loam	Very dark grey	0-5	2.13	0.18	66	1.0	3.0	10.8	6.0	2.0	0.1
Aitong hill, southern foot, in the plains about 100 yards from the base of the hill in grassland.	5991	Moderately hard sub-angular blocky plastic loam	Very dark grey brown	5-9	1.81	0.16	40	0.8	3.1	12.2	6.0	1.9	0.3
	A truncated plains soil showing some similar characteristics to the Kibosek profile above; also derived from Euclea, Olea, Cassine bushland - but a long time ago. It is therefore more truncated and has a lower carbon content in the top soil.												
Oltorotua river, south-east of Aitong hill; grassland on river banks. (Black to dark grey clays - Type No.22 (Scott 1962))	5980	Granular moderately plastic loam	Dark grey	0-3	1.72	0.17	23	0.7	3.2	11.8	2.0	0.5	6.5
	5982	Coarse granular slightly plastic loam	Very dark grey brown	12-15	-	-	19	0.9	3.1	12.0	1.9	0.2	6.6
	5985	Sub-angular blocky sandy clay loam	Yellow brown	27-35	-	-	12	0.8	3.5	6.6	1.4	0.9	5.8

SOME MORE DETAILED

CHEMICAL ANALYSIS (Contd.)

Locality and Vegetation type	Sample No.	Texture	Colour	Depth in inches	% C W-Black	% N	P p.p.m.	Mn m.e. 100g	Mg m.e. 100g	Ca m.e. 100g	pH	K m.e. 100g	Na m.e. 100g
Oltorotua river (contd. from overleaf)	5987	Moderately hard sub-angular plastic loam	Yellowish Brown	40-54	-	-	23	1.0	2.8	9.0	6.5	1.7	0.6

A slightly acidic dark coloured soil of a river terrace; there is a slight rise in acidity at the depth of 27-35 inches; similar to profile 5999-5991 taken from the plains at the S. foot of Aitong hill and to 5958-5964 taken at Kibosek; also originally derived from Euclea, Olea, etc. bushland.

SOME MORE DETAILED

CHEMICAL ANALYSES (Cont..)

Locality and Vegetation type	Sample No.	Texture	Colour	Depth in inches	% C W-Black	% N	P p.p.m.	Mn m.e. 100g	Mg m.e. 100g	Ca m.e. 100g	K	Na m.e. 100g	pH m.e. 100g
Mara River near Tsetse Control camp; on the E. bank in grass-land. (Black to Dark grey clays - Type 22 (Scott 1962))	5970	Friable granular loam	Dark grey brown	0-7	1.17	0.11	44	1.0	3.8	14.2	2.0	0.1	7.3
	5971	Hard fine sub angular blacky plastic loam	Brown	7-14	0.53	0.06	23	0.8	4.4	9.2	2.0	0.8	6.8
	5972	Friable fine sub-angular blocky slightly plastic sandy loam	Yellowish brown	14-24	-	-	23	0.9	3.6	7.8	2.3	1.1	6.8
	5973	Very friable fine sub-angular blocky loam	Yellowish brown	24-28	-	-	23	0.8	3.1	6.6	2.4	1.2	7.0
	5974	Very fine granular loamy sand	Yellowish brown	28-36	-	-	30	1.0	2.8	7.2	2.5	1.6	7.2
	5975	As above - calcareous nodules present	As above	36-54	-	-	32	0.9	3.5	15.4	2.7	2.2	8.1
	5976	Slightly calcareous sand with some mica	Dark brown	54-59	-	-	34	1.0	3.3	13.3	2.4	2.2	8.2

SOME MORE DETAILED

CHEMICAL ANALYSES (Cont...)

Locality and Vegetation type	Sample No.	Texture	Colour	Depth in inches	% C W-Black	% N	P p.p.m.	Mn m.e. 100g	Mg m.e. 100g	Ca m.e. 100g	K	Na m.e. 100g	pH m.e. 100g
Mara River near Tsetse Control camp; on the E. bank in grass- land. (Black to Dark grey clays - Type 22 (Scott 1962))	5977	Fine, subangular blocky, slightly calcareous sand	Yellow brown	59-65	-	-	32	1.1	3.1	11.3	2.2	2.4	8.1
	5978	Weak fine sub- angular blocky, slightly calcareous loamy sand	Pale brown	65-80	-	-	40	1.1	3.0	16.0	2.2	3.1	8.2
	5979	Fine, subangular blocky loam with calcareous concretions	Brown	80-84	-	-	40	0.9	3.1	15.0	1.9	3.8	8.2

A moderately deep truncated soil, lower layers derived from gneiss; mangiferous sand present between 28-36 inches. Covered in riverine forest 12 years previously

Cont.....

(Analysed by E.Bellis, Scott Agricultural Laboratories, Kenya Agricultural Department)

NAROK SALT LICK

(Samples collected by L.E.D. Wateridge, Kenya Veterinary Department)

Locality and Vegetation type	Sample No.	Texture	Colour	Depth in inches	C% milli mohs	Na %	P p.p.m.	Mn m.e. 100g	Mg m.e. 100g	Ca m.e. 100g	K m.e. 100g	Na m.e. 100g	pH
	5992	Structureless sand	Grey brown	0-16	-	-	63	0.4	0.4	3.8	4.5	3.0	9.2
Salt lick	5993	-do-	Olive grey	16-28	0.77	0.04	60	0.1	0.2	0.8	2.9	2.0	9.3
in eroded area in the	5994	Weak, fine granular loamy sand	Very pale brown	28-42	7.23	2.69	42	0.5	0.2	0.6	5.6	4.6	10.5
middle of Narok	5995	-do-	Pale brown	42-48	1.11	0.66	34	0.6	0.4	1.4	3.8	3.9	9.6
Township	5996	-do-	Yellowish brown	48-67	2.78	0.83	40	0.5	0.6	0.6	5.1	5.1	10.1
	5997	Subangular blocky, breaking to fine granular loamy sand with calcareous weathered ash grits	-do-	67-75	9.04	3.39	46	0.3	0.7	5.6	5.1	6.7	10.4
	5998	Lumps of calcareous weathered tuff	Pale yellow	75-81	4.31	2.20	62	0.3	0.8	4.4	5.2	6.1	10.0

Cont...

NAROK SALT LICK (Cont..)

Locality and Vegetation type	Sample No.	Texture	Colour	Depth in inches	C % milli mohs	Na %	P p.p.m.	Mn m.e. 100g	Mg m.e. 100g	Ca m.e. 100g	K m.e. 100g	Na m.e. 100g	pH
Salt lick in eroded area in the middle of Narok Township	5999	Slightly calcareous weathered tuff	Pale yellow	81-108	8.62	5.67	68	0.4	0.9	6.6	4.9	6.0	10.4
	6000	-do-	-do-	108-144	6.53	3.00	76	0.4	0.8	1.4	4.7	6.1	10.4

BIOLOGICAL TEST (CUNNINGHAMELLA) % OF PLUS ALL

	Depth in inches	
N	21	This soil is deficient in available
P	59	phosphorus, nitrogen and sulphur
S	59	

Three samples from Masai salt licks in the Narok area, tested at Muguga by M.T.Friend, had an electrical conductivity of only about 0.3 and therefore could not be regarded as being very saline. These soils were, however, very alkaline as their pH values were 10, 8.5 and 9.4. This alkalinity is usually the result of exchangeable sodium and these soils may be classified as non-saline alkaline soils.

N.B: A non-saline alkalini soil is one that contains sufficient exchangeable sodium to interfere with the growth of most plants and does not contain appreciable quantities of soluble salts. The exchangeable sodium percentage is greater than 15 and the electrical conductivity of the saturation extract is less than 4 millimohs per centimetre (at 25°C). The pH reading of the saturated soil parts is usually greater than 8.5

BIOLOGICAL TESTS

(Cunninghamella) per cent of plus all

LOCALITY	Sample No.	Depth in inches	N	P	S
Kilgoris	7448	0-3	52	63	93

pH 6.1 - a medium acid soil well supplied with basic nutrients, phosphate and biologically available nitrogen.

Kibosek,	5958	0-4	31	-	88
Trans-Mara	5959	4-8	31	-	92
"Half mile strip"	5960	8-12	14	41	72

pH 7.0 - a neutral soil deficient in biologically available nitrogen and phosphate at a depth of 8 inches

LOCALITY	Sample No.	Depth in inches	N	P	S
Aitong Area, base of a small hill	5965	0-3	38	67	67
	5966	3-6	19	78	100
	5967	6-10	31	75	97

pH 6.2 - 7.4 - a soil affected with sodium from a depth of 3 inches downwards; deficient in biologically available nitrogen, phosphate and sulphur; probably not very suitable for normal plant growth.

Aitong Area, top of a small hill, shallow skeletal soil	5968	0-4	32	88	64
	5969	4-7	29	74	81

pH 6.3 - slightly acid; too shallow to be of any agricultural importance

LOCALITY	Sample No.	Depth in inches	N	P	S
Mara River, on the N.E. bank near the Tsetse Camp	5970	0-7	44	57	65
	5971	7-14	53	74	74

pH 7.3 - 8.2 - decreasing slightly and then increasing; deficient in the surface horizon in biologically available phosphate and sulphur. A moderately deep soil, 84 inches

Oltorotua River, banks S.E. of Aitong hill	5980	0-3	10	52	70
	5981	3-12	10	59	73

pH 6.5 - decreasing to 5.8 at a depth of 27-35 inches, then increasing again to 6.5 at 40-54 inches; deficient in biologically available nitrogen and phosphate

LOCALITY	Sample No.	Depth in inches	N	P	S
Aitong Hill, southern slope	5988	0-5	19	72	62
	5989	5-12	24	81	67

pH 6.1 - a slightly acid and shallow skeletal soil, deficient in biologically available nitrogen and phosphate

Aitong Plains, near the southern foot of the hill	5990	0-5	24	81	62
	5991	5-9	19	72	72

pH 6.0 - an acid soil deficient in biologically available nitrogen and sulphur

Narok Township, salt lick	5992	0-16	21	59	59

pH 9.2 - increasing to 10.4 at a depth of 67 inches; a recent saline/alkaline sand bed overlying bedded volcanic ash; deficient in biologically available nitrogen, phosphate and sulphur

LOCALITY	Sample No.	Depth in inches	N	P	S
Mount Suswa,		0-3	11	29	88
northern foot		18	31	27	100
at 5,200 feet		36	26	26	97
		48	6	21	93

pH 6.9 - in the surface horizon, increasing to 10.0 at a depth of 4 feet; there is a deficiency of biologically available nitrogen in the surface horizon and of phosphate throughout.

Mount Suswa,	4487	0-3	10	19	84
northern rim	4488	12	18	36	107
of the caldera	4489	24	28	12	75
at 6,000 feet	4490	30	16	29	84

pH 6.0 - in the surface horizon rising to 9.7 at $2\frac{1}{2}$ feet; deficient in biologically available nitrogen. According to Bellis (1964) "these should be intractible soils supporting a specialised alkali-tolerant vegetation". This statement is true only in the fact that *Sporobolus spicatus*, which is a saline indicator, occurs where the first profile was dug at the foot of mount Suswa. The other plants present were normal constituents of grassland.