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MINISTRY OF NATURAL RESOURCES
GEOLOGICAL SURVEY OF KENYA

GEOLOGY OF THE ELDORET AREA

DEGREE SHEET 34, N.W. QUARTER
(with coloured geological map)

by

L. D. SANDERS, B.Sc., Ph.D., F.G.S., A.M.I.M.M.
Chief Geologist

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FOREWORD

The Eldoret area is mainly agricultural in character and so far no minerals, apart from constructional materials, have been worked in it. The geological survey described in the report indicates that because of the nature of the rocks, little mineral wealth can be expected in the area. About half of it is covered by barren young lavas, which hide older rocks that might contain minerals of value. The exposed older rocks in the north-eastern part of the area are, however, of a type that indicate that only deposits of non-metallic minerals, such as garnet, kyanite and graphite, can be expected. Some deposits of such minerals are known and are described in the report.

The older rocks on the west contain traces of gold and the tin mineral cassiterite, but the occurrences are such that the occurrence of workable deposits seems unlikely.

The lava-covered part of the area has good fertile soils and the lavas contain aquifers that can be tapped by drilling. At the lava edges the water appears as springs, and in other parts of the area there are well-developed rivers. A section of the report is devoted to water-supply, and the flow of waters in the lavas is illustrated by a diagram that will be useful in planning exploration for subterranean water.

The first editing of the script of the report was carried out by Dr. E. P. Saggerson, Acting Chief Geologist, and the final editing in part by the writer, but mainly by Dr. N. J. Guest, Chief Geologist.

Nairobi.
16th November, 1960.

WILLIAM PULFREY,
Commissioner (Mines and Geology).

CONTENTS

ILLUSTRATIONS

PLATES

MAPS

ABSTRACT

This report describes an area of approximately 1,200 square miles situated in western Kenya between the townships of Eldoret and Kitale, bounded by latitudes 0° 30′ N. and 1° 00′ N. and by longitudes 35° 00′ E. and 35° 30′ E. Most of the area is agricultural country standing between altitudes of 5,500 and 8,000 feet, and produces cereals, wattle-bark, sisal, coffee, sun-flower seed and pyrethrum; stock and dairy farming are also important activities. Forest reserves occupy the highest country in the north-east.

The Uasin Gishu plateau, bounded to the north by steep escarpments overlooking the Nzoia valley, and to the west by smaller escarpments facing the Sosiani valley, is formed by sheets of phonolitic lava accompanied by basal tuffs and grits; the lavas entered the region from the south-east in great mobile floods which spread over a peneplained surface in Miocene times.

Crystalline rocks of the Basement System underlie the Uasin Gishu lavas and are also seen over the remainder of the area. The Basement System rocks are divided into two regional groups:—

(i) A series of well-differentiated superincumbent folded metamorphosed sediments of marginal geosynclinal facies occupying the elevated Cherangani region, and (ii) a granite-migmatite foundation underlying the less elevated country around Turbo; this has been subjected to syntectonic metasomatism and shearing in thrust-zones that dip eastwards beneath the superincumbent meta-sedimentary series.

In the east, Tertiary or Pleistocene faults connected with rift valley movements have displaced both lavas and metamorphic basement.

An account is given of the petrography, genesis and structure of the various rocks, and the economic prospects and water resources of the area are assessed.

GEOLOGY OF THE ELDORET AREA

I—INTRODUCTION

The area covered by this report comprises the north-west quarter of degree sheet 34 (Kenya) (Directorate of Overseas Surveys sheet No. 89), bounded by latitudes 0° 30′ N. and 1° 00′ N., and by longitudes 35° 00′ E. and 35° 30′ E. It is approximately 1,200 square miles in extent and lies astride the Uasin Gishu and Trans-Nzoia districts between Kitale at the north-western corner, and Eldoret at the southern boundary. Part of the Nandi reserve extends into the region west of Eldoret, and the eastern margin lies in the Elgeyo-Marakwet district.

Maps.—Topographical maps referring to the region are:—

1:500,000, Kitale E.A.F. No. 1717 (1946).

1:350,000, Degree Sheet, Africa $\frac{\text{North-A36}}{\text{X}}$ G.S.G.S. No. 1764 (1925).

1:250,000, Cadastral (Special) Sheet No. 1, Eldoret.

1:62,500, Cadastral Sheets $\frac{\text{North-A36}}{\text{X}}$ 1a, 1b, 1c and 1d.

1:50,000, Preliminary Plots 89/I, 89/II, 89/III and 89/IV (1958).

During the survey geological information was plotted on air-photographs taken by No. 82 Squadron of the Royal Air Force in 1950, and on 1:62,500 cadastral field-sheets. The final map is based on the appropriate cadastral sheets with minor modifications and additions derived from the air-photographs. Contours are based on the computed heights of major and secondary trigonometrical stations, bench-marks on the Kenya-Uganda railway, and barometric spot-heights.

Population and Communications.—The greater part of the region is a European farming district situated in what was formerly an unfrequented grazing area lying between the Cherangani-Elgeyo tribal areas and the Nandi border, and is margined by the Elgeyo-Marakwet reserve in the east, the Nandi reserve in the south-west, the Central and North Nyanza reserves in the west, and the Suk reserve in the north.

The principal towns, Kitale and Eldoret, are expanding municipalities. Eldoret is a principal station on the Kenya-Uganda railway some 237 miles north-west of Nairobi while Kitale is linked to the main Kenya-Uganda line by a branch railway extending northwards from Leseru. Both towns have railhead installations including sidings, godowns, and stockyards as well as the usual township trading facilities embracing banks, a post office, shops and garages. There are also schools, recreation clubs, and a hospital within the township vicinities. Smaller trading centres are situated at Hoey's Bridge and Soy on the Kitale branch railway, and at Turbo on the Kenya-Uganda railway.

There are as yet no tarmacadamized trunk roads in the district, but this part of the Uasin Gishu and Trans-Nzoia is served by a network of well maintained earth roads, important among which are the Eldoret-Turbo section of the main road from Eldoret to Uganda,* and the Eldoret-Kitale road†. Other roads extend northwards from Eldoret to Kamorin and Tambach on the Elgeyo escarpment, and also to Sergoit, Moiben, Karuna and Marakwet. There are air strips at Kitale and Eldoret.

* Part macadamized December, 1963.

† Macadamized 1963.

Climate, Vegetation and Fauna.—Although the Eldoret area lies within one degree of the equator, daily temperatures are moderate and the climate is equable throughout the year, since much of this part of Kenya stands at an altitude of more than 6,000 feet above sea-level. Rainfall reaches a maximum during the months of April, May and August, whilst December, January and February are the driest months. Some temperature and rainfall statistics are given in Table I.

TABLE I—TEMPERATURE AND RAINFALL IN THE ELDORET AREA

(*from records of the East African Meteorological Department*)

1. RAINFALL

Station	No. of years recorded up to 1957	Mean annual rainfall (in.)	Mean wettest month (in.)		Mean driest month (in.)	
Kitale	40	50·18	May	7·61	Jan.	0·85
Eldoret	9	40·29	Aug.	6·87	Feb.	1·01
Turbo	31	50·77	Aug.	8·39	Jan.	0·86
Hoey's Bridge ..	31	48·22	Aug.	7·69	Jan.	0·98
Soy	41	46·71	Aug.	8·34	Jan.	0·95
Cherangani	34	42·85	July	6·65	Jan.	0·77
Moiben	16	38·87	April	6·76	Jan.	0·64

2. TEMPERATURE (Degrees Fahrenheit)

Station	No. of years recorded up to 1957	Mean maximum	Mean minimum	Highest maximum	Lowest minimum
Kitale	5	78·3	50·5	89·2	39·5
Eldoret	10	73·9	49·4	87·0	40·0

This climatic environment induces the natural growth of a tree savannah over much of the region, but with agricultural development the bush has been progressively cleared and land placed under the plough, so that the original character of the country can only be seen outside the arable areas. It is evident from these areas, and from the accounts of the first settlers to arrive in this part of Kenya, that much of the Uasin Gishu was formerly open *veld* (grassland with isolated tree growth), whilst the low country of the Nzoia, Moiben and Sosiani valleys supported a denser thorn-bush with strips of deciduous and evergreen forest near to the watercourses.

In the north-east of the area the Cherangani hills rise steeply to heights exceeding 9,000 feet; in consequence the rainfall here is considerably higher than over the Kitale plains and Uasin Gishu plateau, so that the higher parts of the Cherangani are clothed in forest containing limited timber reserves of cedar, podo and mixed hardwoods. Bamboo thickets are abundant above about 8,700 feet.

The entire area supported a rich fauna at the opening of the present century, and the Uasin Gishu plateau afforded a natural home for eland, impala, wilderbeest, hartebeest, zebra, the smaller gazelles, reed-buck, ostrich, giraffe, cheetah, lion and buffalo, whilst the more densely vegetated areas supported baboon, monkey, leopard and rhinoceros, with elephant in the forest areas. The impressions of the late Cecil Hoey on arriving at Sergoit Rock in 1906 leaves one in no doubt concerning the former abundance of game in this part of Kenya—"Never shall I forget pitching my first camp there and seeing the thousands and thousands of game roaming over the plains between the Elgeyo forest and the Nandi border. Probably lions were more numerous in this district than most, to say nothing of elephant and the rhino, which one encountered in considerable numbers" (Hoey, 1955).*

Today the herds of game have disappeared apart from small numbers of reed-buck and a few giraffe. In the wooded valleys duiker, monkey and baboon are seen occasionally, and leopard are shot or trapped from time to time. Birds including francolin, guinea-fowl, kavirondo cranes and several varieties of duck are common.

History of development.—The first considerable influx of settlers into this region took place in 1905-1906, and cultivation of wheat and maize begain on a small-scale. The prevalence of rust in wheat caused many early crop failures until rust-resistant varieties became established as a result of researches at the Njoro experimental station near Nakuru. Difficulties of stock-rearing were numerous; East Coast fever attacked imported cattle reducing their numbers almost to nil, and lymphangitis killed many horses. Fencing was hard to maintain in a district populated by large herds of zebra, which were often stampeded by lion at night.

In 1907 a Post Office was established on Farm No. 64. A District Commissioner's Office and Police Post came into being soon afterwards, and at a meeting of settlers called by the Governor, Sir Percy Girouard, it was decided to name the site Eldoret.

Shortly before the 1914-18 war, A. C. Macdonald, Director of Agriculture, in company with Cecil Hoey, examined the country north of the Nzoia river lying between Mount Elgon and the Cherangani hills with a view to future European settlement. The area became known as the "Trans-Nzoia" and was subsequently surveyed and divided into a large number of farm plots many of which were taken up by the "Soldier Settlement Scheme" of 1918. Development in the region remained slow until the middle twenties, mainly on account of the long transport haul from railhead, but in 1926 the Uasin Gishu and Kitale sections of the Kenya-Uganda railway were opened to traffic to the considerable benefit of agriculture in the area. The main crops produced today are maize, wheat, wattle-bark, sisal, coffee, sun-flower seed and pyrethrum. Dairying and rearing of livestock for slaughter are also important activities.

II—PREVIOUS GEOLOGICAL WORK

Records of previous geological observations made in this region are few. Joseph Thomson crossed the area in November, 1883 on his way from Kamasia to Lake Victoria via Kaberas in the Nzoia valley (Loftus, 1951, pp. 60-61), and a similar route appears to have been followed by E. E. Walker, who noted that the plateau region west of the Elgeyo escarpment consisted entirely of lava, and also recorded banded garnet gneisses in the (Nzoia ?) river (Walker, 1903, p. 7). Prior (1903, p. 239) described specimens of phonolite taken from the Uasin Gishu plateau, and a few years later Muff (1908, p. 46) noted that the Elgeyo escarpment revealed a section of gneiss overlain by volcanic rocks; the volcanic rocks were subsequently shown as an upper and lower phonolite in a section by Gregory (1921, p. 108), later reproduced by Krenkel (1925, p. 237). Krenkel also published a geological map of East Africa erroneously showing the Mount Elgon volcanics as contiguous with the Uasin Gishu lavas.

*References are quoted on pp. 48 and 49.

Brief reference to the metamorphic rocks between Mount Elgon and Uasin Gishu was made by Murray-Hughes (1933, p. 2) as part of a wider discussion concerning the geological succession of Western Kenya, and both Murray-Hughes (*op. cit.*, p. 6), and Shackleton (1951, p. 371), refer to the geology of the Tambach section of the Elgeyo escarpment, close to the eastern margin of the area.

Recognition of the farming potential of the region stimulated interest in local sources of fertilizer and soil study; the area was surveyed for sources of agricultural lime by Scott (1932, p. 2), and the red earths and black or grey clays of the Uasin Gishu were described by Milne (1936, p. 21).

Bullard (1936, p. 502) made gravity measurements at Kitale and Eldoret as part of a gravity survey of East Africa.

Descriptions of the geology of adjacent areas are contained in the following Reports of the Geological Survey of Kenya—the Broderick Falls area, to the west (Gibson, 1954), the Cherangani Hills area, to the north (Miller, 1956), and the Kapsabet-Plateau area, to the south (Jennings, 1964).

Basement System rocks shown on the geological map of the Broderick Falls area are denoted permeation gneisses (*Xs''*) and migmatites (*Xg*) under the same colour. Adjacent parts of the geological map accompanying the present report are differentiated as migmatite (*Xg*), augen gneisses (*Xna*) and foliated granite or granodiorite (Ф), under appropriate colours.

Rocks shown in the Cherangani Hills area as undifferentiated Basement System (*X*) are equivalent to migmatites (*Xg*) at the northern margin of the Eldoret area. At this margin also horizons of calcareous gneiss which do not appear on the Cherangani Hills map have been drawn to the common boundary.

III—PHYSIOGRAPHY

1. Topography and Drainage

The area referred to in this report may be divided into three physiographic units developed by the combined influence of bedrock geology, Pleistocene earth-movements, and erosion. They are:—

1. The Southern Cherangani hills.
2. The Uasin Gishu plateau.
3. The Kitale plain, and the Nzoia, Sosiani and Kipkarren valleys.

The Southern Cherangani Hills.—In the north-eastern corner of the area the southern foothills of the Cherangani rise abruptly from the levels of the Nzoia and Moiben valleys to summit heights exceeding 9,000 feet. This upland region consists of several parallel ridges and deep intervening valleys of roughly north-south trend. The main hill-features are those of Chemurokoi (9,548 feet), Kuserua (9,200 feet), Kapsiliat (8,539 feet), and Kapserwa (7,543 feet) which are grouped to the south and west of the Kaisongul-Labot massif, known locally as "Flat-top", and stand at a height of about 10,370 feet near the southern margin of the Cherangani Hills area (Miller, 1956).

The Uasin Gishu Plateau.—This is the most extensive single physiographical unit in the area and is solely determined by the present limits of the Uasin Gishu phonolite lavas. The edges of the lava outcrops are deeply incised by the main rivers and their tributaries, so that prominent escarpments overlook the Nzoia valley in the north, and the Sosiani valley in the west.

In the vicinity of Eldoret the plateau is approximately 7,200 feet above sea-level; it rises progressively towards the Rift Valley at Elgeyo some twenty miles to the east of Eldoret, where at Kamorin it reaches an elevation of just over 8,000 feet. The present surface of the plateau exhibits a downward gradient directed towards the north-west, so that elevations at the north-western limits of the plateau, for instance near Hoey's Bridge, are roughly 1,000 feet less than those near Eldoret; the gradient has been brought about both by the present inclination of the irregular floor on which the lavas were deposited and by a progressive thickening of the phonolite accumulations towards their source in the Rift Valley region.

The comparatively flat profile of the plateau is interrupted at Sergoit (7,870 feet) and Karuna (7,693 feet), where inliers of Basement System gneisses and quartzites protrude through the lava flows and stand above the level of the surrounding country.

The Kitale Plain and the Nzoia, Sosiani and Kipkarren Valleys.—The part of Trans-Nzoia lying within the present area is undulating country of moderate to low relief. Kitale is situated at the north-western corner of the area at an elevation of 6,200 feet; between here and Hoey's Bridge tributaries of the Nzoia river have incised broad valleys below 6,000 feet, but the smoothly rounded interfluves stand at elevations of between 6,100 and 6,200 feet so that here there is a widespread uniformity of plain-level corresponding to that at the western base of the Uasin Gishu phonolites.

Headstreams of the Nzoia, notably the Moiben and Cherangai, follow deep strike-valleys incised in the softer metamorphic beds of the southern Cherangani hills. Directional control of the drainage pattern by the underlying rocks is conspicuous in this part of the area, but further to the west, near Kaisagat, the Nzoia begins a westerly course roughly at right-angles to the regional strike of the bedrock. In this section, extending to Hoey's Bridge and beyond, the river follows the foot of the northward-facing escarpment at the edge of the Uasin Gishu plateau, and is seldom more than two miles distant from the northern limits of the phonolite outcrop. Some seven miles to the west of Hoey's Bridge the Nzoia takes a sweep to the south, and then follows the regional strike of the metamorphic rocks in a generally south-south-easterly direction to Hemstead's Bridge, where it once again takes up a westerly course and skirts the phonolite escarpment to the west of Soysambu (6,340 feet).

The south-western part of the area is drained by the Sosiani and Kipkarren rivers. The Sosiani rises near the crest of the Elgeyo escarpment and flows westward through Eldoret to Selby Falls (Plate I (*a*), Fig. 1), where it plunges from the edge of the Uasin Gishu phonolite onto metamorphic rocks, and then follows the foot of the lava escarpment to Turbo, eventually joining the Kipkarren river near the western margin of the area. The Kipkarren river over most of its course is strongly influenced by the north-westerly grain of the Basement System rocks, and to the south-west of Turbo the river has exploited a tectonic zone in which fissile mylonites have been preferentially eroded.

Main drainage systems in the area are shown in Fig. 1.

2. Erosion Surfaces

Three erosion surfaces can be recognized in the area:—

1. The Kitale plain and Uasin Gishu sub-volcanic surface 6,100-6,800 feet.
2. The end-Cretaceous (?) surface 7,100-7,800 feet.
3. Remnants of the Lelon plateau 9,600 feet.

The Kitale Plain and Uasin Gishu Sub-Volcanic Surface.—The lowermost lavas of the Uasin Gishu plateau rest on sporadically distributed tuffaceous sediments and agglomerates which lie unconformably on a peneplained surface of metamorphic rocks.

For sections A-B, C-D see Fig 2

Fig. 1—Physiographical map of the Eldoret area.

Elevations of this extensive sub-volcanic planation can be determined with accuracy along the north-facing escarpments of the plateau where the surface is accessible in an east-west section some thirty miles in length, and in the western escarpments where the base of the lava can be traced in a north-south section from Hoey's Bridge to Eldoret. Additional data on the height of the sub-volcanic surface is available from bore-holes reaching through the plateau lavas into the metamorphic basement.

The base of the phonolite is located at an elevation of 6,200 feet at the north-western extremity of the plateau, near Hoey's Bridge, and rises southwards to nearly 6,400 feet west of Eldoret. A steeper gradient is displayed by the east-west section between Hoey's Bridge and Moiben where the surface slopes upwards towards the southern Cherangani hills and the shoulder of the Rift Valley at 28 feet per mile. The north-westward projection of this surface is concordant with the eastern sub-Elgon surface and the Kitale plain. The sub-Elgon surface rises gradually from about 5,300 feet near the Kenya-Uganda border to 5,600 feet fifteen miles further to the east; a further ten miles eastwards the extreme western limit of the Uasin Gishu phonolite stands at a base level of 5,800 feet close outside the western margin of the Eldoret area, so that the sub-Elgon and Uasin Gishu surfaces share a common peneplain having a mean westerly slope of 21.5 feet per mile (1 : 245) over a distance of approximately 65 miles.

In the northern and western escarpments of the plateau tuffaceous sediments with fossil wood, and green agglomeratic tuffs containing nephelinite fragments accompanied by pyroclastic biotite, melanite, and perovskite, are located beneath the base of the phonolite at Moiben and Selby Falls, where the deposits seldom exceed 20 feet in total thickness. Immediately outside the eastern boundary of the area, near Tambach, over 400 feet of stratified tuffaceous sediments can be seen in the face of the Elgeyo escarpment beneath phonolite (Shackleton, 1951, p. 371). The Tambach beds contain a Miocene fauna including crocodile, tortoise and possibly a rhinocerid, and like the thinner sub-volcanic sediments observed to the west, contain nephelinite derived from early Miocene eruptions. These beds were deposited in local depressions over an erosion surface which approached maturity in early Miocene times; they were soon afterwards covered by floods of phonolite from the Rift Valley region.

Shackleton (*op. cit.*, p. 379), recognized the coincidence between the Uasin Gishu surface, the eastern sub-Elgon surface, and the Kitale plain, stating that together they represented an extension of the sub-Miocene bevel having a westward tilt of approximately 1 : 230 (Trendall, 1959, p. 4). The Kitale plain had, however, been regarded by Dixey (1948, p. 26) as a separate surface residual on the Uganda or sub-Miocene peneplain. This view was supported by Gibson (1954, p. 9) who found evidence of a local change in level at the base of the Elgon volcanics, and drew attention to the considerable vertical separation of 1,900 feet between the Kitale plain and the West Suk lowlands lying at the foot of the Trans-Nzoia escarpment. The existence of the Kitale plain as a separate erosion bevel is also accepted by Pulfrey (1960, p. 7) who states that south of Kitale it is the surface on which the lavas of the Eldoret region were laid down.

The old land surface underlying the volcanic rocks north of Eldoret is irregular, and at the time of the first Miocene lava extrusions it was evidently immature, isolated residuals of the more resistant metamorphic rocks being scattered over it. The smaller hills were probably ultimately covered by successive lava floods, but as a result of subsequent erosion, they have again appeared as small inliers of gneiss standing only a few feet above the present surface of the surrounding phonolites, as can be seen in an area of several square miles between Leseru and Nel's Bridge. The larger inlier at Sergoit, standing more than 600 feet above the plateau, was possibly never covered by lava.

Original elevations on the Miocene surface, whilst conspicuous topographically, were not so important as negative irregularities, such as depressions and valleys, which served as areas of accumulation for early Miocene sedimentation and controlled the local direction of movement of the lava flows.

The end-Cretaceous Surface.—To the west of Sagotio and Chemurokoi the southern Cherangani hills present a remarkable uniformity of summit heights. For several miles to the north of Kapserwa (7,543 feet) the country is deeply incised, but crests of the hilly interfluves all stand at between 7,500 feet and 7,600 feet; this erosion surface stands about 1,000 feet higher than the sub-Miocene peneplain, it has been referred to as the end-Cretaceous surface and can be correlated with an erosion level seen in the summits of the Nandi highlands south of the Nzoia (Gibson, 1954, p. 9) and in the Kisii highlands some 100 miles further south (Shackleton, 1944, p. 13, and 1946, p. 52).

Sergoit Rock and the hills seen south of Turbo, including Kaptabei and Ndalat, are residuals of the end-Cretaceous surface; a reduction in summit elevations of the residuals from 7,870 feet at Sergoit Rock to 7,200 feet at Ndalat is an expression of the westerly inclination of the end-Cretaceous surface parallel to the lower sub-Miocene surface as shown in Fig. 2.

Remnants of the Lelon Plateau.—In the north-eastern corner of the region the highest parts of the southern Cherangani hills reach elevations of between 9,000 feet and 9,600 feet and are concordant with a high erosion surface referred to as the Lelon plateau (Miller, 1956, p. 5), which extends to the north outside the boundaries of the present area. This is the highest and oldest peneplain recognized in the southern Cherangani, although further to the north a higher plateau corresponding to the principal summits of the Cherangani massif has been recorded (*op. cit.*, p. 5).

IV—SUMMARY OF GEOLOGY

The geology of the area is determined by two rock groups the consolidations of which were separated by a vast period of earth history. They are: —

1. Metamorphic rocks of the Basement System.

2. Tertiary lavas and tuffs.

Basement System rocks forming the southern Cherangani hills consist of Pre-cambrian para-gneisses and schists of originally sedimentary origin and are accompanied by crystalline limestones and quartzites. The rocks are thrown into folds overturned towards the west so that the succession is repeated across the strike; both foliation and shear-planes dip towards the east.

In the western half of the area migmatites and granodiorites constitute a foundation to the metamorphosed sedimentary rocks seen in the north-east. The foundation is traversed by easterly dipping thrust-zones containing metasomatized mylonites. Intrusions of metadolerite and peridotite are found in the migmatite area.

Tertiary phonolite lavas entered the region from the east and south-east during the Miocene period. They obscure a large portion of the Basement System and reach their greatest thickness in the high country bordering the Rift Valley near Elgeyo. Two separate flows have been distinguished in the Uasin Gishu; the lowermost rests on tuffaceous sediments in the Sosiani valley, west of Eldoret, and also near Moiben, and extends to Turbo and Hoey's Bridge. It is overlain by a similar and less extensive flow between Sergoit and Eldoret.

Late Tertiary and Pleistocene faults connected with rift valley movements displace both Basement System and phonolites in the east and north-east part of the area.

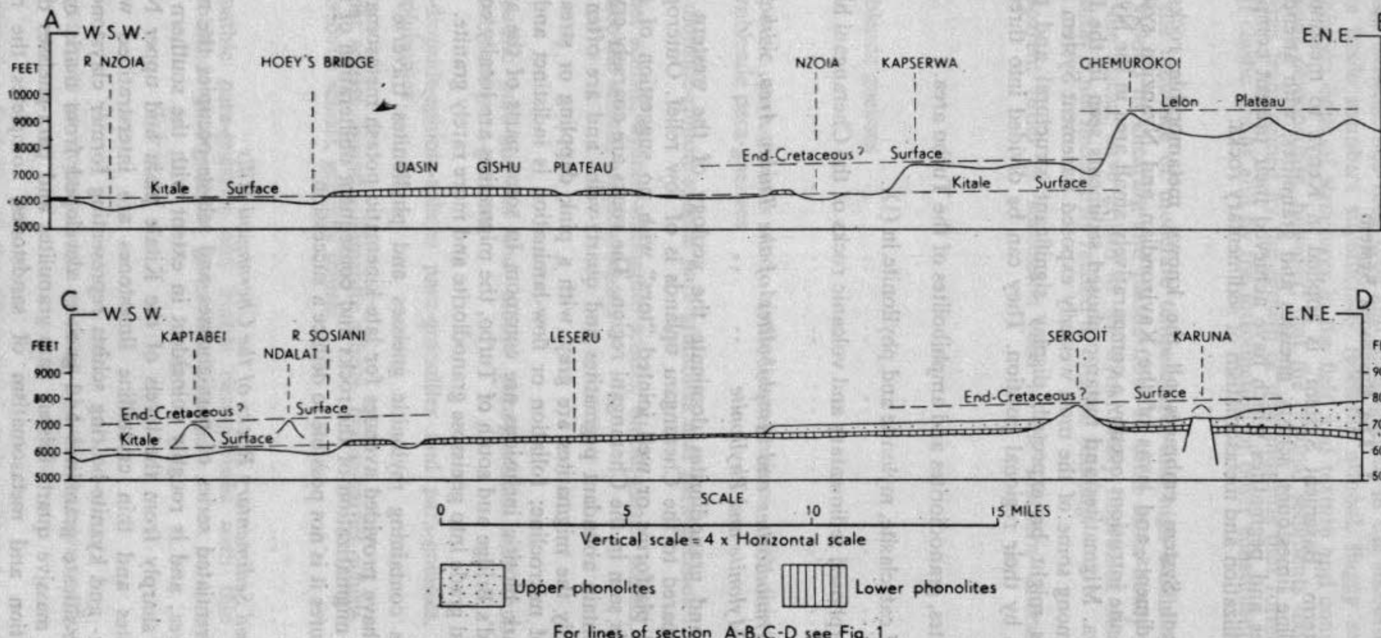


Fig. 2—Sections to show the Erosion Surfaces in the Eldoret area.

V—DETAILS OF GEOLOGY

1. The Basement System

The group term "Basement System" is applied in Kenya to metamorphic rocks including crystalline limestones, schists, gneisses and granulites, with attendant migmatites, amphibolites and pegmatites which have achieved their present composition as a result of recrystallization and metasomatism of sedimentary rocks.

The Basement System embraces all the known metamorphic rocks in Kenya excluding the sediments and lavas of the Kavirondian and Nyanzian systems, which together with granite intrusions occupy a comparatively small area in the Nyanza region of western Kenya. Migmatites and metamorphosed sediments seen in the Eldoret area are, therefore, among some of the most westerly exposed Basement System rocks in the territory, and as might be expected, display significant structural and petrographic features dictated by their regional position. They can be divided into three distinctive groups:—

(1) Migmatites, granodiorites and amphibolites of the Turbo area.

(2) Zones of cataclasite, mylonite and phyllonite in (1).

(3) Metamorphosed sedimentary and volcanic rocks of the Cherangani hills.

1. *Migmatites, Granodiorites and Amphibolites of the Turbo Area, with* 2. *Zones of Cataclasite, Mylonite and Phyllonite*

Migmatites and granodiorites dominate the geology of the western half of the area, which compared to the Cherangani uplands is of low relief. Outcrops are often smoothly eroded platforms or well jointed "tors" with no suggestion of stratification of the rocks, as is seen in the Cherangani region. The rocks are coarsely crystalline and massive; they contain abundant pegmatites and quartz-veins and are often invaded by dolerites. Typically the migmatites are grey, with a pink dappling or streaking due to concentrations of microcline; foliation or flow-lamination is indistinct and variable in direction and dark biotitic inclusions are common. In some parts of the area, notably around Hemstead's Bridge and south of Turbo, the migmatites are locally comparatively homogeneous and grade into gneissose granodiorite and more rarely granite.

Thrust-zones containing mylonitic gneisses and phyllonites traverse the granitic foundation and have provided avenues for late-kinematic potash metasomatism. Owing to the advanced migmatization of the rocks and consequent obliteration of recognizable sedimentary features it is not possible to deduce a succession.

3. *Metamorphosed Sedimentary Rocks of the Cherangani Hills*

A well-differentiated series of para-gneisses and schists occupies the north-eastern corner of the area, and is roughly coincident in extent with the southern Cherangani hills which rise sharply from the levels of the Kitale plain and upper Nzoia valley. Massive quartzites and thin crystalline limestones are interstratified with biotite-, graphite-, garnet- and kyanite-bearing schists representing former claystones or shales. Interbedded calc-silicate granulites and gneisses developed from marls or calcareous sandstones, and massive quartz-felspar para-granulites and para-gneisses derived from the recrystallization and metasomatism of sandstones, completes the metamorphic assemblage.

The rocks have a stratiform disposition, with uniform dip to the east; sharp contacts are often seen between one rock type and its neighbour in the succession, and outcrops of the more fissile members superficially resemble normal, flaggy sedimentary rocks. Closer examintion both of structures in the field and texture and composition of rocks in thin sections demonstrate, however, that the original sediments have been recrystallized and often transformed by the growth of new minerals that formed at the expense of the initial clastic grains and by the introduction of other constituents, notably potash and soda.

Under the influence of moderate temperatures and high confining pressures these rocks have yielded by shearing and plastic flow. In some cases newly formed minerals, particularly the micas, have grown in the dynamically impressed shear-planes so that their orientation is not necessarily related to original bedding.

The apparent order of succession seen in the southern Cherangani hills is as follows:—

	Approx. thickness (feet)
Biotite-hornblende gneisses	1,000– 1,200
Quartzites	200– 1,000
Quartzo-felspathic para-gneisses and biotite para-gneisses with thin biotite-hornblende para-gneisses	1,000– 3,000
Hornblende-diopside-epidote-sphene para-granulites and para-gneisses..	2,000– 3,000
Kyanite-garnet schists, kyanite-sillimanite schists, biotite-garnet schists, biotite-muscovite schists, graphite schists	300– 1,200
Quartzites	300– 600
Quartzo-felspathic para-gneisses and biotite para-gneisses with thin biotite-hornblende para-gneisses	2,400– 3,000
Hornblende-diopside-epidote-sphene para-granulites and para-gneisses, garnet-amphibolites	3,000– 4,000
Kyanite-garnet schists, kyanite-sillimanite schists, biotite-garnet schists, biotite-muscovite schists, graphite schists	300– 500
Quartzites	300– 500
Quartzo-felspathic para-gneisses and biotite para-gneisses with thin biotite-hornblende para-gneisses, garnet-amphibolites	10,000–12,000
TOTAL	20,800–30,000

The major units are repeated in a number of folds that are overturned towards the west.

The contrasting features of the Cherangani meta-sedimentary sequence and the migmatites and granodiorites of the Turbo area are summarized in Table II.

TABLE II.—CONTRASTING FEATURES OF THE METAMORPHOSED SEDIMENTS OF THE CHERANGANI HILLS AND THE MIGMATITES AND GRANODIORITES OF THE TURBO AREA

FEATURE	Cherangani Metamorphosed Sediments (Superincumbent)	Turbo Migmatites (Foundation)
TOPOGRAPHY	Ribbed topography, high relief	Flat or undulating country, low relief
	Alternating hard and soft beds that strongly influence the drainage pattern	Comparatively uniform bedrock that only weakly influences the drainage pattern
	Good exposures	Poor to moderate exposures
PETROGRAPHY	Stratiform, flaggy, well differentiated metasediments Quartzites, limestones calc-silicate para-gneisses, kyanite-graphite schists, psammitic para-granulites	Massive coarse-grained heterogeneous migmatites flow-foliated, with abundant amphibolite and biotite *schlieren* Some areas of more uniform xenolithic granodiorite and granite
	Pegmatites rare, only thin concordant veins	Pegmatites common, both cross-cutting and concordant
	Albite felspathization	Potash porphyroblastesis
	No dolerites recorded	Dolerite dykes
STRUCTURE	Major and minor folds overturned towards west	No decipherable major folds
	Regular axial-plane foliation, often concordant with bedding; dips 30°–50° E. or NE.	Foliation dips steep and variable
	Common reduction of inverted limbs in folds	Acute plastic deformation Easterly dipping thrust faults related to folding in superincumbent Cherangani series
	Thin mylonitized thrust-zones near base	

(1) MIGMATITES, GRANODIORITE AND AMPHIBOLITES OF THE TURBO AREA

In the western parts of the area Basement System rocks are best exposed in the Nzoia valley around Soysambu, in the Sergoit, Sosiani and Kipkarren valleys to the south of Turbo, and in the Kaptabei-Ndalat hills. In these regions, and over adjacent areas of many square miles, massive coarse-grained granitic bedrock is comparatively uniform in composition, and there are no meta-sedimentary layers each possessing distinct mineralogical and textural features as in the Cherangani hills.

Outcrops present a heterogeneous appearance imparted by numerous pegmatite veins and dark biotitic inclusions in a grey or pink gneiss. Examination of thin sections taken from specimens collected over a wide area tend to show, however, that the bulk composition and texture is in fact more uniform than the mixed appearance of the rocks would suggest.

On the map accompanying this report areas of comparatively homogeneous granodiorite have been differentiated from neighbouring veined granodioritic migmatites, although the differences between the two are slight and contacts are transitional.

(*a*) *Migmatites*

The migmatites consist of three components:—

(i) Grey or pink coarse, veined microcline gneiss.

(ii) Pegmatite veins, quartz lenses and stringers.

(iii) Biotite-hornblende inclusions with xenolithic to agmatitic habit.

Granodioritic gneisses constitute over 90 per cent of the migmatite areas. In hand-specimen the grey parts consist of quartz, plagioclase and biotite, and are intimately veined by a relatively coarse, pink, microcline-quartz combination, which seems to have formed by the penetration and fixation of potash throughout the fabric of the rock so that there is an ultimate tendency towards uniformity of composition.

Pegmatitic veins often parallel the weakly defined foliation of the gneisses. The pegmatite veins are knotted with large porphyroblasts of microcline-perthite and margined by thin biotite-rich selvages; some of the larger pegmatites cut across both the concordant pegmatites and the foliation of the enclosing gneiss. Quartz stringers and lenses are rare, but may be seen in some outcrops.

Dark biotitic and hornblendic inclusions varying in size from thin elongated strips or *schlieren* to large blocks measuring many feet across are conspicuous in the migmatites. These biotite-rich rocks are often seen as angular breccias representing the disrupted parts of larger biotitic or hornblendic masses, the fragments of which have been forced apart by the intervening gneiss (Plate IV, *b*). In some exposures the fragments are seen as curved plates, and in many instances they preserve an internal foliation or banding unrelated to the flow foliation of the neighbouring migmatite.

Thin sections taken from a large number of specimens collected over a wide area show that the migmatites are of monotonous composition. The texture is porphyroblastic due to the growth of albite-oligoclase or microcline porphyroblasts in a granulitized and crystalloblastic mosaic of quartz, oligoclase, and microcline. A rough foliation is often imparted by lenticular aggregates of quartz showing advanced distortion and strain, in contrast to the later formed felspar porphyroblasts. Biotite, accompanied often by accessory iron ore, apatite, sphene and/or epidote, occurs in small ragged flakes weakly orientated in the finer-grained portions of the matrix.

The dark colour of inclusions in the migmatite is related to the amount of contained biotite and to the presence of hornblende which is not commonly found in the host gneiss, apart from local areas of contamination near to inclusions. Occasionally the biotite or hornblende is accompanied by diopside, sphene, and ilmenite, so that the inclusions themselves may represent a late stage in the dissolution of calcareous sediment.

(*b*) *Granodiorites*

The granodiorites are very closely related to the granodioritic migmatites, and a distinction between the two is based on appearance in the field rather than on petrographic differences determined in the laboratory. These granodiorities do not possess the typical textures exhibited by granodiorites occurring in an undoubted intrusive setting, for instance in stocks and ring dykes in volcanic regions; thus the felspars are rarely euhedral or internally zoned, and microcline is more abundant than orthoclase.

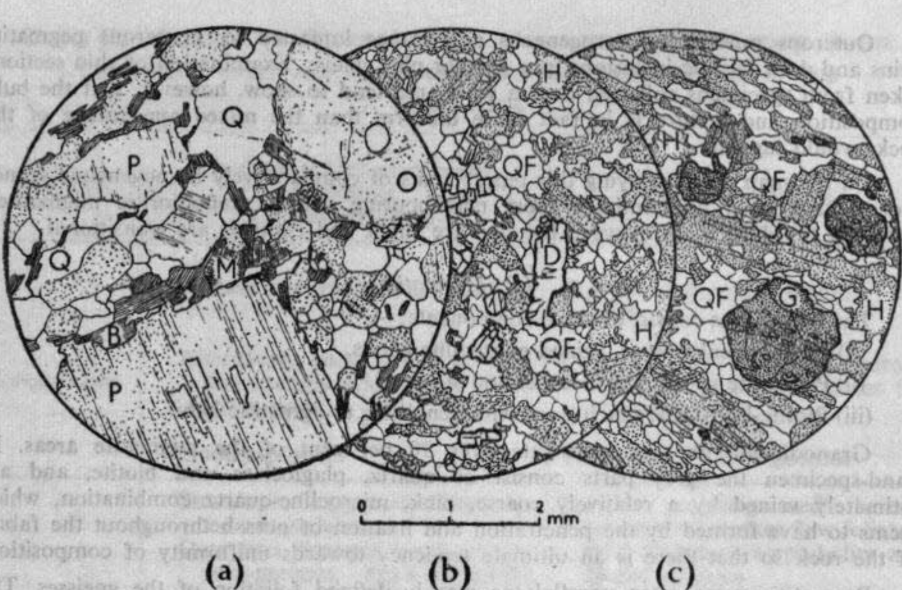


Fig. 3—Drawings of thin sections of rocks from the western part of the Eldoret area :—

(a) Granodiorite migmatite. Specimen 34/665, Sosiani river, at Turbo. Crossed nicols, × 13. Quartz (Q), Microcline (M), Orthoclase (O), Plagioclase (P).

(b) Xenolith in migmatite. Specimen 34/699, from Kipkarren Bridge. Ordinary light, × 13. Quartz and felspar (QF), Hornblende (H), Diopside (D).

(c) Garnet amphibolite. Specimen 34/672 from Ndalat. Ordinary light, × 13. Quartz and felspar (QF), Hornblende (H), Garnet (G).

The granodiorite of the Turbo area has achieved its present composition by re-crystallization and metasomatism of pre-existing materials, exemplified by the porphyroblastic growth of both potash-felspar and plagioclase in a dynamically deformed granitic medium, the granulitized relics of which have sometimes escaped complete re-crystallization. Outcrops are massive and well-jointed, and of a more uniform appearance than that of the average neighbouring granodioritic migmatite. The foliation is ill-defined or absent, and quartz crystals are sufficiently large to protrude from weathered surfaces imparting a roughened vermicular appearance to the exposures. The rocks are often dappled with pink microcline porphyroblasts, resembling the phenocrysts of a porphyritic granite or granodiorite. Xenoliths are generally small, well-rounded, and comparatively light in colour by comparison with the large dark angular inclusions seen in the adjacent migmatites.

In thin section, porphyroblasts of plagioclase are conspicuous; it is usually oligoclase with fine ablite twin lamellae often alternately saussuritized; the crystal margins sometimes contain minute inclusions of quartz or mica (as in specimens 34/637* from Soysambu, and 34/635 from two miles WNW. of Hemstead's Bridge). Occasionally the felspar achieves a subhedral crystal form, with one or two straight edges, or may show Carlsbad twinning, as in specimen 34/747 from Kaptabei.

Microcline porphyroblasts usually have irregular margins with vermicular inclusions or myrmekite, but sometimes approach a euhedral crystal form, particularly in zones of cataclasis where microcline of late growth is preferentially developed in the granulitized matrix, as in specimen 34/746 from the summit of Kaptabei.

* Numbers prefixed by 34 refer to specimens in the regional collections of the Geological Survey, Nairobi.

Quartz is found in strained crystals or as isolated inclusions in felspar, whilst flakes of biotite are often concentrated about the oval or rectangular margins of the felspar porphyroblasts and scattered in roughly orientated aggregates throughout the finer-grained groundmass.

Biotite is usually the only mafic mineral present and seldom exceeds more than five per cent of the rock; in some localities hornblende occurs in addition. It preponderates over biotite in the granite outcrops near Morton's Bridge in the south-western corner of the area. Micrometric modes and partial chemical analyses for specimens of migmatitic granodiorite and gneissose granite are given in Table III.

(c) *Amphibolites*

Most amphibolites recorded in the Turbo area are of no great size and have been variously altered and assimilated by the gneisses in which they are enclosed; it is of some interest therefore to find that the Ndalat group of hills (7,206 feet) is composed entirely of many hundreds of feet of comparatively uniform amphibolite covering an area of several square miles. Ndalat is a conspicuous feature situated some ten miles to the west of Eldoret. The hill consists of a series of ridges rising sharply from the Sosiani valley to a height of about 1,000 feet above the surrounding country (Plate II, *b*).

TABLE III.—MICROMETRIC AND PARTIAL CHEMICAL ANALYSES OF MIGMATITIC GRANODIORITES AND GNEISSOSE GRANITES

Specimen No.	1	2	3	4	5	6	7	8	9	10	Av.
	%	%	%	%	%	%	%	%	%	%	%
Quartz	41·0	30·6	32·4	38·9	28·8	35·8	38·6	31·8	29·9	28·4	33·6
Microcline	14·3	24·9	36·3	29·6	28·5	11·8	9·2	24·7	35·2	38·6	25·3
Plagioclase Ab_{75-80}	35·9	39·5	27·1	27·1	36·7	34·9	44·9	36·6	27·6	27·9	33·8
Biotite	8·2	4·6	3·9	4·2	4·4	7·0	6·6	5·6	6·4	4·2	5·5
Muscovite	0·5	0·3	0·2	0·2	0·2	0·3	0·2	0·4	0·1	0·2	0·2
Apatite	0·1	—	—	—	0·1	0·1	0·3	0·1	0·2	0·1	0·1
Chlorite	0·1	0·1	0·1	—	—	—	0·2	0·2	0·2	—	0·1
Ore	—	—	—	—	0·3	0·2	—	0·6	0·3	0·6	0·2

Specific Gravite (Mean of 5)=2·65

PARTIAL CHEMICAL ANALYSES

Specimen No.	3	5	7
	%	%	%
SiO_2	72·34	67·76	68·95
Al_2O_3	14·73	15·77	15·44
Na_2O	2·94	4·06	5·18
K_2O	5·54	4·98	1·82

Analyst: J. Furst.

1. 34/637 Migmatitic granodiorite. Soysambu, eight miles SSW. of Hoey's Bridge.
2. 34/657 Migmatitic granodiorite. Hemstead's Bridge, eight miles north of Turbo.
3. 34/663 Gneissose granite. 1,000 yards east of Turbo.
4. 34/665 Migmatitic granodiorite. Sosiani river at Turbo.
5. 34/667 Gneissose granodiorite. Arabchepuk, two miles south of Turbo.
6. 34/681 Migmatitic granodiorite. Kabiemet, nine miles south of Turbo.
7. 34/684 Migmatitic granodiorite. Kabiemet, 10 miles south of Turbo.
8. 34/710 Migmatitic granodiorite. Sosiani river, five miles south-east of Turbo.
9. 34/746 Gneissose granite. Kaptabei, five miles south of Turbo.
10. 34/747 Gneissose granite. Kaptabei, six miles south of Turbo.

Massive generally north-eastward dipping garnet-amphibolites outcrop on the steep hill slopes of Kablamulu at the north-western end of the massif, and are in contact with mylonitic gneisses and thin sheared talc-actinolite schists (specimen 34/671), at the base of the hill. Elsewhere the limit of amphibolite outcrops closely follows the boundaries of the hills, and the indicated structural pattern is of a synclinal fold plunging northwards. Specimens 34/672 (Fig. 3c) and 34/673, are typical of the hard dark green rocks seen along the easternmost ridge of Ndalat, they consist of strongly orientated hornblende prisms and pink garnet in an evenly foliated matrix of andesine and quartz, the average proportions of which are hornblende 50 per cent, garnet nine per cent, andesine 25 per cent, quartz 24 per cent, sphene and iron ore one per cent. Specimens 34/678 and 34/679 from the same locality, are similar in outward appearance, but in thin section the former is seen to contain diopside in addition to hornblende and garnet, while ziosite appears in the latter.

Throughout their outcrops the garnet amphibolites are distinctly foliated and in some exposures present a stratified appearance due to the alternation of bands of dark garnet-free amphibolite or hornblende gneiss with coarser garnetiferous amphibolite. An almost rhythmic distinction between the two clearly represents original differences in the lavas or tuffs from which the rocks were probably derived.

Thin brown anthophyllite schists (specimen 34/674), and green glistening tremolite-actinolite schists (specimen 34/676), are intercalated in the garnet amphibolites on the north-eastern ridge of Ndalat.

(2) Cataclasites, Mylonites and Phyllonites

The dominantly granodioritic rocks of the western half of the area exhibit the effects of cataclasis and crystalloblastic deformation on a regional scale. Rocks that lack textural evidence of having undergone shearing accompanied by internal distortion and rupture of their mineral constituents, followed by the metasomatic growth of felspar, are the exception rather than the rule.

The deformed rocks are classified under three headings:—

(*a*) *Cataclasites.*—Coarse-grained augen gneisses and mylonitic gneisses.

(*b*) *Mylonites.*

(*c*) *Phyllonites.*

(*a*) *Cataclasites*

(i) *Augen Gneisses*

Augen gneisses are found in deformation zones of considerable width, where they are associated with thin mylonitic sheets in which crushing and milling of the constituents have been more acute. The gneisses are well displayed in the south-western foothills of the Cherangani hills in a broad belt between Kipkoitet and Kapserwa, and are also to be seen in the Chepsera valley east of Kapserwa. They also occur in magnificent thrust-sections in the Nzoia gorge about three miles west of Hemstead's Bridge, in the Sergoit river one mile east of Turbo, near Kabiemet school, and at the north-western extremity of Ndalat.

The augen gneisses are grey rocks with thin felspathic veins and a marked foliation interrupted by lenticular or typical "eye-shaped" *augen.* The foliation is imparted by thin streaky or lenticular aggregates of strained and granulated quartz and wavy laminations of biotite. The matrix is of fine to medium grain and contains large oligoclase and microcline porphyroclasts, as in specimens 34/701 from the Sergoit valley two miles east of Turbo, 34/736, from two miles south-west of Kabiemet school, and 34/755, from two miles west of Hemstead's Bridge.

As might be expected the composition of the cataclasites is sometimes related to that of the metamorphic rocks through which thrusts and zones of deformation penetrate; for instance, specimens 34/642 and 34/764 from the Kipkoitet valley, contain trails of fractured garnet derived from the garnetiferous gneisses which have been involved in powerful thrust movements. The deformed rocks of the Turbo-Kitale foundation on the other hand do not generally appear to carry garnet porphyroclasts, but shreds of hornblende are common where the cataclasites occur in hornblendic granodioritic migmatite, for example in specimens 34/703 (Fig. 4a), from Sergoit valley one mile east of Turbo, and 34/734 from the Kaigat river six miles ESE. of Ndalat. Many of the cataclasites contain epidote granules, as in specimens 34/477 from three miles north of Moiben post office, 34/683 from 300 yards west of Kabiemet school, and 34/707 from 800 yards east of Buckley Bridge.

(ii) *Mylonitic Gneisses*

Textures of the mylonitic gneisses are intermediate between those of the coarser cataclasites and true mylonites. They are dark strongly-foliated rocks often containing strings of felspar or quartz porphyroclasts, as in specimen 34/630 from the Little Nzoia river at Ziwa, and 34/649 from the Nzoia river, two miles west of Hoey's Bridge. A delicate wavy foliation is often produced by thin lamellae of biotite and dusty iron ore, and is well shown in specimen 34/669 from the north-west corner of Ndalat.

(*b*) *Mylonites*

The mylonites are black, very hard, splintery rocks intercalated as sheets in mylonitic and augen gneisses of the major zones of differential movement (Plate V, *b*). Although they are compact or dense, and might therefore be expected to resist erosion, in point of fact their high fissility permits rapid weathering and in consequence they are often poorly exposed.

The rocks can be seen about two miles west of Ndalat in the broad valley between Kablamulu and Kaptabei; and again appear in the Sergoit river about one mile to the east of Turbo and also in the stream-section to the north of Croxford Bridge. The Nzoia gorge some three miles west of Hemstead's Bridge contains sections where the river crosses the strike of mylonites and mylonitic gneisses. Mylonites in the lower parts of the Cherangani hills succession can be seen in the Moiben valley near Kaisagat and in the Kapserwa hills one mile to the north of Kokorowa.

In thin section the mylonites are fine-grained streaky rocks rendered dark by dusty submicroscopic iron ore and mica. The matrix of minutely granulated quartz and felspar is foliated and intensely shredded into strain-polarizing aggregates enclosing larger distorted or shattered porphyroclasts which have escaped complete milling, as in specimens 34/643 (Fig. 4b), from the Kipkoitet valley, and 34/758 from three miles west of Hemstead's Bridge.

The degree of cataclastic deformation often varies in a single outcrop from normal to extreme mylonitization exemplified by thin films or sheets of glassy ultramylonite rarely more than a few inches in thickness, in which the finely-ground matrix cannot be resolved under the microscope. Even here, however, a few almost perfectly rounded porphyroclasts remain, and like the larger porphyroclasts in the less intensely deformed mylonites also indicate parent rock type. Thus in specimens 34/599 from Kokorowa, 34/715 and 34/717 (Fig. 4c), from two miles west of Ndalat, the porphyroclasts are often fragments of strained quartz-felspar aggregates similar to that of the matrix in the neighbouring mylonitic or augen gneisses. Specimen 34/611 from three miles S.S.E. of Kapserwa, is an unusual type of lineated white mylonite outcropping on the continuation of basal quartzites of the Cherangani metasedimentary rocks. In thin section it is seen to be composed entirely of strained quartz granules.

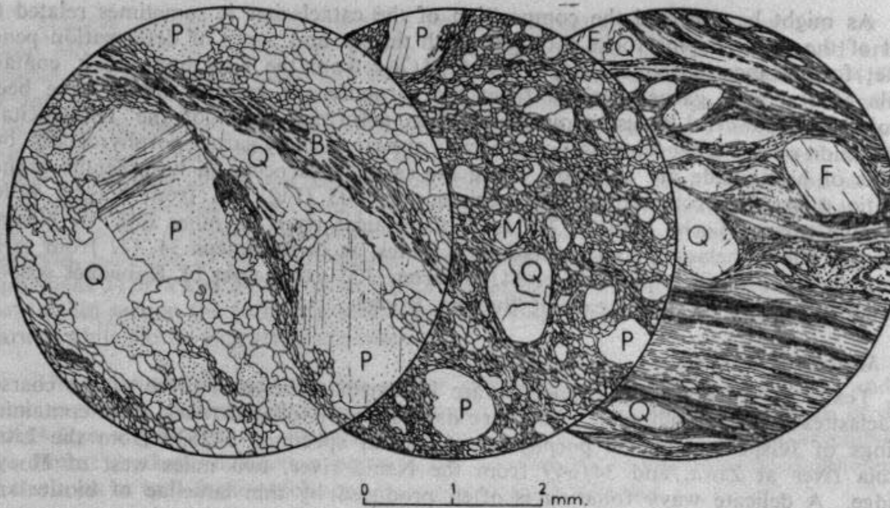


Fig. 4—Drawings of thin sections of sheared rocks from the Eldoret area :—

(a) Augen gneiss. Specimen 34/703, from one mile east of Turbo. Ordinary light, × 13. Quartz (Q), Plagioclase (P), Biotite and Hornblende (B).

(b) Mylonite. Specimen 24/643 from Kipkoitet. Crossed nicols, × 13. Quartz (Q), Microcline (M), Plagioclase (P), Sericite and iron ore in matrix.

(c) Mylonite. Specimen 34/717, from two miles west of Ndalat. Ordinary light, × 13. Quartz (Q), Felspar (F).

(c) *Phyllonites*

Fine-grained schistose rocks owing their delicately foliated texture and fissile appearance to extreme deformation are comparatively rare in the area, but were recorded in the Kipkarren valley in the south-western corner of the area, and in the Cherangani foothills.

Specimen 34/794 from 400 yards east of Russel's Bridge, is a flaggy pink rock with a closely spaced streaky, green foliation, and dappled with small dark green porphyroblasts. In thin section it is seen to be calcareous, with dark lamellae containing biotite, hornblende and green diopside. The finely granulitic and felspathic matrix contains small granules of sphene and apatite.

Specimens 34/641 from Kipkoitet and 34/601 from Kokorowa, are micaceous phyllonites with thin wavy foliations of muscovite and chlorite, both occurring in thrust-zones.

(3) Metamorphosed Sedimentary and Volcanic Rocks of the Cherangani Hills

Rocks forming the southern Cherangani hills constitute a group distinct from the monotonous migmatites and granodiorites occupying the western part of the area. The Cherangani rocks represent the metamorphic equivalents of a differentiated marine sedimentary sequence which was probably deposited on a continental shelf.

For descriptive purposes the rocks are described under the following headings:—

Metamorphosed Sedimentary Rocks

(*a*) *Calcareous Rocks*

(i) Crystalline limestones (marbles).

(ii) Wollastonite gneiss and rock.

(iii) Calcareous para-granulites, para-gneisses and amphibolites.

(iv) Skarns.

(*b*) *Pelitic Rocks*

(i) Kyanite-garnet-biotite schists.

(ii) Sillimanite-garnet-biotite schists.

(iii) Kyanite-sillimanite-biotite schists.

(iv) Garnetiferous schists.

(v) Graphite schists.

(vi) Felspar-porphyroblast gneisses.

(*c*) *Semi-pelitic Rocks*

(*d*) *Psammitic Rocks*

(i) Quartzites and muscovite quartzites.

(ii) Quartz-felspar para-granulites and para-gneisses.

Metamorphosed Volcanic Rocks

(*a*) Hornblende gneisses and amphibolites.

(*b*) Biotite-hornblende gneisses.

(*a*) *Calcareous Rocks*

Pure crystalline limestones are rare in the southern part of the Cherangani hills and they are associated with stratified granulites and gneisses containing diopside, epidote, sphene and lime-garnet, representing the metamorphosed equivalents of calcareous sandstones and marls.

(i) *Crystalline Limestones* (*Marbles*)

The best exposures of crystalline limestone are to be seen in the Moiben river at a point where it flows through a narrow gorge about four miles south of Kapsiliat summit (8,539 feet). They are coarsely crystalline pink and white rocks containing interfoliations of calc-silicate minerals, phlogopite or graphite, together with lenticular inclusions of dark green or brown finely granulitic quartz-epidote-pyroxene skarn, that often project from the smoothly weathered surfaces of the enclosing limestone.

In the Moiben river three parallel limestone outcrops, separated by hornblendic and calc-silicate gneisses, have respective widths of 20 yards, 15 yards and 50 yards, in order from west to east. The interval between bands is small, and the three units have been shown as a single band on the map. Continuations of the limestone outcrops can be traced to the north along the steep western slopes of the upper Moiben valley, where the mean strike is 185° with easterly dips varying between 50° and 65°.

Specimen 34/548 from three miles south of Kapsiliat is typical of these crystalline limestones. The specimen is a coarse pink rock composed almost entirely of calcite, together with small amounts of a pale brown pleochroic phlogopite mica and rare wollastonite.

Other outcrops of crystalline limestone can be seen near the crest of Geben ya Mayoto, four miles south of Chemurokoi summit, where the total width of limestone beds is considerably less than in the Moiben gorge. The rocks are pink in colour and interfoliated with narrow felspathic layers, a thin section of specimen 34/577 from one of these layers contains microcline, oligoclase, abundant epidote, pale green amphibole and sphene, together with a small amount of calcite.

(ii) *Wollastonite Gneiss and Rock*

Thin bands up to 1 foot in width of ash-white foliated wollastonite gneiss outcrop near the crest of Jariget, a prominent ridge situated about one mile to the east of Garamoso. In thin section (specimen 34/544), these rocks are seen to consist almost entirely of wollastonite with small amounts of interstitial calcite and a few scattered granules of sphene.

Bands and lenses of grey or pearly-coloured wollastonite rock are also found near to the contacts of the limestone of the Moiben gorge. The wollastonite is generally segregated into tough and compact, almost monomineralic, coarse granoblastic aggregates, occupying lenses adjacent to calcareous and siliceous gneisses.

(iii) *Calcareous Para-Granulites, Para-Gneisses and Amphibolites*

Gneisses, granulites and amphibolites formed by the regional metamorphism of mixed calcareous sediments constitute an important group in the southern Cherangani hills. They are well exposed in the valley and ridge country between Kapsiliat and Chebororua, and excellent sections are to be seen on the steep western slopes of Chemurokoi (9,548 feet).

The amount of contained ferromagnesian and calc-silicate minerals strongly influences the colour and outward appearance of these rocks; the felspathic varieties are pale grey, whilst others are darkened by the presence of hornblende accompanied by diopside, epidote, garnet and sphene, and grade into dense amphibolite whose sedimentary origin is only indicated by the constant development of diopside.

Massive grey medium-grained granulites and gneisses outcrop on the western slopes of both Chemurokoi and Kapsiliat, and can also be seen in the Moiben valley. The rocks have a marked granoblastic texture; quartz and oligoclase constitute more than 60 per cent of the rock and the remainder consists of pale green diopside and pleochroic hornblende, with sphene and ilmenite, as in specimen 34/476 from the Moiben loop-road, three miles south-east of the Chebororua fork. Epidote is a frequent accessory mineral in these rocks, and is sometimes abundant, as in specimen 34/473 from the Cherangai valley, which also contains diopside and scapolite to the virtual exclusion of quartz and felspar.

Gneissose calcareous rocks are more common than the granulitic varieties. In some the coloured minerals are concentrated in bands alternating with felspathic layers, as in specimen 34/533 from two miles SSW. of Chemurokoi (Fig. 5a). This rock contains green diopside together with scapolite and granules of sphene and epidote in a foliated mosaic of quartz and felspar. In specimen 34/845 from 800 yards south-west of Chemurokoi, hornblende is more abundant than diopside and is accompanied by scapolite, sphene and sodic andesine. Rocks of this type are intimately associated with similar gneisses and granulites which contain little diopside or scapolite, but whose nature is indicated by the presence of sphene and epidote, for example specimen 34/499 from the cliffs on the upper western slopes of Chemurokoi. The rock is essentially a plagioclase amphibolite containing some 60 per cent of granoblastic plagioclase. Sedimentary amphibolites of this type resemble amphibolites of igneous origin but are usually distinguishable from the latter by the presence of small amounts of green diopside and interfoliations or lenticles containing epidote or zoisite. Specimens 34/471, from the Cherangai valley, and 34/546 from Sembeywa, are typical of the calcareous amphibolites. In the former rock, hornblende is more abundant than diopside, the two minerals together constituting nearly one-half of the rock, whilst xenoblastic oligoclase-andesine and less than 10 per cent of quartz make up the remainder. Hornblende in subhedral prisms is the dominant mineral in specimen 34/546, plagioclase and quartz are rare, but the calcareous nature of the rock is revealed by scattered grains of diopside together with abundant sphene and ilmenite interstitial between the hornblende. Specimen 34/583 from the south-eastern slopes of Garamoso is a coarse plagioclase amphibolite containing abundant prisms of zoisite showing anomalous interference colours, enclosed in sodic labradorite. In this region dark hornblende gneisses of calcareous origin are delicately laminated with pale green epidote-rich bands each a few inches in thickness, which under the microscope (specimen 34/585 from the eastern slopes of Garamoso) are seen to be quartzose and finely granoblastic with abundant epidote, pale pink garnet and scattered granules of bright green diopside.

(iv) *Skarns*

Dense unfoliated dark green lenses and nodules are common in the calcareous meta-sediments. In thin section most specimens are fine-grained and granoblastic, containing deeply-coloured monoclinic pyroxene and iron-rich epidote in roughly equal proportions, accompanied by pink garnet, ilmenite, and interstitial quartz and labradorite (specimens 34/484 and 34/519 from Chemurokoi). In some rocks of this type garnet is absent, as in specimens 34/483 and 34/534 also from Chemurokoi, but in others, such as specimen 34/527, from 600 yards east of Chebororua, garnet is the dominating mineral. These rocks all contain appreciable quantities of granular iron ore in the matrix and were possibly formed from iron and lime-rich nodules enclosed in the original calcareous sands and silts.

Some visually estimated compositions for the calcareous rocks of the Cherangani hills are as follows:—

	34/473	34/499	34/533	34/546	34/585	34/519
	%	%	%	%	%	%
Quartz	3	4	30	+	46	8
Microcline ..	—	—	7	—	—	—
Plagioclase ..	4	61	28	1	—	10
Pyroxene ..	36	—	15	4	3	40
Scapolite	30	—	12	—	—	—
Hornblende ..	—	25	—	82	—	—
Epidote	17	4	4	—	45	35
Garnet	—	—	—	—	6	4
Sphene	8	2	2	7	—	—
Apatite	2	1	1	—	—	—
Ilmenite	+	3	1	6	—	3

34/473 Diopside-scapolite granulite, Cherangai valley, three miles west of Kapsiliat.

34/499 Hornblende granulite, western slopes of Chemurokoi.

34/533 Diopside gneiss, two miles SSW. of Chemurokoi.

34/546 Calcareous amphibolite, Sembeywa.

34/585 Epidosite, eastern slopes of Garamoso.

34/519 Skarn, Geben ya Mayoto.

(b) Pelitic Rocks

Dark flaggy schists and para-gneisses, derived from clay sediments, are readily weathered and suffer rapid erosion so that they tend to outcrop only where superimposed harder rocks have assisted in protecting them from rapid decomposition and subsequent removal. This is clearly illustrated in the southern Cherangani hills, where visible sections of pelitic schists are located beneath the cliffs and bluffs formed by more resistant quartzites and para-gneisses.

The best sections occur on the western slopes of Chemuroki at height of between 7,600 and 7,800 feet, the exposures extending southwards towards Geben ya Mayoto. Further exposures can be seen on the upper slopes of Garamoso, the western slopes of Sagotio and Jariget, in the valleys north of Kapserwa, and in the Moiben river.

(i) *Kyanite-Garnet-Boitite Schists*

Kyanite and garnet are the characteristic minerals of many of the biotite-rich schists. Outcrops on the hillsides are indicated by talus of dark, crumbly, deeply-weathered rock shedding abundant biotite and blue-grey plates of kyanite over the hill surfaces, The fresh unweathered schists are seen in steep rocky stream-sections where the kyanite-bearing members alternate with interstratified biotitic and garnetiferous para-gneisses.

In thin sections, specimens 34/501, 34/515 (Fig. 5b), and 34/526 from the western sides of the Chemurokoi-Geben ya Mayoto massif, and 34/541 and 34/584 from Garamoso, stumpy blades of kyanite and pale pink garnet are set in a foliated mosaic of dark brown biotite and quartz accompanied by small amounts of xenoblastic oligoclase. The kyanite is subidiomorphic and forms up to twenty per cent of the rocks.

(ii) *Sillimanite-Garnet-Biotite Schists*

Sillimanite is neither well developed nor conspicuous in the rocks forming the southern Cherangani hills; it often occurs, however, in the pelitic schists and is distinguished in outcrops by the presence of white or silken fibres in the foliation planes.

Specimen 34/536 from Geben ya Mayoto, contains minute prisms of sillimanite arranged in sheaf-like aggregates embedded in a fine-grained foliated matrix or dark brown biotite and quartz. In specimen 34/615, from two miles north-east of Kapserwa, the sillimanite occurs in slender prisms, rather than fibres, and is accompanied by garnet and biotite. In each of these examples the total amount of sillimanite does not exceed two or three per cent.

(iii) *Kyanite-Sillimanite-Biotite Schists*

Kyanite and sillimanite occur together with biotite in specimens 34/505 from Geben ya Mayoto, and 34/617 from a locality three miles north-west of Sagotio.

(iv) *Garnetiferous Schists*

The kyanite and sillimanite schists are inter-bedded with garnetiferous schists containing no visible alumino-silicates; they are generally marked by a coarser grain, and contain less biotite, but are more felspathic.

Plate I—(a) Selby Falls, six miles WNW. of Eldoret. At this point the Sosiani river plunges from the Uasin Gishu plateau phonolites onto rocks of the Basement System.

(b) The Sergoit river, seven miles east of Soy. The falls at Nel's Bridge where the river descends from phonolite to gneisses of a Basement System inlier.

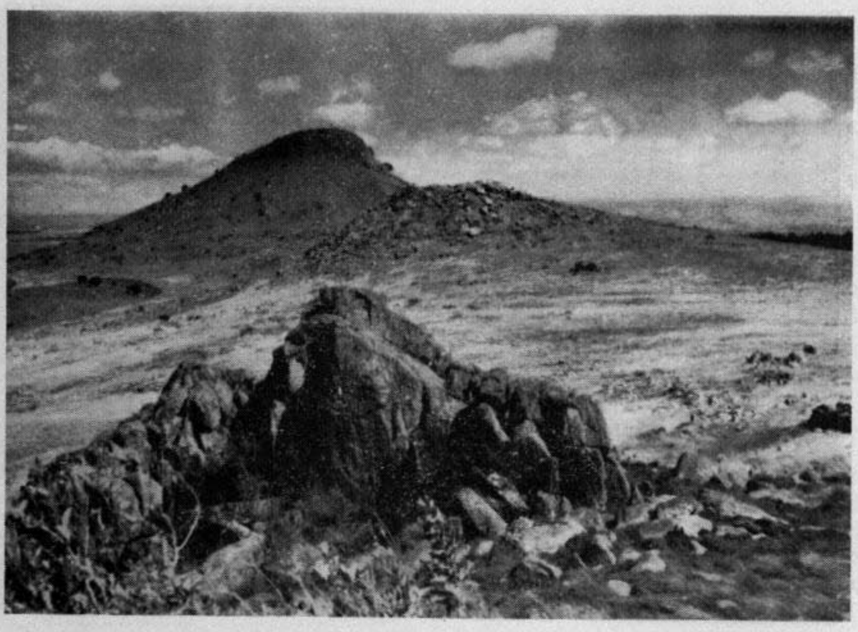
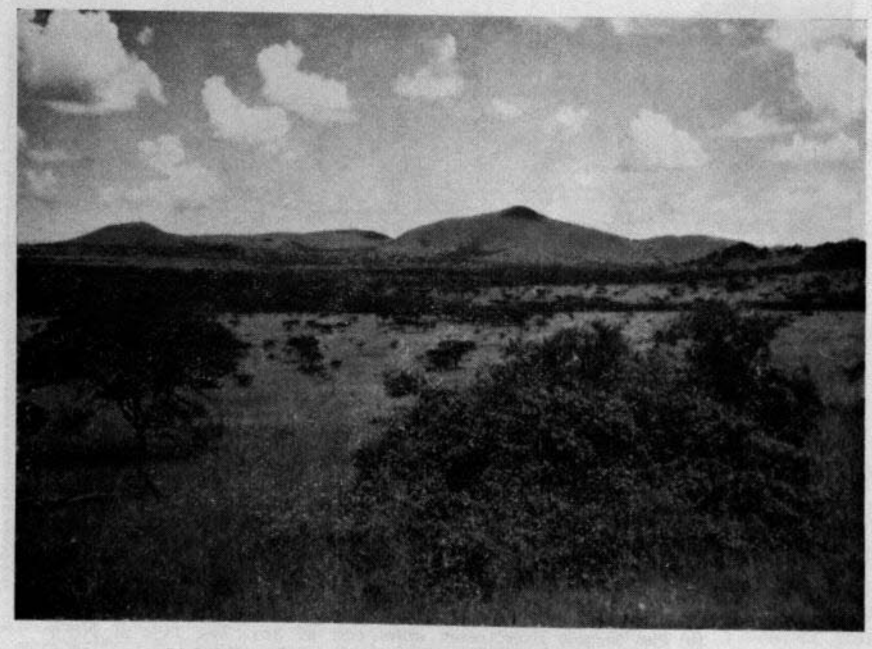


Plate II—(a) Sergoit Rock (7,870 feet), a narrow strip of Basement System gneisses surrounded by phonolite.



(b) Ndalat (7,306 feet) viewed from the east. The distant ridge, some three miles in length, is composed of amphibolite.

Plate III—(a) The southern Cherangani foothills viewed from the south-east. Garamoso (8,942 feet) in centre.

(b) The Kitale plain, looking west from Chemurokoi (9,548 feet). Flaggy, low-dipping quartzites in the right foreground. A Pleistocene fault extends from left foreground into valley in middle distance. Mt. Elgon (14,178 feet) an extinct volcano in left background, distance 60 miles.

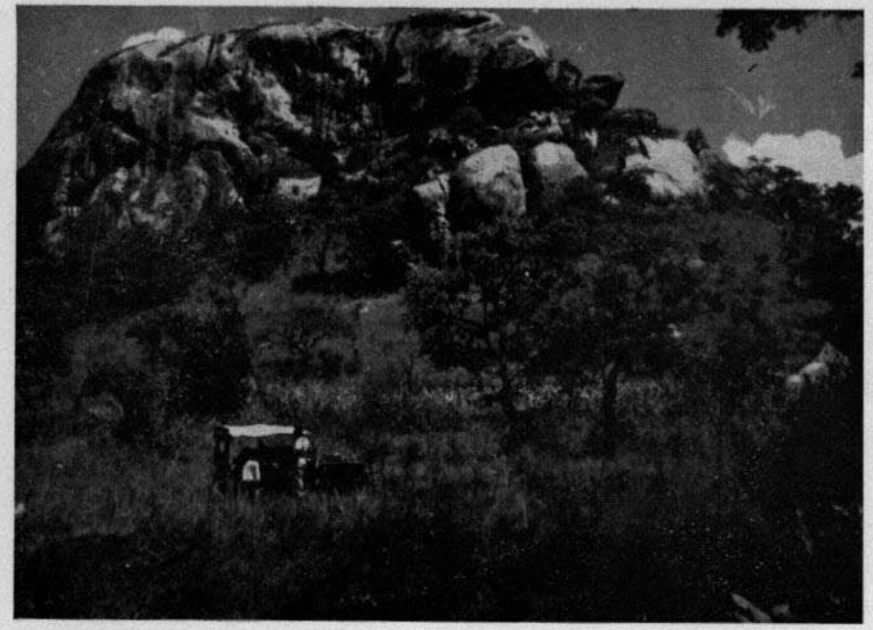
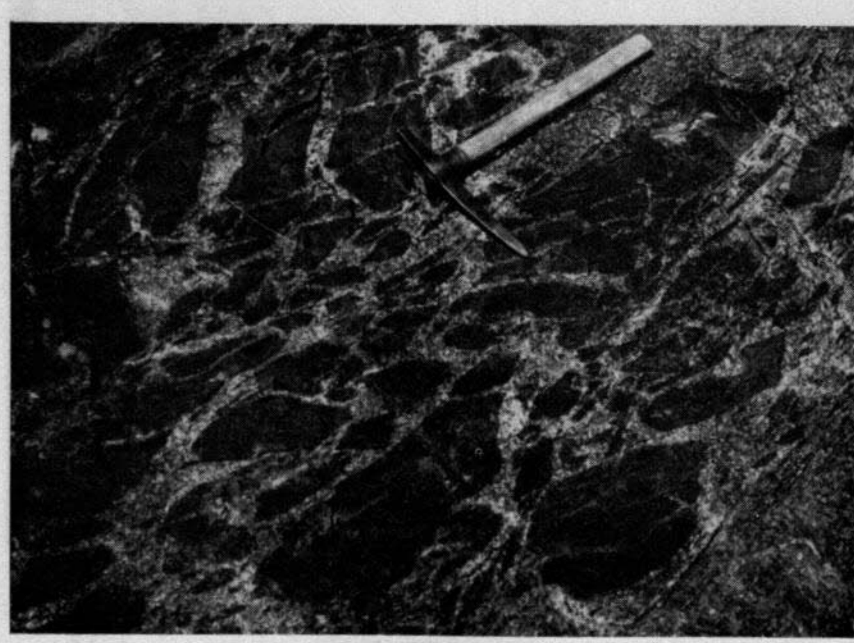


Plate IV—(a) Soysambu (6,340 feet). Typical massive granodiorite of the Turbo area.



(b) Biotite-amphibolite agmatite in granodioritic migmatite. Turbo.

Plate V—(a) Meta-conglomerate in the Tenten valley, three miles north-west of Sagotio.

(b) Black flinty mylonite of shallow dip, one mile north-east of Kokorowa.

Plate VI—(a) Overturned minor fold in alternating thin quartzites and biotite gneisses, four miles SSW. of Kapsiliat. Camera faces north.

(b) Overturned intermediate fold in muscovite quartzite, three miles south of Chemurokoi. Camera faces north-east.

Plate VII—(a) Minor folds in calcareous para-gneisses, Geben ya Mayoto. Camera faces north.

(b) Overturned intermediate fold in veined calcareous para-gneisses, Geben ya Mayoto. B—lineation (parallel to hammer handle) in fluted crenulations at hinge of syncline on left. Camera faces NNE.

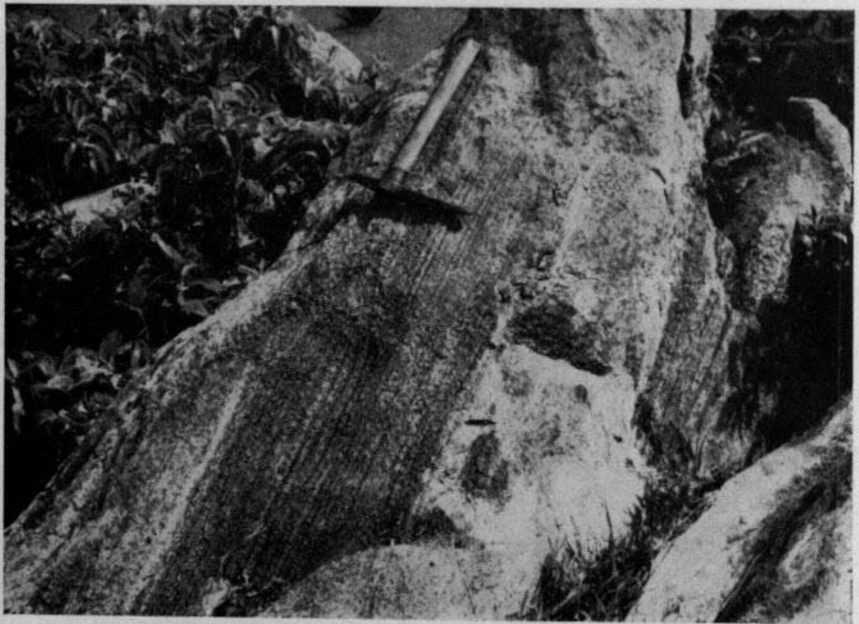


Plate VIII—(a) Dip slab of grey cataclasite with lineations parallel to *a*, two miles south of Kabiemet. Hammer head lies parallel to the regional strike, handle and lineation dip 40° eastwards.

(b) Mullions of eastwards dip with lineations parallel to *a* in thrust-zone, two miles south-east of Kabiemet. Thin black mylonite layers in left foreground.

Specimen 34/504 from Geben ya Mayoto is typical. It contains pale-coloured garnets in a well-foliated matrix in which folia of granoblastic quartz and felspar alternate with more biotitic layers. The felspar content exceeds that of quartz.

(v) *Graphitic Schists*

Thin graphic schists were recorded between Chemurokoi and Garamoso at a height of about 8,500 feet; they also outcrop on the southern extension of the Sembeywa ridge about two miles north-west of Kapsiliat. The Garamoso graphitic schist (specimen 34/542), is a garnetiferous biotite schist with interfoliated flakes of graphite, while the Sembeywa outcrops are of grey or pink felspathic schists (specimen 34/554), containing only rare biotite in addition to graphite. The graphite constitutes about seven per cent of the rock.

(vi) *Felspar-Porphyroblast Gneisses*

Identifiable pelitic schists such as those already described, are sometimes interstratified with dark biotite-rich rocks made conspicuous by large white plagioclase porphyroblasts sometimes measuring one or two centimetres in length. Specimen 34/573 (Fig. 5c), from a deep valley between Jariget and Garamoso, is representative of this group. In thin section the contained felspar, identified as oligoclase, is of a strongly porphyroblastic habit, and constitutes about sixty per cent of the rock; quartz, partly granulitized with strain-shadows, biotite and minor amounts of sillimanite, muscovite, iron ore and apatite make up the remainder. The biotite is often foliated around the felspar porphyroblasts which have evidently grown by replacement.

(c) *Semi-Pelitic Rocks*

Rocks derived from sediments intermediate in composition between mudstones and pure sandstones are usually grey flaggy gneisses containing less biotite than the pelitic schists. Specimens 34/560 from between Chemurokoi and Garamoso, and 34/574 from about one mile east of Garamoso are typical of the group; they are both grey medium-grained biotite gneisses. In thin sections the biotite flakes are small and constitute only a few per cent of the rock, the remainder being composed of a foliated mosaic of quartz, albite-oligoclase and microcline in approximately equal proportions.

Some of the semi-pelitic rocks contain very small amounts of sillimanite or kyanite, as in specimen 34/514, a pale grey flaggy gneiss from the eastern flank of Geben ya Mayoto. In thin section this rock is seen to contain biotite and muscovite in approximately equal proportions set in a foliated quartz-microcline matrix together with a few small slender prisms of sillimanite.

Specimen 34/618, is a delicately laminated gneiss from the foothills of the Cherangani hills about four miles north-west of Kapserwa. In thin section strongly aligned biotite with thin foliations of ilmenite and large crystals of sphene are seen in a fine-grained foliated mosaic of quartz, albite-oligoclase and microcline.

(d) *Psammitic Rocks*

The metamorphic equivalents of pure quartz arenites and felspathic sandstones usually form massive, resistant, and extensive outcrops; in consequence they are found in cliffs and crags at the crests of ridges and on the summits of many of the highest hills.

(i) *Quartzites and Muscovite Quartzites*

Massive reddish-brown or grey-weathering quartzites outcrop over wide areas; they make the hill feature of Karuna (7,693 feet), and extend northwards along the high ridge of Kapsiliat (8,539 feet) to Kapsigoria and Kuserua (9,200 feet), in the extreme north-eastern corner of the area. Similar quartzites are extensively exposed in the Chemurokoi forest reserve, and many of the small hills between Chebororua and the Nzoia river are minor features caused by the presence of relatively resistant bands of quartzite in the metamorphic succession.

Quartzite is seen to the almost total exclusion of other rock types in the Chemurokoi-Kaisongul region (known locally as "Flat Top"), where outcrops extending northwards outside the area cover several square miles. The surface extent in this part of the Cherangani hills does not, however, imply an excessive thickness for the quartzite beds since the regional dip is low and the topography is dominated by great dip-slopes coincident with the gently inclined quartzite sheets.

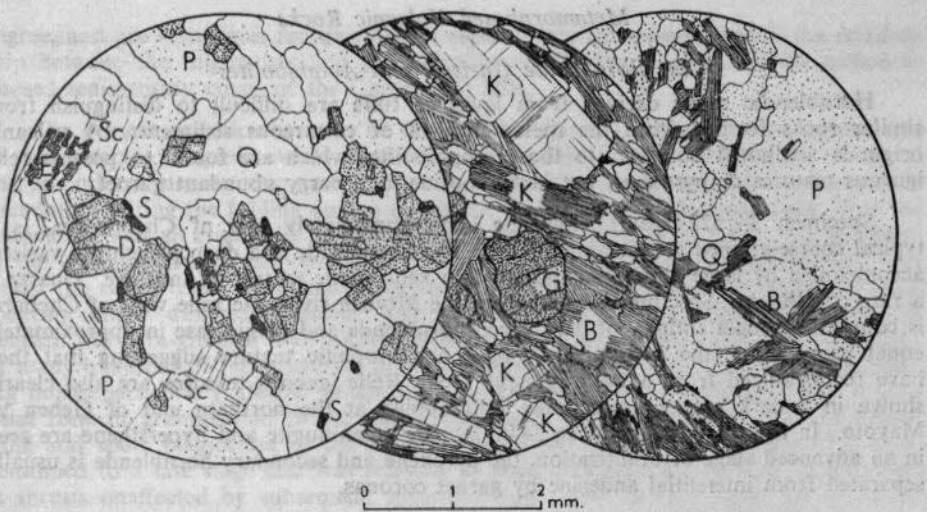
Typically the quartzites are white and translucent on fracture surfaces, with quartz grains reaching a size of 5 mm. or more in the coarsest varieties. Finer-grained, well-foliated muscovite-quartzites are interbedded with the massive layers, and sometimes contain small grains of kyanite, as in specimen 34/532 from one mile north-west of Chebororua. In the vicinity of Chemurokoi lenses and sheets of a tough, green, quartz-diopside granulite are sometimes enclosed in the quartzites, and occasional prisms of colourless diopside occur in an otherwise pure quartz rock, as in specimen 34/481 from the foothills one mile east of Geben ya Mayoto. It is clear from the presence of these lime-silicate inclusions that the original arenites contained thin beds of calcareous sand.

(ii) *Quartz Felspar Para-Granulites and Para-Gneisses*

Felspathic gneisses and granulites believed to have been derived from impure sandstones or grits constitute an extensive group in the meta-sedimentary succession. A regular foliation, granular texture, and interstratification with rocks of undoubted sedimentary origin imply that they represent original arenaceous sediments.

These rocks are very well exposed in the cliffs immediately east of Chebororua, where massive, brown-weathering, weakly foliated gneisses and granulites occupy several hundred feet of the visible section. Specimen 34/523 from this locality, contains about 25 per cent of quartz some of which is poikilitically enclosed in replacive crystalloblastic oligoclase. Microcline and orthoclase are also present in lesser amounts, and dark brown biotite is sparsely scattered throughout the rock. Specimens 34/474 and 34/494 are similar in composition and texture, the former is typical of a pink foliated para-gneiss forming the spine of the ridge known as Sembeywa, some three miles north-west of Kapsiliat, whilst specimen 34/494, was taken from the cliffs of pink para-gneiss between the Moiben gorge and the Karuna-Chebara road.

A distinctive biotitic para-gneiss appears in scattered exposures in the Tenten region, about five miles north-east of Kapserwa. It is dark grey in colour and of medium grain apart from numerous rounded or ovoid quartz inclusions, measuring up to two inches in diameter, which are arranged in banded concentrations resembling graded pebble beds in a conglomerate (Plate V, *a*). The matrix in which these "pebbles" are enclosed is granoblastic and biotitic; specimens 34/598 and 34/616, both from a deep valley situated immediately to the east of Tenten, contain quartz and oligoclase in approximately equal proportions together with microcline, deep brown biotite, and sphene.



(a) (b) (c)

Fig. 5—Microscope drawings of thin sections of metamorphosed sedimentary rocks from the southern Cherangani Hills:—

(a) Diopside gneiss. Specimen 34/533, from two miles SSW. of Chemurokoi. Ordinary light, × 13. Quartz (Q), Plagioclase (P), Diopside (D), Scapolite (Sc), Epidote (E), Sphene (S).

(b) Kyanite-garnet schist. Specimen 34/515, from the western slopes of Chemurokoi. Ordinary light, × 13. Kyanite (K), Garnet (G), Biotite (B).

(c) Felspar porphyroblast gneiss. Specimen 34/573, from Jariget. Ordinary light, × 13. Quartz (Q), Plagioclase (P), Biotite (B).

The compositional range of the pelitic, semi-pelitic and psammitic metamorphosed sediments is briefly indicated below:—

	34/515	34/504	34/573	34/560	34/532	34/494
	%	%	%	%	%	%
Quartz	25	30	25	25	93	35
Microcline or orthoclase ..	—	2	—	15	—	10
Plagioclase ..	20	36	61	54	—	50
Biotite	35	25	10	5	2	3
Muscovite ..	—	3	2	—	3	1
Garnet	3	3	—	—	2	—
Kyanite or sillimanite ..	15	—	1	—	2	—
Iron ore	2	1	1	1	—	1
Apatite	—	—	+	—	—	—

34/515 Pelitic kyanite-garnet schist, Chemurokoi.

34/504 Pelitic garnetiferous schist, Geben ya Mayoto.

34/573 Pelitic felspar-porphyroblast gneiss, Jariget.

34/560 Semi-pelitic biotite gneiss, between Chemurokoi and Garamoso.

34/532 Psammitic muscovite quartzite, Sagotio.

34/494 Psammitic quartz-felspar para-gneiss, three miles ESE. of Kapsiliat.

Metamorphosed Volcanic Rocks

(*a*) *Hornblende Gneisses and Amphibolites*

Hornblendic rocks derived from lavas or tuffs are difficult to distinguish from similar rocks formed from the metamorphism of calcareous sediments. A volcanic origin is attributed however, to those amphibolites which are found to possess relic igneous textures or pyroxene, but lack diopside, and carry abundant garnet.

Specimen 34/522 from below the cliffs immediately east of Chebororua, is a typical coarse-grained garnet amphibolite. The hornblende is a deep pleochroic variety, accompanied by large almandine garnets in a xenoblastic matrix of andesine. Quartz is a rare constituent. Specimen 34/468 from the Moiben river one mile west of Chebara, is composed almost entirely of dark green hornblende and plagioclase in approximately equal proportions; the two minerals have a sub-ophitic texture suggesting that they have recrystallized from a basic igneous rock. Relic igneous textures are also clearly shown in a dark garnet amphibolite outcropping at the northern end of Geben ya Mayoto. In thin section (specimen 34/497), pale green augite and hypersthene are seen in an advanced stage of uralitization, the pyroxene and secondary hornblende is usually separated from interstitial andesine by garnet coronas.

On the Kokorowa-Kapserwa ridge there are outcrops of a dense garnet amphibolite specimen 34/603, containing garnets reaching the size of a golf-ball, in a matrix of large interlocking prisms of hornblende together with scattered granules of iron ore. Nearby, at the summit of Kapserwa (trigonometrical station 89/54), there are scattered outcrops of a distinctive medium-grained garnetiferous amphibolite containing abundant garnets and yellow-brown cummingtonite in a foliated granoblastic matrix of andesine, specimen 34/604. It is likely that both of these examples were derived from igneous rocks.

(*b*) *Biotite-Hornblende Gneisses*

Dark banded hornblendic gneisses can be traced for several miles parallel to the upper reaches of the Moiben river near Chebara. In specimen 34/488, from three miles SSW. of Chebara, hornblende and biotite constitute about one-third of the rock, the remainder consisting of xenoblastic calcic oligoclase accompanied by less than five per cent of quartz, and accessory apatite.

(4) Metamorphism and Granitization

The rocks of the Basement System have achieved their present composition only after the completion of a complex series of transformations involving recrystallization and the development of new minerals under changing conditions of temperature and pressure. In considering these changes the distinction between the migmatites and granodiorites of the Turbo area and the metasedimentary rocks of the Cherangani hills is maintained for descriptive purposes.

(*a*) *Metamorphism and Granitization of the Turbo Area*

Contrast between geosynclinal accumulations and the floor on which they are deposited is liable to be a fundamental feature in those areas where linear subsidence and sedimentation has taken place, since more often than not in the geological record, the foundation has passed through at least one earlier cycle of metamorphism and granitization and in consequence is liable to be granitic in composition. With the onset of the new orogeny both foundation and superincumbent sediments are subjected to intense granitization in the downplunging sections of the geosyncline so that original differences are eliminated, and when these crustal zones are revealed in the migmatite areas of Precambrian terrain, it is often impossible to distinguish between remobilized floor and granitized cover. In the regions marginal to the deep granitization zone, however, cover and floor have not been intermingled and welded together to the same degree, and are sometimes recognizable as separate crustal entities; such is the relationship between the migmatites and granodiorites of the Turbo area and the metamorphosed sedimentary cover of the Cherangani hills.

The present granitic character of the Turbo rocks is considered to be attributable to two separate orogenic events, firstly an earlier cycle of high level granite intrusion, and secondly a metasomatic granitization accompanying penetrative deformation of the foundation during the folding and metamorphism of its superincumbent rocks. That the foundation was an essentially homogeneous crystalline substratum before the inception of the latest orogeny is demonstrated by its mechanical resistance to deformation, thus whilst the cover rocks were folded against and over it, the foundation failed by deep shearing under directed pressure. The shear-zones, which dip generally eastwards beneath the para-gneisses and schists of the southern Cherangani hills, occupy widths of many hundreds of feet and have provided avenues for the free migration of granitizing fluids, particularly alkalis, which have moved upwards and outwards from a deep axial zone of granitization to the east. These fluids became fixed as replacive microcline and sodic plagioclase in the locally granulitized foundation. Compressive stress continued to a late stage and was released by final cataclasis and milling of the rocks in thrusts unaffected by subsequent metasomatism. Attention has been drawn to the important function during orogeny of deep marginal thrusting of this kind in providing free passages for granitizing fluids (Ramberg, 1952, p. 238), and that metasomatism reached an acme during protracted differential movement in the foundation, cannot be doubted from the textures of the rocks seen in the Turbo region. Under extreme metasomatism, viscous microcline granite lenses, veins, and sheets, were formed in the thrust-zones, and it is possible that the thermal effects of outward spreading rheomorphic granite of this type contributed to the comparative uniformity of metamorphic-grade in the mantling meta-sediments, implied by the considerable breadth of both the kyanite and sillimanite zones as at present defined (Sanders, 1954 B, p. 150). Abrupt termination of the Cherangani meta-sedimentary cover at the kyanite grade leaving no apparent lower grade metasediments to the west, tends to indicate that the folding and plastically deforming superincumbent rocks were squeezed outwards towards the west in nappes, now removed by the same deep erosion that has revealed the sheared and resistant foundation over which they were forced.

Some confirmation of the fundamental nature and magnitude of shearing in the foundation is given by occurrences of peridotite in the north-central part of the area; these outcrops follow a north-westerly trend continued by a series of similar peridotite bodies recorded in West Suk (Searle, 1952, p. 18-19). Such ultrabasic intrusions are often found in deep shear zones situated marginally to fold belts of alpine type, and are probably intruded during the initial stages of orogeny (Hess, 1955, p. 393).

(b) Deposition and Metamorphism of the Cherangani Meta-sedimentary Rocks

The southern Cherangani rocks, although strongly metamorphosed, are clearly recognizable as a sequence of sandstones, calcareous sands, limestones, and mudstones with rare volcanic intercalations which have been converted to the appropriate metamorphic rock-types described previously.

Massive pure metamorphic quartzites associated with great thicknesses of calcareous para-gneisses or para-granulites and a general paucity in the succession of amphibolites of volcanic origin, indicate that the original sedimentary sequence was probably deposited in the slowly subsiding shelf region marginal to a tectonically mobile geosyncline in which great thicknesses of greywacke and volcanic rocks were deposited. The distinction between orthoquartzite-limestone accumulations on the one hand, and greywacke-volcanic accumulations on the other, has been drawn by Kay (1951, p. 86); the former are generally found in the belts of intermediate stability, or miogeosynclines, situated between the stable continental margin, and a more active outer geosynclinal belt in which volcanic island-arcs are liable to form.

Subsequent to deposition the Cherangani rocks were subjected to increasing heat and directed pressure as the probable result of crustal downward buckling beneath the thick sedimentary and volcanic accumulations of the geosyncline. In the deepest portions of the downbuckle both geosynclinal floor and its overlying sediments were recrystallized and ultimately migmatized and re-fused so that the original identities of the different rocks were practically obliterated. The zone of maximum intensity for this process is often roughly coincident with the axis of maximum original sedimentation, but not invariably so, as geophysical data tends to show that some active downbuckles of the present day are asymmetric (Meinesz, 1954, p. 152, 1955, p. 327, Bucher, 1957, p. 260-266).

The coarser quartzose sediments and sandstones apart from recrystallization and the growth of biotite, remain comparatively unchanged over a wide range of applied pressure and temperature, but the mudstones and calcareous sediments are more sensitive, so that certain distinctive minerals, stable at the peak of metamorphism, are preserved in them, and form the basis of the facies classification of metamorphic rocks (Eskola, 1920, pp. 143-194, Turner, 1948, pp. 61-107, Turner and Verhoogen, 1951, pp. 433-480, Fyfe, Turner and Verhoogen, 1958, pp. 199-239).

Although sillimanite has been identified in small amounts in some of the rocks, the characteristic mineral assemblage of the pelitic schists of the southern Cherangani hills is kyanite-almandine-biotite-oligoclase so that these rocks are placed in the kyanite-muscovite-quartz subfacies recognized by Francis (1956, p. 356) and Fyfe, Turner and Verhoogen (1958, p. 228). This mineral assemblage is commonly developed in pelitic sediments under conditions of temperature and pressure intermediate between those forming the staurolite-quartz and sillimanite-almandine zones in regions of progressive regional metamorphism.

The calcareous rocks interstratified and isofacial with these pelitic kyanite-bearing schists are typically composed of hornblende-diopside-epidote, or almandine-diopside-hornblende assemblages, together with oligoclase-andesine, scapolite, biotite and/or quartz, and hence fall into the almandine-diopside-hornblende subfacies. Both the pelitic kyanite-bearing assemblage, and the calcareous almandine-diopside-hornblende assemblage, constitute subfacies of the larger almandine amphibolite facies embracing the products of medium- and high-grade regional metamorphism.

It is of interest that the Cherangani rocks are of a lower metamorphic grade than those seen to the south-east in the Kitui area, where sillimanite is the typical grade-index of the pelitic schists, and is isofacial with calc-silicate granulites of Eskola's pyroxene-hornfels facies (Sanders, 1954 A, p. 35). The higher metamorphic grade in Kitui is due to the presence immediately to the west of large areas of migmatite and granitic gneiss where recognizable metasediments have been oblierated by progressive granitization in the now deeply-eroded axial portion of a fold belt (*op. cit.*, p. 35). In contrast, the Cherangani rocks have suffered only weak granitization evidenced by the growth of albite-oligoclase porphyroblasts in the sediments. Potash metasomatism, *lit-par-lit* injection, and other signs of advanced granitization are not seen, and evidently the rocks have escaped the highest grade of metamorphism attended by granitization, due to their marginal position. During medium-grade metamorphism, however, the recrystallizing rocks were under sufficient directed pressure and applied temperature to fold and buckle, and in their more rigid parts to shear outwards and away from the axial region of the geosyncline, as is shown by constant overturn of folds towards the west (Plates VI and VII) with ubiquitous shallow eastward-dipping cleavage planes.

2. Intrusives

(*a*) *Peridotites*

A very coarse, dark green peridotite occurs in scattered outcrops on the northern side of the Nzoia valley in the region of Tosetti's Drift. The contacts of individual intrusions are obscured by soil cover, but an indistinct flow-lamination seen in some exposures would suggest that they are the parts of sill-like lenticular bodies dipping towards the north-east. Boulders of peridotite follow a north-west to south-east trend for a distance of about eight miles, roughly parallel to the axis of the Nzoia valley between Tosetti's Drift and Kaisagat.

Under the microscope olivine and derived serpentine are seen to constitute more than one-half of the rock, with hypersthene and augite making up the remainder. The orthorhombic pyroxene occurs in large, zoned, subhedral phenocrysts sometimes with purple pleochroic margins and often intergrown with replacive brown augite. A serpentinous mesh containing much released iron ore accompanied by smaller amounts of red-brown pleochroic iddingsite, divides the olivine into numerous unaltered and corroded patches, some of which are surrounded by narrow kelyphitic rims of antigorite. Poikilitic crystals of olivine also occur in the pyroxenes, as in specimen 34/609 from one mile south of Kokorowa, and 34/640 from three miles WNW. of Tosetti's Drift.

Further small scattered outcrops of peridotite occur near the western margin of the area some two to three miles north of the Nzoia river, near the Hemstead's Bridge-Laigiri road. They are similar in composition to the peridotite near Tosetti's Drift but in specimen 34/658 the olivine is more serpentinized and augite is not so abundant. Hypersthene occurs in sub-idiomorphic zoned prisms with coloured pleochroic margins.

(*b*) *Dolerites*

Dolerite dykes intrusive into the Turbo migmatites and granodiorites were recorded from a few localities, but none were found in the southern Cherangani hills. The dykes generally range between 1 foot and 20 feet in width and their outcrops are often indicated by dark iron-stained spheroidal boulders with a weathered skin beneath which the fresh dolerite is exceptionally hard. In general appearance and range of composition these dyke rocks are similar to those described from the Broderick Falls area to the west (Gibson, 1954, p. 32), and the Kakamega area to the south-west (Huddleston, 1954, p. 19), of the present area.

In thin section the texture and composition indicates that the rocks have been subjected to some degree of metamorphism. They are usually holocrystalline, with an ophitic or intersertal texture. The felspar ranges from andesine to labradorite but is commonly a saussuritized basic andesine with poorly defined twinning. The pyroxene is a pale green dusty pigeonitic augite, accompanied by accessory iron ore and biotite. Alteration of plagioclase by micrographic growth of fresh felspar and quartz partly obliterates the original laths, and the margins of pyroxene against felspar are in consequence often vermicular. Partial alteration of pyroxene to hornblende, particularly at the margins, is common as in specimens 34/740 and 34/741 from the Kipkarren river seven miles SSE. of Turbo. Specimen 34/730 from Rothman's farm shows a more advanced stage of alteration in which idiomorphic or granular garnet occupies coronas between the plagioclase and pyroxene and is accompanied by vermicules of quartz liberated during the formation of garnet. Biotite is distributed in flakes throughout the rock, and iron ore is concentrated in local skeletal patches, and also occurs in dusty granules in the pyroxene.

3. Tertiary Lavas and Tuffs

Extensive sheets of phonolitic lava underlie the Uasin Gishu plateau north of Eldoret, covering approximately one-half of the entire area and reaching a maximum thickness in the extreme east. The highest parts of the plateau stand at an elevation of about 8,000 feet near Kamorin, while immediately east of the area the base of the phonolite can be seen in the face of the Elgeyo escarpment near Tambach at an elevation of about 6,200 feet (Shackleton, 1951, p. 373), so the total thickness of phonolite at the eastern margin of the area is of the order of 1,800 feet.

The northern and western limits of the flows comprising part of the Uasin Gishu volcanic accumulations are marked by escarpments which can be traced in a northerly direction from near Karuna along the western side of the Moiben valley to Kaisagat, where isolated outliers of phonolite cap a series of small, flat-topped hills overlooking the Nzoia river. From here the escarpment continues in a north-westerly direction towards Tosetti's Drift; it makes a bold feature flanking the southern side of the Nzoia valley and extends through Ziwa to Matunda hill, near Hoey's Bridge. South of Hoey's Bridge the margin of the lava is embayed by the valley of the Little Nzoia, and then takes an arcuate sweep to the south of Soysambu. The edges of the plateau are again seen at Turbo, where the railway follows the foot of the phonolite escarpment. Between Soy and Turbo the Sergoit river has deeply incised the phonolite whose boundary continues southwards and extends to the region of Selby Falls, where the Sosiani river plunges from the edge of the plateau some six miles to the west of Eldoret (Plate I (*a*)).

Phonolite at the summit of the escarpments overlooking the Nzoia and Sosiani valleys is about 200 feet in thickness, some 1,600 feet less than that at Tambach 25 miles to the east. This marked westerly thinning, coupled with the flow-orientation of phenocrysts in the lavas, indicates that they entered the Uasin Gishu from the east and south-east and were probably extruded in an area now occupied by the Kamasian section of the Rift Valley. Only a single flow is present at the north-western limits of the plateau, but it is likely that several separate flows contribute to the greater thickness of phonolite seen in the Elgeyo escarpment.

The earliest lava flood spread across a surface of gentle relief; the tongues of moving lava probably followed valleys and filled depressions before covering the higher interfluves which perhaps were not enveloped until the arrival of a subsequent flow, so the total thickness is liable to vary with the locality. Some estimate of the amount of variation can be made from the surface geology, thus to the north-west of a line drawn between Soy and Moiben the depth from surface to the base of the phonolite is between 150 feet and 300 feet; Eldoret township stands on approximately 400 feet of phonolite; whilst between Eldoret and Sergoit the thickness of lava can be expected to range up to 600 feet, increasing to over 1,000 feet in the Kamorin-Kachouwat region. These estimates are subject to modification when applied to the lavas in proximity to Basement System inliers which appear at Nel's Bridge (Plate I (*b*)) and Sergoit (Plate II (*a*)). The Nel's Bridge inlier has resulted from the erosion and removal of phonolite covering an original elevation of Basement System rocks, unlike Sergoit Rock which, judging by its present height of 600 feet above the surrounding lava, would appear not to have been covered by even the highest phonolite flood.

A narrow strip of Basement System rocks almost surrounded by phonolite in the Karuna region owes its presence to faulting and subsequent erosion.

The succession of lavas and tuffs is:—

(3) Upper Uasin Gishu Phonolite.

(2) Lower Uasin Gishu Phonolite.

(1) Miocene Tuffs and Grits (Moiben Beds and Selby Falls Beds).

(1) Miocene Tuffs and Grits

Some 500 feet of stratified tuffs and grits are to be seen beneath phonolite at Tambach, just outside the eastern margin of the area. They rest unconformably on Basement System gneisses exposed in the middle and lower parts of the Elgeyo escarpment, and their Miocene age is indicated both by contained nephelinite pebbles derived from early Miocene eruptions and by their fossil fauna, which includes crocodile, tortoise and possibly a rhinocerid (Shackleton, 1951, p. 373). Volcanic ashes and interstratified gritty or tuffaceous sediments were deposited during early Miocene volcanic eruptions and were afterwards covered by the first floods of phonolitic lava, so it is likely that similar beds to those exposed at Tambach are widespread beneath the Uasin Gishu plateau phonolite and probably occupy former depressions on the sub-Miocene surface. They are, however, only seen at a few points at the edges of the plateau and are clearly much thinner than the Tambach sequence. They are best exposed in two areas, the first along the edges of the Moiben-Tosetti's Drift escarpment, and the second in the Sosiani valley near Selby Falls.

(a) The Moiben Beds

Brown-weathering grits and blue-grey tuffs outcrop some two miles north-east of Moiben post office on Muringa farm (Plot No. 6837), where about 20 feet of poorly exposed sediments form a thin capping two or three acres in extent at the crest of a spur overlooking the Nzoia valley. The basal beds are coarse felspathic conglomerates, weathering of which has released numerous well-rounded quartz pebbles having a distinctive yellow or brown external staining. The conglomerates are overlain by grits. In thin section (specimen 34/580), the matrix of the conglomerate and the grit is seen to consist of angular ill-sorted grains of quartz and felspar in approximately equal proportions, embedded in an opaline cement. Small grains of hornblende are scattered throughout the matrix, with accessory amounts of garnet, iron ore, pyroxene, epidote, biotite and rutile.

Light-coloured blue-grey unstratified tuffs occur above the basal grits. In specimen 34/381, angular clastic constituents are seen to be quartz, felspar and hornblende, in fragments of smaller size than those seen in the grits. A sub-microscopic ashy matrix constitutes more than one-half of the rock.

Similar tuffaceous grits, some containing fossil wood, were seen at the base of the phonolite at several points along the escarpment overlooking the Nzoia valley. In all cases, however, talus shed from the edge of the lava tends to obscure the relatively soft underlying sediments, which can only be found in scattered blocks beneath the phonolite contact. A brown tuffaceous grit specimen 34/595, was collected from the slopes of the escarpment about four miles SSE. of Tosetti's Drift, and a similar specimen 34/592, comes from the escarpment one mile north-west of the Arobobutch-Moiben confluence.

(b) The Selby Falls Beds

About ten feet of green agglomeratic and grey stratified tuff were located beneath the basal phonolites in the Sosiani valley, approximately one mile SSW. of Selby Falls. The pyroclastic beds deposited in this area are coarser than those seen at Moiben; the agglomerate (specimen 34/711), contains numerous dark nephelinite fragments measuring up to an inch across, enclosed in an ash matrix together with pyroclastic hornblende, biotite, green pyroxene and melanite.

(2) Lower Uasin Gishu Phonolite

Outcrops of phonolite are rare in the flat cultivated country of the Uasin Gishu plateau, the best exposures occurring in the main watercourses draining the plateau, and in the upper parts of the bounding escarpments where the soil cover is generally thin, as at Turbo, Hoey's Bridge, Ziwa, Moiben and Leseru.

The lower phonolite is aphanitic and blue-black in colour, with a conchoidal or splintery fracture. A fine flow-ribbing is seen in some exposures and vesicles are poorly developed. Phenocrysts of soda-orthoclase are present but are usually small, measuring up to 5 mm., and rarely show preferred orientation that would indicate the direction of lava flow. In thin section, specimens 34/461 from Eldoret, and 34/462 and 34/468 from the Sosiani river two miles north-west of Eldoret, the phonolite is seen to have a pilotaxitic texture, with microphenocrysts of elongated soda-orthoclase in a groundmass of patchy aegirine, cossyrite and kataphorite. Abundant laths of soda-orthoclase in the groundmass are associated with nepheline idiomorphs. Accessory minerals include granules of apatite and iron ore.

(3) Upper Uasin Gishu Phonolite

The upper phonolites of the Uasin Gishu plateau are bounded by a west-facing escarpment extending north-westward from Eldoret towards Leseru. Further to the north the escarpment diminishes in height and ceases to be a topographic feature about four miles to the south-east of Nel's Bridge. Escarpments bounding the upper phonolites are again seen immediately to the south of Lake Sergoit.

The upper phonolites are similar to the lower phonolites with the exception that they are generally coarser and contain larger felspar phenocrysts. Specimens 34/458 and 34/460 from near Sergoit Rock and 34/465 from near Kamorin contain phenocrysts of soda-orthoclase exceeding 5 mm. in length. The phenocrysts often show Carlsbad twinning and are accompanied by smaller phenocrysts of aegirine set in a groundmass of felspar laths. Felspars of the groundmass are arranged in criss-cross or divergent radial groups partly enclosed by small patches of aegirine, cossyrite and kataphorite. Some rectangular or hexagonal isotropic interstices may represent altered nepheline, and other parts of the groundmass show a colourless isotropic base of sodalite, analcite, or glass. Accessory minerals include scattered granules of iron ore and small flakes of red-brown strongly pleochroic biotite.

These phonolites probably correspond to the Losuguta type phonolites described by Prior (1903, p. 238), and Smith (1931, p. 236).

4. Recent Superficial Deposits

Red-brown earths derived from the lavas of the Uasin Gishu plateau cover most of the central and eastern parts of the area. Soils covering the phonolites are comparatively thin; they drain freely, have a friable texture, and near the edges of the plateau are liable to be easily eroded. The red earths are partly lateritized and often contain layers of cellular ironstone or "murram"; this is located at shallow depth and is excavated for road surfacing over much of the plateau. Non-calcareous black or grey clays occur on the plateau in shallow valleys and areas of poor drainage.

In the northern and western parts of the area pink or brown sandy soils cover the Basement System rocks; they are generally lighter in texture and less fertile than the plateau soils. The soil profile is generally thin but deepens over the talus accumulations at the western foot of the Cherangani hills.

VI—STRUCTURE

The chief structural features of the area are shown in Fig. 6. They can be conveniently divided into structures impressed on the Basement System rocks in Precambrian times and those which developed much later during Pleistocene rift faulting. The Precambrian structures are complex, and further complicated in the north-east by normal faulting near to the Rift Valley.

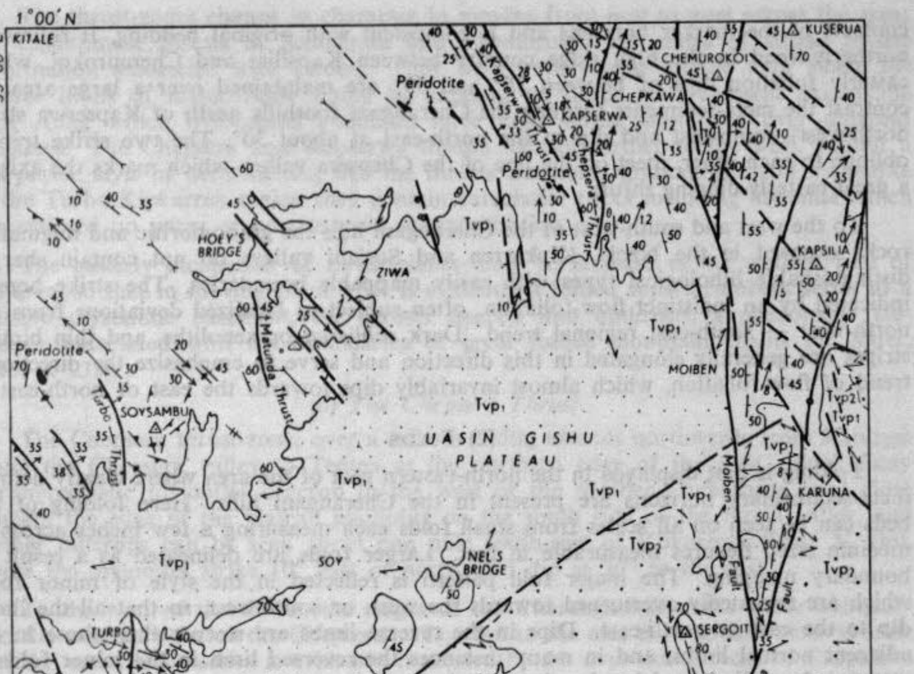


Fig. 6—Structural map of the Eldoret area.

1. Structures in the Basement System

(1) Lithological Boundaries and Regional Trend

Distinct lithological boundaries are only clearly seen in the rocks of the southern Cherangani hills where the contacts of distinct marker beds, such as quartzites and graphitic schists, can be followed across country for considerable distances. A strongly developed foliation in the neighbouring gneisses or schists usually lies parallel to the contacts of the marker horizons and is coincident with original bedding. It follows a northerly-trend in the high ridge country between Kapsiliat and Chemurokoi, where easterly foliation dips of between 35° and 50° are maintained over a large area. In contrast the meta-sediments forming the Cherangani foothills north of Kapserwa strike north-west—south-east and dip to the north-east at about 30°. The two strike trends, oblique to each other, meet on the line of the Chepsera valley, which marks the axis of a great easterly-dipping thrust.

To the west and south-west of the Cherangani hills the granodioritic and migmatitic rocks exposed in the Nzoia, Kipkarren and Sosiani valleys do not contain sharply distinguishable lithological types with easily mappable boundaries. The strike here is indicated by an indistinct flow-foliation, often subject to localized deviations from the north-west — south-east regional trend. Dark *schlieren* or xenoliths, and thin biotitic stripes are generally elongated in this direction and serve to emphasize the directional trend of flow-foliation, which almost invariably dips towards the east or north-east.

(2) Folds

Folding is best displayed in the north-eastern part of the area where clearly defined meta-sedimentary horizons are present in the Cherangani hills. Here folding of the beds can be seen on all scales from small folds each measuring a few inches across to medium sized flexures measurable in feet. Larger folds are delineated as a result of boundary mapping. The major fold pattern is reflected in the style of minor folds which are repeatedly overturned towards the west, or south-west, so that all the limbs dip to the east or north-east. Dips in the reverse limbs are steeper than those in the adjacent normal limbs, and in many instances the reversed limb in the minor folds is attenuated or eliminated by shearing on eastward dipping surfaces parallel to the axial plane of the fold (Plate VI (*a*)). The majority of these folds were evidently produced by flexural slip on easterly-dipping movement planes. A similar pattern is indicated by folds of regional dimensions; thus where a single marker horizon is repeated across the strike the outcrops all dip eastwards, but the inferred reverse limb is comparatively steep, and often terminated against acutely distorted rocks of different type, sometimes containing rolled masses or thrust *mélange,* as on the eastern slopes of Geben ya Mayoto, and on the southern face of Garamoso. Due to the nature of the larger folds the normal limbs outcrop over great areas in broad eastward-inclined dip slopes, the overall impression is one of coincidence between foliation and bedding.

The arched hinges of folds of intermediate dimensions are to be seen at the southern end of Geben ya Mayoto, on Jariget and between Kapserwa and Kipkoitet. The ridge known as Jariget, is co-axial with a small overturned anticline so that respective folded beds outcrop in crescentic form across the crest of the ridge; here, as at Geben ya Mayoto, the metamorphic layers show different competency during folding, so the more resistant hornblendic beds outcrop in gently curved slabs, but the intervening layers sometimes develop drag-folds or minor crenulations where curvature is acute (Plate VII, (*a*)).

In the Turbo area flow-folds in the migmatites are irregular; the Ndalat amphibolite is, however, folded into an open syncline of northerly plunge.

(3) Thrusts

The lowermost parts of the Cherangani meta-sedimentary succession and the more homogeneous area of granodiorite and migmatite lying to the west, is traversed by a series of major thrust-zones following a north-westerly or north-south direction and dipping eastwards. Rocks in the thrust-zones are closely foliated; the more mylonitic types are flaggy and often outcrop in dip-slabs upon which both strike and dip of the shear-foliation can be precisely measured (Plate VIII, (*a*)). The thrusts have been differentially eroded so their axes are usually followed by valleys, and outcrops of mylonite therefore tend to be masked by superficial deposits.

The thrust-zones change in character in moving from east to west across the area; the easternmost thrusts at Sembeywa and Chemurokoi are zones of strong plastic deformation associated with folding. They have been drawn on the map where the reverse limbs of major folds would be expected to occur and represent axial-plane slips along which overturned anticlines have been thrust westwards over adjacent synclines. The Chepsera and Kapserwa thrusts located further to the west, exhibit a less plastic style of deformation; like the thrusts traversing granodiorite and migmatite in the Turbo-Kipkarren region they contain cataclastic rocks including mylonite which has suffered no para- or post-tectonic recrystallization.

The easterly inclination of thrust-planes tends to increase in the western part of the area, so that in moving from what is evidently a folded superincumbent series to a massive crystalline basement, the thrusts steepen into upthrusts, a phenomena frequently associated with the boundaries of great folded mountain chains (de Sitter, 1956, p. 235).

(a) The Chepsera Thrust

The Chepsera thrust-zone, over a mile in width, extends northwards from Kaisagat along the Chepsera valley to Tenten at the northern edge of the area. Black flinty porphyroclastic mylonites outcrop to the west of the Moiben-Chebororua road close beneath the edge of the plateau phonolite on the south side of the Nzoia valley, and further outcrops can be seen about one mile south-east of Kokorowa (Plate V, (*b*)), where the mylonites strike 10° east of north, and dip at 30° to the east.

To the west of the thrust, the ridges of the Cherangani foothills strike obliquely into the western sides of the Chepsera valley, but to the east the regional strike is such that the underthrust series is evidently truncated by the over-riding rocks of Chepkawa and Sagotio.

(b) The Kapserwa Thrust

A series of thrusts follows the margins of the south-westerly facing Cherangani foothills near Kapserwa. Deep valleys cutting across the regional strike reveal dip sections demonstrating that the ribbed upland is a thrust-front. The Losorua river and its tributaries plunge in cascades and rapids over augeniferous cataclasites and mylonites dipping uniformly towards the ENE. and north-east; similar rocks can be followed south-eastwards beneath the southern slopes of Kapserwa where the mean strike of the thrust-zone is 25° west of north, and dip measurements on mylonites in several different localities vary between 28° and 30° east.

A thick apron of superficial soil and gravel carried from the foothills masks much of the bedrock between Kapserwa and the Nzoia river, but the rocks seen in stream-cuttings close to the foot of the hills are mylonitic, so the thrust-zone probably extends beneath the floor of the Nzoia valley north-west of Tosetti's Drift. Since the zone separates differentiated meta-sediments of the Cherangani hills from granodiorites and migmatites occurring further to the west, it is possibly a thrust-unconformity penetrating deeply into the crust which has provided an avenue for peridotite intrusion (p. 27).

(c) The Matunda Thrust

Lineated mylonitic gneisses striking NNW. dip eastwards at approximately 5° in the Little Nzoia river about five miles downsteam from Ziwa sisal factory. The thrust-zone to which they belong passes northwards beneath the phonolite and trends towards Hoey's Bridge. Judging by the intensity and width of mylonitization it is not so important a structure as the previously described thrusts.

(d) The Turbo Thrust

This is a powerful thrust traversing the Turbo granodiorite and migmatite. The effects can be seen for widths of over a mile, and the trend of the eastward-dipping shears can be followed for a distance of 12 miles from the southern margin of the area, to a point one mile north-east of Turbo where it disappears beneath the phonolite. The main thrust-zone emerges north-westwards from beneath the phonolite about two miles west of Hemstead's Bridge, continuing out of the area towards Mount Elgon, and may ultimately connect with a thrust mapped on the Kenya-Uganda boundary north of Mount Elgon (Searle, 1952, p. 75).

South of Turbo the cataclasites in the thrust-zone trend in a north-south direction, oblique to the regional strike of the crystalline basement, so that foliation of the undeformed rocks swings progressively into the thrust-line. Near the southern margin of the area the westernmost part of the zone of deformation is seen in a deep valley to the west of Kabiemet, where massive slabs of grey cataclasite strike 22° east of north, and dip 40° ESE. Deformation is more intense to the east of Kabiemet, where thin mylonitic sheets on similar strike and dip are interfoliated with rocks displaying strong eastward-plunging lineations (Plate VIII, (*a*)); rods or mullions of the same orientation are developed in the zone of maximum movement (Plate VIII, (*b*)). The thrust continues northwards between Kaptabei and Ndalat; black flinty mylonites of easterly dip can be seen about two miles west of Ndalat, and mylonitic gneisses with talc-actinolite schists outcrop on the slopes of a small hillock marking the extreme north-western corner of Ndalat. From here the thrust runs into the Sosiani valley and eventually crosses the Sergoit river about one mile east of Turbo. Here microcline augen-gneisses and mylonites dip at 40° to the east, and can be followed into the valley north of Croxford Bridge where they disappear beneath the phonolite. A similar eastward dip is maintained in a thick sequence of augen gneisses and mylonites exposed in the Nzoia river to the west of Hemstead's Bridge, representing the continuation of the Turbo thrust north of the phonolite outcrop.

(*e*) *The Kipkarren Thrust*

Near its confluence with the Sosiani river at the western margin of the area the Kipkarren river follows a zone of dark mylonitic gneisses and blastomylonites striking north-west—south-east and dipping at about 40° to the north-east. The thrust-zone in which they outcrop extends south-eastwards between Kaptabei and the Kipkarren valley and is distinguished by the presence of muscovite phyllonites and actinolitic schists.

(4) Normal Faults

Small displacements of the phonolite by late Tertiary or Pleistocene faults can be seen in the escarpments between Moiben and Hoey's Bridge, near Turbo and also north-west of Selby Falls. The fault-planes are brecciated and silicified, and the disrupted lava is often strongly stained with iron oxides, but the vertical movements involved seldom exceed 20 feet.

Faulting on a larger scale is evident close to the boundaries of the Rift Valley, and three of the fractures deserve separate mention.

(*a*) *The Karuna Fault*

A powerful hinge-fault extends for a distance of over 20 miles from the upper Moiben valley near Chebara to a point about six miles to the south of Sergoit Rock. It passes close to the east of Karuna, and in that area cleaved phonolites are downthrown to the east against quartzites of the Basement System. Steeply-dipping haematite breccias mark the position of the fault in the Moiben river between Kapsiliat and Kibuswa.

Faulting of this kind accounts for the great thickness of phonolite seen in the upper part of the Tambach escarpment two miles east of the present area; the sub-Miocene surface has been stepped down towards the Rift Valley, near Elgeyo, enabling preservation of the upper phonolite on a narrow shoulder above the main escarpment. The Karuna fault probably has an eastward downthrow exceeding 200 feet in its southern portion.

(b) The Moiben Fault

Two miles east of Moiben, the flat plateau of phonolite falls steeply away to the Arobobutch valley at a straight north-south trending escarpment. Here the base of the phonolite is seen at a height of 6,750 feet, whilst on the eastern side of the valley it stands at an altitude of 7,100 feet on the upthrown side of an intervening fault, which can be traced southwards for a distance of 15 miles to where it converges on the Karuna fault east of Sergoit Rock.

The Moiben and Karuna faults throw in opposite directions and hence bound a narrow wedge-shaped strip of Basement System rocks, flanked on both sides by phonolite. Each of the faults has a northerly trend, roughly parallel to the larger north-south trending rift valley faults known to exist a few miles further to the east (Shackleton, 1951, p. 373).

(c) The Kapkitoi and Associated Faults

Smaller faults oblique to the main Rift Valley fractures, can be seen in the southern Cherangani hills. They are probably branch faults, or second order shears, forking from the sides of the rift in a north-westerly direction, where cleavages, silicified breccias, and local displacements indicate their position. The trace of one such fault can be followed for several miles to the WNW. of Chemurokoi (Plate III (*b*)), and another is followed by the Kapkitoi valley, the line of dislocation passing approximately two miles to the north-east of Karuna and following a north-westerly direction towards the confluence of the Moiben and Arobobutch rivers. The fault lets down phonolite on the south-west against quartzites and para-gneisses on the north-east, and has an indicated south-westerly throw of about 700 feet.

(5) LINEATIONS

Lineations are to be seen on exposed surfaces over much of the southern Cherangani hills. They are particularly well developed as an expression of quartz orientation in the massive quartzites of Kapsiliat and Chemurokoi, and elsewhere occur as striations due to corrugation of micaceous partings and to the intersection of cleavage and bedding.

In the high valley and ridge country of the north-eastern part of the area lineations generally plunge gently to the NNE. parallel to the axes of minor folds. In the south-western foothills of the Kapserwa region, however, they parallel the thrust-front flanking the hills, and plunge gently to the SSE. and south-east. The latter lineation trend is also parallel to the regional strike of the Turbo grandiorite and migmatite and is maintained over a large area to the west and south-west of the Cherangani hills, where the axis of plunge is always gentle to the north-west or south-east.

The commonest lineations, both in the Cherangani hills and the Turbo regions are, therefore, parallel to the axes of minor and major folds and are B—lineations produced by rotational movement during the regional folding. In the zones of maximum thrust, however, a less common type of lineation is seen with axes almost perpendicular to the regional B—lineation; this has been produced by direct penetrative movements during thrusting and is accompanied by stretching of the rocks in the direction of movement. It is evidently an α—lineation producing rodding and mullions perpendicular to the strike of the mylonite zones.

(6) JOINTS

Tension- or cross-joints are commonly developed in all rock types of the Basement System, but are most obvious in the quartzose para-gneisses and quartzites, imparting a marked cleavage to the latter. In the Cherangani hills the dominant trend of these joints is east-west, with deviations of up to 15° on either side of this direction, so they produce a regular splitting of the rocks almost perpendicular to their regional strike.

In the Turbo-Kipkarren area tension-jointing in the massive crystalline rocks follows a north-east to south-west trend across the regional strike, and in conjunction with steeply-dipping strike-joints causes the division of outcrops into rectangular blocks.

Longitudinal joints following the strike are not so conspicuous as cross-joints, but are commonly developed in the folded rocks of the Cherangani hills as radially disposed fractures about the axes of folds, and as bedding-plane joints.

2. Structures in the Phonolites

Apart from late Tertiary and/or Pleistocene faults referred to above, the phonolites are devoid of post-consolidation structures. The geometry of phonolite crystal texture was, however, strongly influenced by flat flowage at the time of extrusion, as is shown by a marked orientation of contained felspar phenocrysts parallel to the base of each flow, so that in vertical sections of the lava the majority of the visible felspars are horizontally disposed in a dark matrix which is sometimes flow-stratified.

The orientation of phenocrysts is not so strong on horizontal surfaces, i.e. where the flows are viewed in plan, and frequently they appear to lie at random, but careful examination usually shows a preponderance of phenocrysts, with axes deviating about a mean, indicating the direction of flow. These trends (Fig. 6) show the Uasin Gishu flows have travelled towards the west and north-west. Flow-orientation of phenocrysts is often confirmed by the elongation of gas vesicles in the same general direction.

VII—MINERAL DEPOSITS

An assessment of the mineral prospects of the area is governed by the following considerations:—

1. Lava covers approximately one-half of the area and hence reduces the total area of potentially mineralized rock which is available for surface examination; on the other hand fertile volcanic soils derived from plateau lavas are of importance in an essentially agricultural district, and tuffs and weathered gneisses beneath the lavas carry ground-waters which can be reached by bore-holes and also give rise to springs at the margins of the plateau, so contributing to the overall water-supply of the area.

2. Basement System gneisses and schists found in the southern Cherangani hills consist of regionally metamorphosed sedimentary rocks with no granite intrusions and few pegmatites, so that only economic minerals produced by reconstitution of the original sediments, such as graphite, alumino-silicate refractories, and garnet, are likely to have developed.

3. Basement System rocks of the western part of the area, although granitic in composition, have been eroded to deep crustal levels, so that a contrasting sedimentary cover likely to contain mineralized veins is not preserved.

4. The only metalliferous mineralization recorded in the region occurs in tension-faults associated with late Tertiary or Pleistocene rift valley fractures.

1. Gold

In 1933 gold lode and alluvial claims were registered in the Kaigat and Sosiani valleys approximately ten miles west of Eldoret and in the Little Nzoia valley about seven miles south-east of Hoey's Bridge. Peggings were registered on Plots Nos. 756, 761/2, 770/2, 819, 2971/R, 2971/3, 3768 and 4354, but the claims were allowed to lapse in 1934 without record of gold production. Trenches and shafts which had been opened in the claims west of Eldoret were reported on by Murray-Hughes (1933, p. 18) as containing small quartz veins measuring up to eight inches in width lying in hornblende-garnet gneiss and schist. Although the veins were proved to be gold-bearing their geological setting was not considered favourable for payable gold values.

Quartz veins can be seen in outcrops of pink or grey granodioritic migmatite in the Sosiani valley, and in the Soysambu section of the Nzoia valley. They seldom exceed two feet in width and are often visibly lenticular, thinning out to stringers within a few yards. Some of these veins contain a trace of gold on assay, and it is possible that others contain a few dwts. of gold, but in view of their small size erosion is unlikely to have brought about any notable alluvial concentrations of gold in the adjacent streams.

2. Tin (Cassiterite)

Specimens of granodiorite and amphibolite taken from the Little Nzoia valley and submitted to the Mines and Geological Department by P. R. J. M. Heard in 1933 were found to contain small grains of pale green cassiterite or tinstone. Duplicate assays made in Nairobi and in the laboratories of the Tanganyika Geological Survey Department, confirmed that of six specimens submitted five contained amounts of tin oxide (SnO_2) varying between 0.03 and 0.46 per cent and a sixth 2.75 per cent. Tin claims located in the Little Nzoia valley on Plots 4342 and 841, and near the Moiben river on Plots Nos. 853 and 854 were registered by Heard in April, 1933, but no workable deposits were located and the claims were allowed to lapse in the following year.

Cassiterite-bearing gneisses were also recorded in the Nzoia valley west of Hoey's Bridge by Murray-Hughes (1933, p. 8). The average tin assay of several samples was 0.02 per cent and Hughes concluded that small amounts of tinstone were likely to be widely distributed in this area.

The present survey shows that disseminated cassiterite occurs within and near the margins of a flow-foliated xenolithic granodiorite outcropping at Soysambu and occupying much of the ground to the west and south-west of Hoey's Bridge; concentration of cassiterite in the granodiorite is far too low to warrant mining, but grains of alluvial tinstone occur in heavy concentrates from thin river sands and gravels occurring in the Little Nzoia north of Soysambu. There are, however, no extensive alluvial benches either in this tributary or in the main valley of the Nzoia further to the west. A more favourable area for alluvial deposition lies in the Nzoia valley approximately six miles downstream from Hemstead's Bridge, immediately outside the western margin of the area, where for a distance of several miles the Nzoia flows sluggishly in a broad and swampy valley floor.

3. Iron and Manganese

Steeply-dipping sheared and lineated quartzites are veined and impregnated with iron oxides in the Karuna fault near Kibuswa. The mineralization can be seen on the western side of the Moiben river at the bridge between Kibuswa and Kapsiliat, where veins of reniform grey-black specularite and martite coat the bedding planes of the quartzites and impregnate the steep eastward-dipping shatter-zone which is mineralized over a width of 60 feet.

The iron oxides contain an appreciable proportion of manganese, probably as manganite, $Mn_2O_3H_2O$ or pyrolusite, MnO_2; a representative sample of the ore assayed 21.04 per cent manganese. (Analyst: J. Furst, Lab. No. 27830.)

4. Graphite

Graphite schists were recorded in two localities in the southern Cherangani hills. Thin beds of graphite-biotite-garnet schists outcrop at the head of a deep valley about half a mile to the east of Garamoso summit, and a pink-weathering flaggy graphite gneiss was mapped on the Sembeywa ridge, two miles north-west of Kapsiliat.

Samples of both types of rock were experimentally treated for graphite recovery; as a result it was found that the Sembeywa sample yielded a favourable percentage of crucible-grade graphite, whilst the Garamoso sample yielded only a little graphite of poor quality.

The gneiss at Sembeywa is felspathic and granulitic, containing large clean flakes of graphite accompanied by very little mica. It outcrops close to the crest of a long ridge about 800 yards to the west of the Charangai river, and can be followed for nearly a mile in a north-north-easterly direction on Plots Nos. 2232 and 3052, where the mean width of the gneiss is 10 feet, with easterly dip of 55°.

A crushed sample of the gneiss was treated in a Knapp and Bates floatation cell using 10 per cent sodium silicate and phosocresol "B" as cell reagents. Screen analysis of the graphite concentrate so produced was carried out in a Rotap screen shaker, and assays were made on the +80 mesh concentrate, the −80 mesh portion being discarded. The results were as follows:—

SCREEN ANALYSIS

*Screen B.S.S. (*Tyler)*	*Wt. gms.*
+22	2.80
−22+25	4.95
−25+44	27.57
−44+60	17.50
−60+80	12.20
* −80	12.73
Total concentrate	77.75

Weight of −10 mesh ore treated	= 1,219 gms.
Therefore total recovery of graphite concentrate	= 6.40 per cent
Recovery of +80 mesh graphite	= 5.50 per cent
Assay percentage ash in +80 mesh concentrate	= 7.45 per cent
Recovery of crucible-grade graphite	= 3.17 per cent

Analyst: M. S. Vig.

In this small-scale experiment the flake size of the sample is satisfactory for the production of crucible or lubricant grade graphite, and the ash value is also within the specification for both commercial varieties.

5. Kyanite

Soft friable kyanite schists outcrop on the southern shoulder of Garamoso, on the eastern slopes of Geben ya Mayoto, and on the western side of Jariget. Individual schist layers are between 5 feet and 20 feet thick and contain approximately 20 per cent of kyanite in well-developed blades which often stand out from the softer biotite-rich matrix on weathered surfaces. Accumulations of glassy blue kyanite crystals washed from the higher slopes are to be seen in gullies at the eastern foot of Geben ya Mayoto, and a few tons of high-grade alluvial kyanite is readily available in this locality. Elsewhere the kyanite-bearing rocks are deeply weathered and could probably be mined to shallow depths with comparative ease. Neither the size of the kyanite crystals nor their proportion in the rock is sufficient, however, to encourage hard-rock mining.

6. Garnet

Garnet is common in the metamorphosed rocks of the Cherangani series, occurring in biotite schists, calcareous gneisses and amphibolites, where it is found as small grains seldom exceeding 5 mm. and making up only a minor portion of the rocks. It has, therefore, no economic significance.

Dark brown rocks outcropping below the cliffs east of Chebororua, and on the crest of Sembeywa, are, however, highly garnetiferous, containing over 60 per cent of granular garnet intergrown with quartz and occasionally diopside; the rocks are thin sheets or lenticles enclosed in calcareous gneisses and measure up to 6 feet in width, extending along the strike for several hundred feet so that the amount of available garnet is considerable.

At Kokorowa, an exceptionally coarse garnet-amphibolite outcrops over an area of about two acres on the long spur to the east of Kapserwa. The contained garnets measure up to 2 inches in diameter, while the surrounding soils and hill slopes below the outcrop carry gravels composed almost entirely of marble-sized fractured garnets.

7. Talc

Talcose actinolite schists were recorded at the north-western end of Ndalat. The talc is impure and intimately mixed with amphibole and mica in the few outcrops to be seen, but further prospecting in the talcose layers of this area might locate lenses of pure talc.

8. Quartzite

Quartzites of the southern Cherangani hills are extremely pure and of considerable thickness in the Chemurokoi, Kapsiliat and Karuna areas. The coarse and highly crystalline beds are usually free from micaceous or graphitic folia and are often ash-white on external surfaces and translucent internally. The proportion of contained iron in selected outcrops is liable to be sufficiently low to permit their use as a source of silica in the manufacture of glass and refractories.

9. Limestone

Several thousand tons of limestone suitable for calcining for agricultural or building lime is available in the Moiben valley. The magnesia content of the crystalline limestones may not be uniformly low enough to permit their use in the manufacture of standard cement. Some of the outcrops are pink in colour and dappled or banded with green minerals, so they may have possibilities as ornamental stone.

10. Ballast and Road-Stone

Phonolitic lava, although not ideal material for use as road-metal or ballast, is so abundant in the Uasin Gishu that it is used extensively. The phonolite is quarried from the western plateau escarpments three miles north-west of Eldoret, and also at Matunda hill.

Apart from the local demand for road foundation material in the vicinity of Eldoret and Kitale, requirements for surfacing the existing earth roads of the plateau are largely met from murram pits excavated in superficial earthy lateritic ironstone deposits which are common on the lava surface.

11. Building-Stone

Rock suitable for quarrying and dressing into building-blocks is rare in the area. Both phonolite and gneiss have been used as building-stone in the past, but the former is extremely difficult to dress and the latter is likely to be fissile and variable in composition.

The survey of the area demonstrates that in places the phonolites of the Uasin Gishu are underlain by tuffs and grits some of which are likely to provide good building-material. The beds are thin and comparatively soft so that they are nearly always masked by talus shed from the hard overlying phonolite; because of this they were only seen in outcrops near Moiben and Selby Falls. Elsewhere loose blocks of tuff mixed with phonolite near the Basement System-phonolite contact indicate these beds may be extensive, and it is considered that prospecting accompanied by shallow pitting at selected sites near the base of the phonolite would reveal further localities where building-stone is available. The sinuous margin of the phonolite has a length of about 135 miles in the area (*see* coloured geological map at end), so that the contact extends through a large number of farm plots. It does not follow, however, that tuffs or grits underlie the edge of the phonolite everywhere, since these basal rocks are likely to have accumulated in broad pockets.

Horizontal blue tuffs outcropping about 200 feet below the crest of the escarpment north of Moiben, on Plots 6837, 3764 and 850, are approximately 10 feet thick and would require selective quarrying along the strike to avoid removal of prohibitive amounts of lava overburden. This is also applicable to the outcrops in the Sosiani valley, on Plot No. 771. In each of these localities the tuffs are virtually unstratified and should cut equally well in all directions.

12. Water

The principal rivers flowing through the area rise in the high forested country bordering the rift valley at Elgeyo where the drainage of the smaller tributaries is controlled by the absorbent forest soils. The upper Nzoia river is fed by the Moiben, Arobobutch, Charangai and Losurua streams and becomes a sizeable river at Hoey's Bridge. The south and central parts of the area are drained by the Sosiani, Sergoit and Kipkarren rivers. Eldoret obtains a municipal water-supply from a tributary of the Sosiani, the Ellegirini river, rising in the Kaptagat forest to the south of the area; while Kitale pumps water from the Itobbus river, a tributary of the Nzoia, rising on Mount Elgon. Flow statistics for some of the rivers in the area from the records of the Hydrology Section, Ministry of Works, Nairobi, are given below:—

TABLE IV—ANNUAL FLOW OF RIVERS IN THE ELDORET AREA

*Mean Flow in cusecs**

Year	NZOIA R.	ITOBBUS R.	SOSIANI R.	SERGOIT R.
	Three miles upstream from Hoey's Bridge	Near Glanville's Halt	At Eldoret	Seven miles E. of Eldoret
1949	71·7	31·2	59·9	11·57
1950	106·4	66·0	31·5	6·14
1951	133·1	41·0	150·5	32·9
1952	100·5	34·3	143·4	35·7
1953	66·6	30·1	20·9	4·1
1954	91·2	54·5	72·5	16·8
1955	86·5	46·3	46·1	10·1

*cusec—volume of water passing a given point measured in cubic feet per second.

Farms adjacent to the larger rivers and tributaries obtain their water by ram, and those not so fortunately situated from boreholes, earth dams, and roof catchments. Furrows are used to draw water from the steeper watercourses in the southern Cherangani hills for both irrigation and the generation of domestic electricity. During recent years the most successful method of water conservation has been achieved by the construction of numerous small dams which collect the seasonal run-off from minor streams on the flanks of the hills. On the elevated Uasin Gishu plateau, however, available surface water is limited; the generally flat country is crossed by comparatively few streams and receive less rainfall than the neighbouring areas to the west and north (*see* p. 2), in such circumstances ground-water obtainable by bore-holes assumes some importance.

Available records of some eighty-six water-borings made in the Eldoret area are summarized in Table V. The bore-holes ranging between 128 and 500 feet in depth, are distributed over the whole area (Fig. 8); those sited in the rocks of the Basement System generally obtain water from the upper pervious and decomposed zone in a relatively impervious crystalline foundation, whilst bore-holes sited in the phonolite draw water from both the upper decomposed levels of the lava and deeper basal portions of separate flows where intercalated tuffs or volcanic ash provide aquifers. Some of the deeper drillings reach through the phonolites to the metamorphic rocks beneath, and obtain their main supply from this level.

Collation of bore-hole rest levels indicates that movement of ground-water in the phonolites is westwards away from the high shoulder of the Elgeyo escarpment and down the hydraulic gradient towards the lower areas of the plateau near Ziwa, Soy and Leseru, where water often issues from the base of the phonolite in scattered springs situated at the heads of valleys incised into the edges of the phonolite escarpment. The Karuna fault lies athwart this direction of movement so that water is forced to the surface at several springs located on the line of the fault (Fig. 7). The Moiben fault, lying to the west of the Karuna metamorphic strip, has the opposite effect on groundwaters, permitting them to sink to lower levels and escape northwards towards the Moiben valley, as shown by the failure to reach water at 450 feet in bore-hole C. 1658 sited near to the fault-zone about 800 yards north of

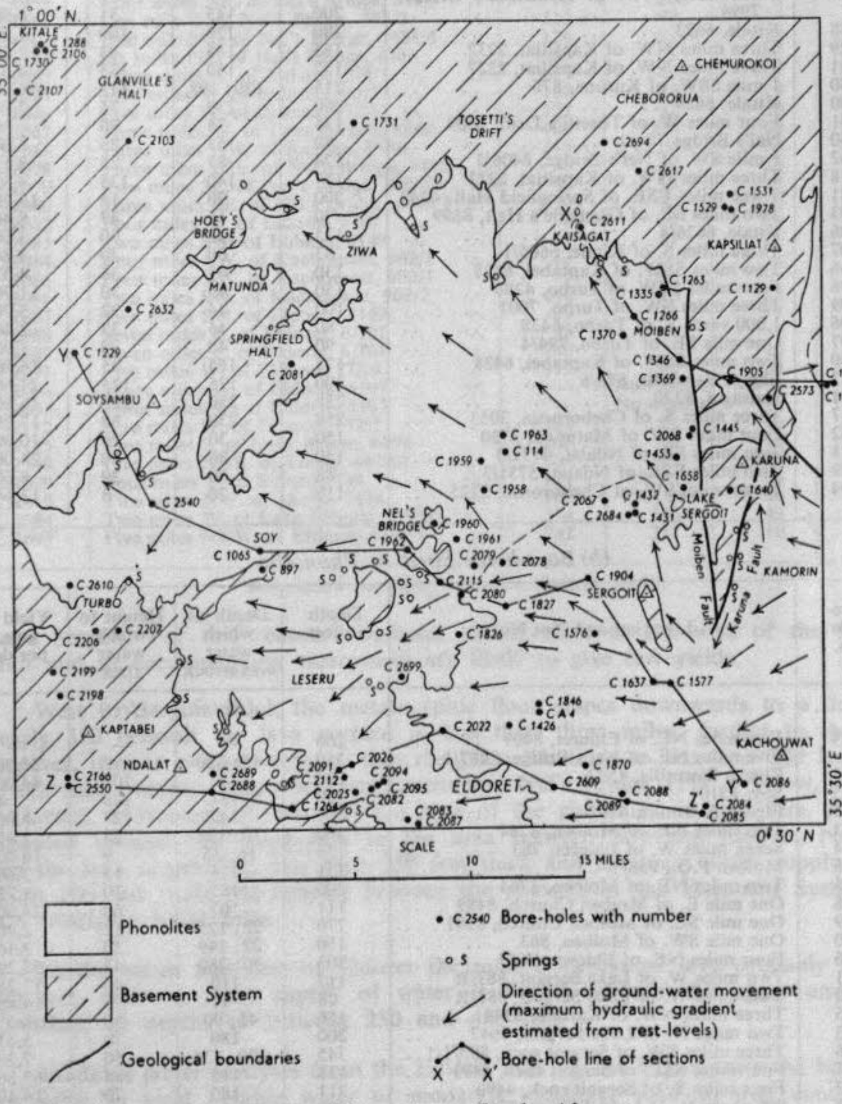


Fig. 7—Location of bore-holes and springs in the Eldoret area.

TABLE V—BORE-HOLES IN THE ELDORET AREA

(From records of the Hydraulic Branch of the Ministry of Works)

(a) Bore-holes sited in metamorphic rocks of the Basement System

Bore-hole No.	Location and Plot No.	Depth in feet	Depth at which water was struck (*feet*)	Height to which water rises (*feet*)	Yield in gals. per day
C.897	One mile S. of Soy, 8510/R	105	95	4	5,700
C.1129	Two miles S. of Kapsiliat, 3051	500	190; 410	138	5,280
C.1229	Three miles NW. of Hemstead's Bridge, 7994..	200	145	51	8,800
C.1288	Kitale, 6623	180	120	100	1,200
C.1529	Three miles NW. of Kapsiliat, 2232 ..	165	145	93	2,000
C.1531	Three miles NW. of Kapsiliat, 2227 ..	157	140	135	4,320
C.1640	1 mile SSW. of Karuna, 876	215	120; 198	112	36,000
C.1730	Kitale, 6624	260	230	75	2,900
C.1731	Four miles W. of Tosetti's Drift, 6509 ..	135	78	70	360
C.1960	Nel's Bridge 781/2	80	53	28	6,000
C.1962	1 mile SW. of Nel's Bridge, 8406/4 ..	124	87	25	3,120
C.1978	Three miles NW. of Kapsiliat, 2232 ..	157	140	135	4,320
C.2081	Three miles ESE. of Springfield Halt, 4340	200	70	15	13,200
C.2103	Two miles SE. of Glanville's Halt, 8699 ..	70	55	47	8,400
C.2106	Kitale, 6626/8	135	102	90	3,600
C.2107	Three miles S. of Kitale, 6605/1	83	60	30	3,840
C.2166	Two miles SSW. of Kaptabei, 6428 ..	130	45	36	4,320
C.2198	Four miles SSW. of Turbo, 4286	150	45	30	11,760
C.2199	Three miles SW. of Turbo, 7001	100	44	32	5,760
C.2206	1,000 yards S. of Turbo, 6438	80	45	33	2,400
C.2207	One mile SE. of Turbo, 794/4	90	40	30	1,900
C.2550	Two miles SSW. of Kaptabei, 6428 ..	178	165	45	16,800
C.2573	Elgeyo Sawmills, 873/6	300	175	135	21,600
C.2611	Kaisagat, 8320	258	250	120	16,800
C.2617	Three miles S. of Chebororua, 3053 ..	258	230	80	17,280
C.2632	Four miles SW. of Matunda, 3730 ..	150	30	28	10,000
C.2688	Two miles SE. of Ndalat, 5731/3	120	86	30	24,000
C.2689	Two miles ESE. of Ndalat, 5731/3.. ..	88	70	30	8,600
C.2694	Three miles SW. of Chebororua, 2225 ..	110	20	8	13,440

(b) Bore-holes Sited in Phonolite

Bore-hole No.	Location and Plot No.	Depth in feet	Depth at which water was struck (*feet*)	Height to which water rises (*feet*)	Yield in gals. per day
C. A/4	Five miles NE. of Eldoret, 8409	200	—	—	—
C.114	Five miles NE. of Nel's Bridge, 8487/1 ..	350	45; 320	30	24,000
C.1044	Elgeyo Sawmills, 4592	298	142	107	44,000
*C.1065	Soy, 8510	350	181	148	40
C.1074	Elgeyo Sawmills, 4592	400	147	127	48,000
*C.1263	Two miles NE. of Moiben, 3764	300	30; 135	25	3,450
C.1264	Seven miles W. of Eldoret, 763	125	16; 35	9	14,400
*C.1266	Moiben P.O., 858/1	351	175	15	3,600
*C.1335	Two miles NE. of Moiben, 3764	200	185	20	1,728
*C.1346	One mile E. of Moiben Church, 8489 ..	111	107	60	24,000
C.1369	One mile SE. of Moiben Church, 8181 ..	270	22; 125	12	2,400
C.1370	One mile SW. of Moiben, 863	150	22; 149	20	3,168
C.1426	Four miles NE. of Eldoret, 7643	303	50; 280	43	55,200
C.1431	Two miles W. of Lake Sergoit, 883/R ..	117	110	40	17,280
C.1432	Two miles W. of Lake Sergoit, 883/R ..	28	11	5	14,400
*C.1445	Three miles NW. of Karuna, 8344.. ..	156	45; 90	30	Dried up
*C.1453	Two miles N. of Lake Sergoit, 8647 ..	200	180	70	5,630
*C.1576	Three miles SW. of Sergoit rock, 893/1/1 ..	345	290; 335	50	7,200
*C.1577	Four miles SSE. of Sergoit rock, 4491 ..	138	115	88	63,360
*C.1637	Four miles S. of Sergoit rock, 4490 ..	211	180	70	14,400
*C.1658	800 yards N. of Lake Sergoit, 876	450	—	—	Nil
C.1826	Four miles SSE. of Nel's Bridge, 890/1 ..	150	63; 120	5	14,400

(b) Bore-holes Sited in Phonolite—(*Contd.*)

Bore-hole No.	Location and Plot No.	Depth in feet	Depth at which water was struck (*feet*)	Height to which water rises (*feet*)	Yield in gals. per day
C.1827	Four miles SE. of Nel's Bridge, 888/5 ..	150	40; 140	15	34,560
C.1846	Five miles NE. of Eldoret, 8409	425	100; 425	35	9,600
C.1870	Six miles ENE. of Eldoret, 898	350	241	60	40,800
*C.1904	Three miles WNW. of Sergoit rock, 886/2	400	51; 380	40	10,080
*C.1905	Three miles N. of Karuna, 861/4	200	148	120	10,000
C.1958	Three miles NE. of Nel's Bridge, 879/1 ..	70	50	26	12,000
C.1959	Four miles NE. of Nel's Bridge, 879/1 ..	50	20	8	9,600
C.1961	One mile E. of Nel's Bridge, 781/3 ..	112	98	27	2,880
C.1962	One mile SW. of Nel's Bridge, 8406/4 ..	124	87	25	3,120
C.1963	Six miles NE. of Nel's Bridge, 8383 ..	83	51	17	14,400
C.2022	Three miles N. of Eldoret, 776/1	415	380	75	34,560
C.2025	Five miles W. of Eldoret, 761/1	108	75	24	14,400
*C.2026	Five miles W. of Eldoret, 772/1	122	82	30	12,000
*C.2067	Three miles W. of Lake Sergoit, 8566 ..	400	390	60	4,800
C.2068	Three miles NW. of Karuna, 8344 ..	215	35; 98	30	3,600
C.2078	Three miles ESE. of Nel's Bridge, 8405/1..	60	49	26	9,120
C.2079	Two miles SE. of Nel's Bridge, 8405/2 ..	40	15	8	4,800
*C.2080	Three miles SE. of Nel's Bridge, 6498/1 ..	130	40	6	12,000
C.2082	Four miles W. of Eldoret, 6107	70	35	24	5,280
C.2083	Two miles SW. of Eldoret, 8149	51	39	25	7,680
C.2084	Four miles SW. of Kachouwat, 902/1 ..	83	—	—	Nil
C.2085	Four miles SW. of Kachouwat, 902/1 ..	80	—	—	Nil
C.2086	Two miles SW. of Kachouwat, 902/2 ..	140	70	35	5,760
C.2087	Two miles SW. of Eldoret, 8149	60	31	18	12,000
C.2088	Seven miles E. of Eldoret, 6/101	98	—	—	Nil
C.2089	Seven miles E. of Eldoret, 6/101	80	35	18	5,760
C.2091	Five miles W. of Eldoret, 772/4	117	82	34	14,400
C.2094	Three miles W. of Eldoret, 6107	—	No records	—	—
C.2095	Three miles W. of Eldoret, 6107	—	No records	—	—
C.2112	Five miles W. of Eldoret, 772/5	122	98	30	1,200
*C.2115	Two miles S. of Nel's Bridge, 6498 ..	200	80	10	12,000
*C.2540	Five miles NNE. of Turbo, 4479/1 ..	204	184	26	16,800
C.2609	Four miles E. of Eldoret, 734	231	85; 110	64	56,000
C.2610	Two miles NW. of Turbo, 7446	100	30; 88	26	60,000
C.2684	Two miles W. of Lake Sergoit, 883/R ..	354	340	49	28,800
C.2699	Five miles NNW. of Eldoret, 6500/1 ..	242	231	10	72,000

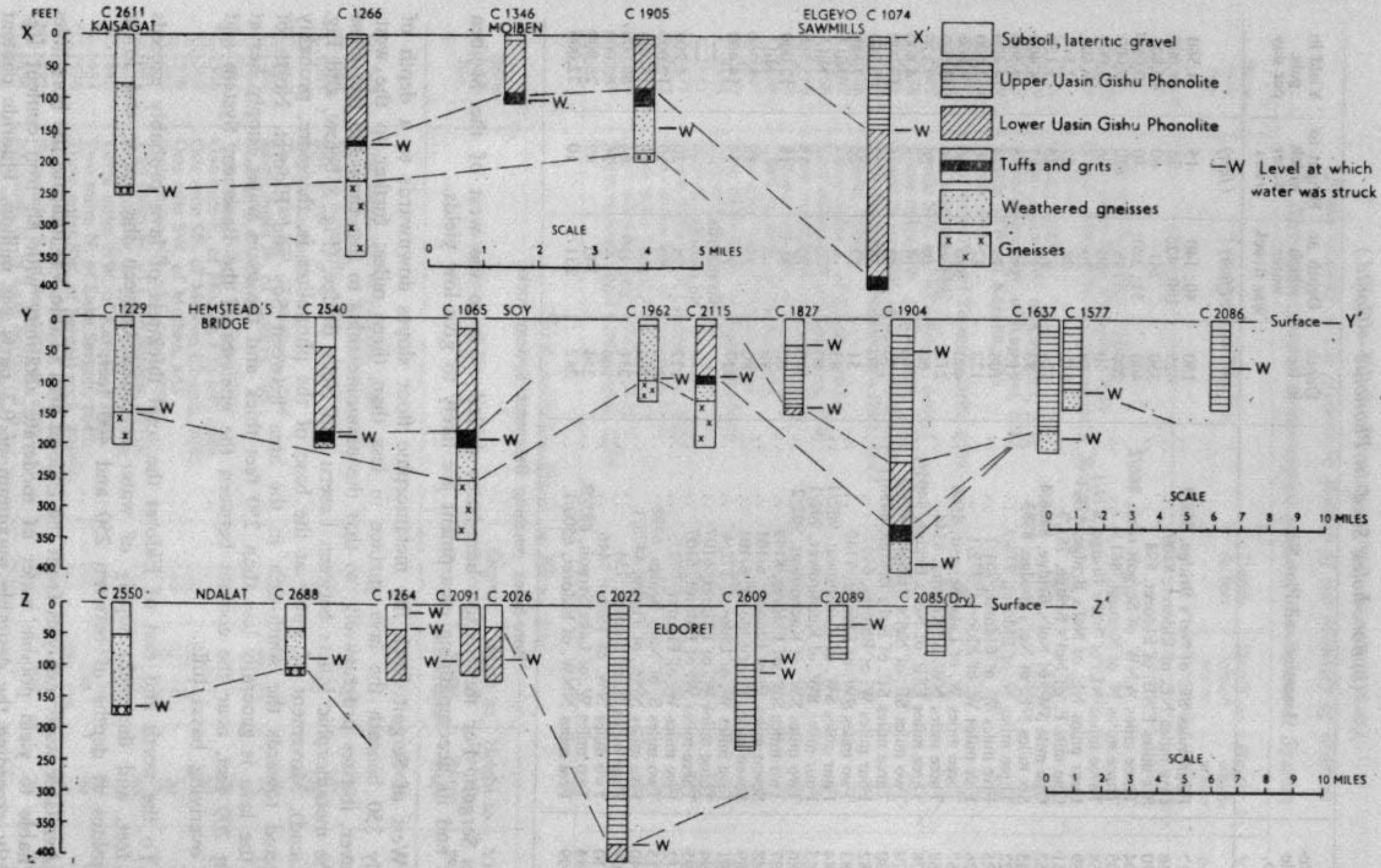
*Bore-holes reaching Basement System rocks.

Lake Sergoit. For this reason bore-holes drilled close to the west of the Moiben fault and its accompanying escarpment are likely to give low yields.

West of Sergoit Rock the metamorphic floor slopes downwards to a depth of nearly 350 beneath the lava surface in less than three miles; further to the west, however, it rises progressively, so that the phonolite thins to less than 100 feet close to the metamorphic inliers between Leseru and Nel's Bridge, (Fig. 8 below, and Fig. 9 at end). Movement of water at the base of the phonolites is, therefore, probably deflected towards the south-west in the area between Soy and Eldoret. North of Soy the lava is generally less than 250 feet thick and the main water supply lies at about 200 feet, near the contact between the gneisses of the Basement System and thin overlying basal tuffs.

To the north and east of Eldoret the total thickness of lava probably exceeds 500 feet, and the main supply of water is found between the upper and lower phonolites at depths of between 250 and 400 feet.

Available water analyses from the Eldoret area (Table VI) indicate the bore-holes are liable to yield potable water of moderate alkalinity with an iron content frequently exceeding the desirable maximum of 0.3 parts per million. Fluoride content is generally less than one part per million, but may exceed this figure, as in water



For lines of section see Fig. 7 and for geological sections see Fig. 9

Fig. 8—Selected bore-hole sections from the Eldoret area.

analysed from bore-hole C.1266. Two analyses of well-water from Moiben, and river water from Chebororua, contain excessive amounts of iron which can be suitably reduced by addition of lime to produce potable water.

TABLE VI—WATER ANALYSES FROM THE ELDORET AREA
(From Records of the Hydraulics Department, Ministry of Works)

Sample No.	Parts per Million								
	pH	$CaCO_3$	NH_3	Cl	SO_4	NO_2	Fe	SiO_2	F
Rivers									
2497 ..	7·0	40	0·18	1	tr	pres	2·9	20	0·2
857/8 ..	7·5	206	0·30	5	tr	pres	0·9	26	0·8
986 ..	7·1	62	0·03	7	tr	pres	0·7	20	0·5
Wells* and Bore-holes									
1055* ..	5·8	50	0·64	6	nil	pres	2·5	36	0·9
1056* ..	6·3	113	1·9	14	nil	pres	3·2	30	0·5
1806 ..	8·0	264	tr	65	10	nil	0·5	30	6·3
1833 ..	7·8	104	0·12	1	nil	pres	tr	50	0·2
1194 ..	7·5	90	0·11	0·16	7	pres	0·4	25	0·1
232 ..	6·7	133	0·14	15	13	nil	0·3	30	0·8
522 ..	8·3	85	nil	1	nil	nil	1·5	30	0·2
Springs									
2729 ..	5·9	87	0·25	4·0	tr	nil	3·2	18	0·6
202 ..	6·3	60	0·28	4·0	8	nil	—	—	0·7

2497 Chebororua River S. Cherangani Hills.
857/8 Little Nzoia River.
986 Sosiani River, Turbo.
1055 Well "A" Moiben Trading Centre.
1056 Well "C" Moiben Trading Centre.
1806 Bore-hole C.1266. Moiben.
1833 Bore-hole C.2025. Five miles W. of Eldoret.
1194 Bore-hole C.2540. Five miles NNE. of Turbo.
232 Bore-hole C.1426. Four miles NE. of Eldoret.
522 Bore-hole C.2688. Two miles SE. of Ndalat.
2729 Spring S. of Moiben Post Office.
202 Spring near Moiben Trading Centre.

13. Hydro-Electricity

The Sosiani river at Selby Falls is utilized to drive two water turbo-alternators each generating 180 kilowatts of electricity for local consumption in Eldoret. The river is controlled by a weir immediately above the falls, thus providing a normal working head of 100 feet above the intakes of the turbines which are housed a few hundred yards from the foot of the falls.

Elsewhere in the area, two locations are favourable for small hydro-electric schemes similar in scope to that at Selby Falls, but in each case the cost of water control would be higher than those incurred at Selby Falls.

The first favourable site is at the confluence of the Sosiani and Kipkarren rivers, approximately five miles south-west of Turbo. Here the flow of the Sosiani is more than twice that at Selby Falls, since it is combined with that of its tributaries, the Sergoit and Kaigat. For about a mile before reaching the Kipkarren, the Sosiani descends a steep and rapid section above which weir control would provide a working head of over 100 feet for a generating station situated near the confluence of the rivers.

The second possible site is in the upper Moiben valley about three miles to the south of Kapsiliat, where the Moiben river passes through a deep, narrow gorge with a gradient of about 300 feet per mile. The volume of the river here is probably less than that of the Sosiani at Eldoret, but is well maintained because of its proximity to the forest area, and damming between the rock walls of the gorge above the steepest section would augment the head of water provided by the valley gradient.

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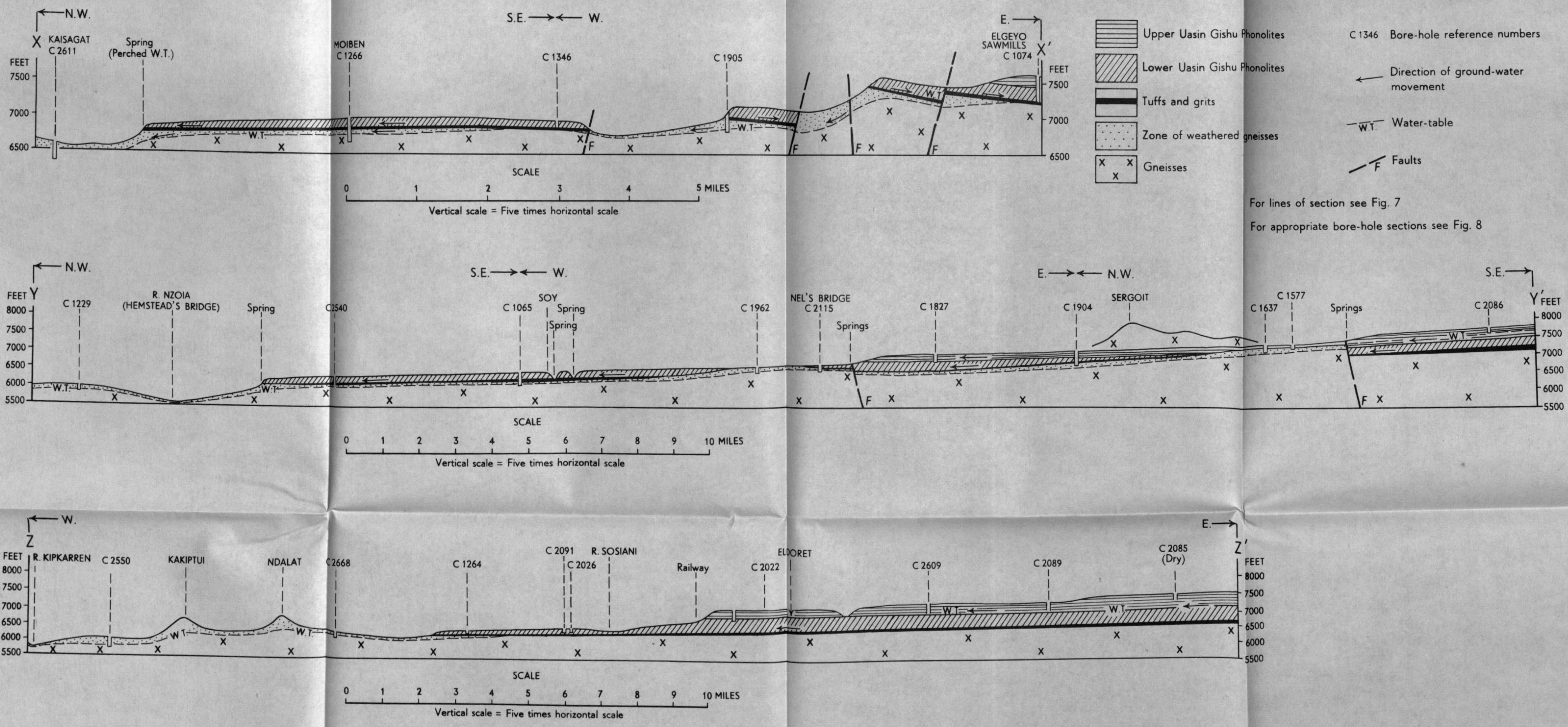


Fig. 9. Geological sections based on bore-hole data

GEOLOGICAL MAP OF THE ELDORET AREA

To accompany Report No. 64

DEGREE SHEET No. 34, NORTH-WEST QUARTER (Directorate of Overseas Surveys Sheet No. 89)

FOR REPORT AND MAP OF THE AREA FURTHER NORTH SEE REPORT No. 35, "GEOLOGY OF THE CHERANGANI HILLS AREA" BY J. M. MILLER, 1956

FOR REPORT AND MAP OF THE AREA FURTHER SOUTH SEE REPORT No. 63, "GEOLOGY OF THE KAPSABET-PLATEAU AREA." BY D. J. JENNINGS.

Del. A. COUTINHO

EXPLANATION

TERTIARY

- Tvp₂ — Upper Uasin Gishu phonolites
- Tvp₁ — Lower Uasin Gishu phonolites
- Miocene: Tmf — Tuffs, tuffaceous grits, agglomeratic tuffs

BASEMENT SYSTEM (Not in stratigraphic order)

ARCHAEAN

- Psammitic: Xq — Quartzites
- Semi-Pelitic: Xsc — Quartzo-felspathic para-gneisses and biotite para-gneisses with thin biotite-hornblende para-gneisses
- Pelitic: Xs — Kyanite-garnet schists, kyanite-sillimanite schists, biotite-garnet schists, biotite-muscovite schists, graphitic schists
- Calcareous: Xl — Crystalline limestones
- Calcareous: Xc — Hornblende-diopside-epidote-sphene para-granulites and para-gneisses
- Xp — Laminated para-gneisses and schists, undifferentiated
- Xb — Biotite-hornblende gneisses
- Xhh — Hornblende gneisses
- Xhg — Garnet amphibolites
- Xg — Microcline-oligoclase-biotite-hornblende migmatites with granitic sheet and vein reticulation
- Xma — Banded microcline augen-gneisses, metasomatized porphyroclastic sheared gneisses and mylonites
- G Gh — G Gneissose flow-foliated porphyroblastic microcline granites or granodiorites with biotite hornblende xenoliths, and pegmatites; Gh Hornblende granites

INTRUSIVES

- Uo — Peridotites
- D — Dolerites

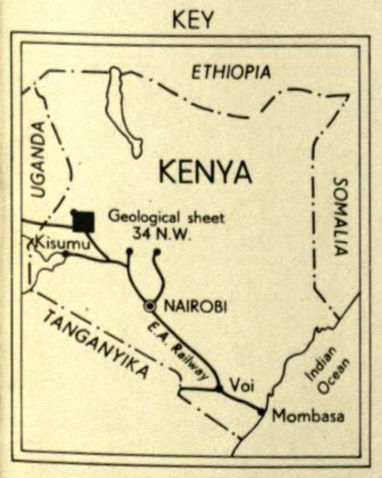
Geological boundaries, observable
Geological boundaries, approximate
Geological boundaries, gradational
Dip of foliation
Vertical foliation
Horizontal foliation
Strike of foliation, dip not shown
Dip of cleavage
Vertical cleavage
Plunge of lineation
Minor folds with plunge
Joints, inclined
Joints, vertical
Flow layers, with dip
Flow layers, vertical
Preferred orientation of phenocrysts
Faults, normal, with dip
Faults, inferred
Faults, hinge
Thrust-zones with dip
Mylonite zones
Mineral localities
Giant quartz veins

Railway
Main roads
Secondary and private roads
Primary trigonometrical stations
Secondary trigonometrical stations
Plane-table resected points
Spot-heights in feet
Form-lines at 200-ft. intervals
Principal points of aerial photographs
Escarpments
Bore-holes with numbers
Springs
Permanent water
Falls or rapids, dams
P. Police Post; P.O. Post Office
Farm boundaries with L.R. numbers (not all shown)
District boundaries
Forest Reserve boundaries
Line of section

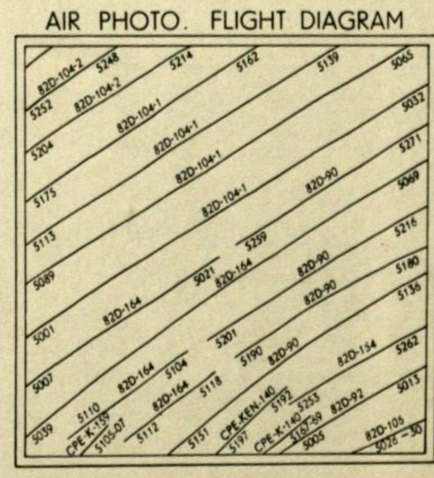
Plot boundaries and railways based on 1:62.500 Cadastral Sheets North A-36 / X-I-(a.b.c.d)

Magnetic declination approximately 3°00′W.

KEY



AIR PHOTO. FLIGHT DIAGRAM



MINES & GEOLOGICAL DEPARTMENT. KENYA
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Scale 1:125,000

MILE 1 0 1 2 3 4 5 6 7 8 9 10 MILES

1 inch = 1·972 miles or 1·014 inches = 2 miles

GEOLOGICALLY SURVEYED BY L. D. SANDERS, GEOLOGIST
Between February and August 1957

SECTION FROM A to E
Scale equal to that of map
Vertical scale = Horizontal scale