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MINISTRY OF NATURAL RESOURCES
GEOLOGICAL SURVEY OF KENYA

GEOLOGY OF THE LALI HILLS-DAKADIMA AREA

DEGREE SHEET 61, SW. QUARTER
(with coloured geological map)

by

R. G. DODSON, M.Sc., Ph.D.
Geologist

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FOREWORD

In mapping the Lali Hill-Dakadima area Dr. Dodson was perhaps unfortunate in having to cover nearly 1,200 square miles of uninhabited country with only one small rock outcrop. Indeed, the very title of the report is taken from hills which lie outside the area, but which the author mapped in order to gain some clues as to the intervening geology. In view of the almost complete absence of outcrops and float material geophysical methods (magnetic and gravity) were resorted to in a fairly successful attempt to elucidate the structure of the hidden rocks of the area.

Dr. Dodson concludes that the area has no economic possibilities, and its best potential is its present use as a game area.

B. H. BAKER,
Commissioner of Mines and Geology.

16th February 1966.

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ABSTRACT

The report describes an area in Eastern Kenya of 1,181 square miles extent, bounded by the meridians 39° 00′ E. and 39° 30′ E., and by latitudes 2° 30′ S. and 3° 00′ S. The area lies to the north of the mid-Galana valley, and is situated between the Lali Hills in the south and Dakadima in the north.

The area falls within a single physiographic unit: the vast plain known throughout East Africa as the end-Tertiary peneplain.

With the exception of a small exposure of lava in the south-western corner, the area is devoid of any rock exposures. Dakadima, a small hill to the north of the area, was mapped, and a description of this hill is included in the report. Magnetometer and gravimeter traverses carried out in the area are described.

GEOLOGY OF THE LALI HILLS-DAKADIMA AREA

I—INTRODUCTION

General.—The area described in this report is the south-western quarter of degree sheet 61 (Kenya), Director of Overseas Surveys sheet No. 185, bounded by meridians 39° 00′ E. and 39° 30′ E., and by latitudes 2° 30′ S. and 3° 00′ S., of which the extent is 1,181 square miles. The area includes a portion of the Tsavo (East) National Park and is divided by the Kilifi and Tana river district boundaries.

Population.—The region is uninhabited, the nearest human settlement being the small Walengula village of Kisiki Cha Mzungu, a few miles from the south-eastern corner of the area. During particularly favourable rainy seasons Wagalla tribesmen have been known to wander as far south as the northern limits of the area in search of grazing for their flocks of sheep and goats, but generally the complete lack of water, the harsh nature of the country and the abundance of tsetse-fly have prevented human settlement.

The area includes a number of rhinoceros, elephant, carnivores and some species of antelope, but up until 1957 this region was the scene of poaching on a tremendous scale. During 1957 personnel of the National Parks Administration and the Game Department conducted an anti-poaching campaign, and within the limits of the present area alone about 1,000 elephant skeletons and carcases were discovered.

Climate and vegetation.—The area is part of a vast, arid, featureless plain which extends northwards as far as the eye can see. The maximum variation of altitude across the area in any direction is less than 500 ft. To the south the Lali Hills and the Galana Valley form important physical features, while northwards the monotony of the plain is relieved by two low lying hills, Dakadima and Dakadakatha. The vegetation of the area appears to be similarly homogeneous. It consists mainly of low acacia thorn scrub with sparsely distributed euphorbia. In most parts the grass covering is patchy. There are no valleys, river courses or even *lagas*, (dry gullies similar to those of the North-Eastern Region) although numerous depressions do hold water for short periods after the rains, acting as localized centres of internal drainage.

Communications.—An indifferent road connecting Mambrui on the coast with Lugard's Falls and Mutha, passes through the south-western corner of the area. A track between Lali and Dakadima, originally cut by the National Parks Administration during the anti-poaching campaign, was cleared sufficiently to make it passable to motor vehicles, but in view of the poor state of this track and the rapidity of local vegetation growth, it is unlikely that it will remain recognizable as such for more than a year unless it receives some attention in the future. To carry out a west-east geophysical traverse across the area, a straight line was cut through the bush in an approximately easterly direction from the surveyed bench mark level 98 to the eastern boundary, meridian 39° 30′ E. This motorable track too will become unrecognizable unless it receives attention within the next few years.

Strangely enough, an airstrip is situated on the eastern side of Dakadima. The history of this airstrip is interesting. Prior to the 1939–1945 war, Count von Blixen, the famous hunter, managed to establish a rough track between Lali and Dakadima. He cleared the bush on the eastern side of the hill sufficiently to prepare a rough airstrip which he used for landing hunting safari parties flown from Nairobi. The landing strip received scant attention in the following years until the advent of the anti-poaching campaign in 1957 when personnel of the National Parks Administration cleared the runway once more to allow the landing of supplies and equipment for the field teams engaged in the operations.

Maps.—Mapping of the area presented some problems. The 1/500,000 scale map (Voi E.A.F. No. 1714), at present the only large-scale topographical map of the area, shows two hills, Dakadima and some miles to the north-east, Dakabima. During the course of this survey it became obvious that the two hills shown were, in fact, mistaken localities for a single hill, Dakadima. An attempt at fixing the position of this hill by plane-table resection was made by the writer, but in view of the great distances of the fix points used, some of which were over eighty miles away, the fix-point was insufficiently accurate. Mr. P. Sutcliffe, resident surveyor of the Survey Department, Mombasa, fixed an astral point at Dakadima and another at Kona Lali, a mud wallow to the north-west of Lali. The final map was drawn from kodatrace strips on which data from air photographs had been drawn, and reduced to a 1/83,333 scale.

Acknowledgments.—The writer wishes to express his thanks to Messrs. W. Woodley and D. Sheldrick of the Tsavo National Park (East) for whose kindness and assistance he is greatly indebted.

II—PREVIOUS GEOLOGICAL WORK

Little geological work had been carried out in the area prior to the present survey. As far as is known none of the early explorers such as Captain F. D. Lugard and J. W. Gregory reported specifically on the present area. The early caravan route along the Galana valley, followed by several explorers, passed through the relatively open bush within a mile of the Galana river. In 1957–58 geological investigations of the coastal region by B.P.-Shell Petroleum Development Company of Kenya Ltd. included a gravimeter traverse along the Mutha-Mambrui road, part of which is included in the area. The results of this work, however, are confidential.

Sanders described the geology of the Mid-Galana area to the south (Sanders, 1959)*. He considered the Mid-Galana area to be part of the *Nyika*, the third of three physiographic zones of the coastal belt described by Gregory (1896, pp. 222–3). He added that the Nyika forms part of the end-Tertiary erosion surface. Rocks of the Basement System occupy the south-western portion of this area and a wedge-shaped inlier extends northwards from the Galana valley. He described the Basement System rocks as a high-grade metamorphic sedimentary succession, typically made up of such rock types as graphitic limestones, calc-silicate schists, biotite and hornblende gneisses, amphibolites, and granitoid gneisses. He divided the Duruma Sandstones into three broad lithological units with a total thickness of some 15,000 ft.:—

Duruma Sandstones	Upper	4. Mazeras Sandstones and Shimba Grits.
	Middle	3. Mariakani Sandstones. 2. Maji ya Chumvi Beds.
	Lower	1. Taru Grits.

The upper division of the Mariakani Sandstones is absent in the Mid-Galana area but his subdivision of the lower and middle divisions is as follows:—

THE DURUMA SANDSTONES OF THE MID-GALANA AREA

Series	*Group*	*Thickness in Feet*
Mariakani Sandstones	7. *Mottled sandstone group*—Current-bedded, micaceous, poorly cemented sandstones. Unfossiliferous. Conglomerate and interformational breccias at base	2,500
	—Unconformity and overlap—	
Maji ya Chumvi Beds	6. *Upper shale and flagstone group*—Shales and flagstones with *Estheria*. Marine neritic beds with *Eotriassic fish*	2,800
	5. *Lower shale group*—*Palaeanodonta* beds, carbonaceous shales, thin calcareous sandstones, limestones. *Voltzia, Ullmania*	2,000

*References are quoted on p. 13.

Series	Group	Thickness in Feet
	—Disconformity—	—
	4. *Calcareous group*—Calcareous flagstones, thin siliceous limestone, oolitic limestone	500
	3. *Sandstone group*—Conglomerates, felspathic sandstones, calcareous sandstones, mudstones..	2,000–3,000
Taru Grits	—Probable Unconformity—	
	2. *Arkose group*—Thick arkose wedges grading upwards into felspathic grits, and carbonaceous shales with carbonized plant remains	1,000–4,000
	1. *Basal group*—Conglomerate, arkose, tillite .. —Unconformity—	100–200
		10,900–15,000

Structurally the Duruma Sandstones form a northward pitching syncline in the north-west of this area, the eastern unit dipping coastward.

The geology of the area to the west is described in a Geological Survey report by Sanders (1963, Voi-South Yatta area). The main physiographic units of this region are (1) the prominent Yatta Plateau, formed by Kapiti type phonolite, (2) remnants of the sub-Miocene bevel, (3) the end-Tertiary erosion surface. The rock types described by Sanders consist of Basement System schists, gneisses, granulites, and limestones, Duruma Sandstones, and the Yatta phonolite.

The area to the east, extending from the eastern boundary of the present area to the coast-line, was described in a Geological Survey report by Williams (1962, Hadu-Fundi Isa area). He pointed out that of the three physiographic divisions of the coastal belt suggested by Gregory, the Nyika coincides roughly with the distribution of the Permo-Trias Duruma Sandstones, adding that this plain occupies the western part of the Hadu-Fundi Isa area, adjacent to the present area. Williams recognized three main tectonic directional trends in the coastal region.

(i) N.N.E.—S.S.W.

(ii) N.W.—S.E.

(iii) E.—W.

III—PHYSIOGRAPHY

Erosion Surface.—The Lali Hills-Dakadima area is part of a vast plain which covers most of the eastern and north-eastern part of East Africa. Known as the end-Tertiary erosion surface, the plain extends in most directions as far as the eye can see. Locally the plain slopes down in an approximately easterly direction from 900 ft. in the west to just below 500 in the east, an overall slope of about 11 ft. per mile. The slope appears to be uniform but detailed altitude measurements along a west-east cut-line show a distinct step in the slope (*see* Fig. 1).

Comparison of the altitudes along traverse lines to the north of the cut-line confirm the extension of this step. Two possibilities explaining this feature may be considered. It may have been caused by the heaping up of material eroded from the sub-Miocene bevels west of the present area and deposited along the margins of the older surface, or alternately the step may correspond with a fault-line having an easterly downthrow, evidence for which is obscured by overlying Quaternary soil deposits. The writer favours the latter explanation, particularly in view of data provided by Thompson (1956, p. 42) and Sanders (1959, p. 40), indicating that the coastal belt was subjected to faulting as late as the Pliocene or Pleistocene.

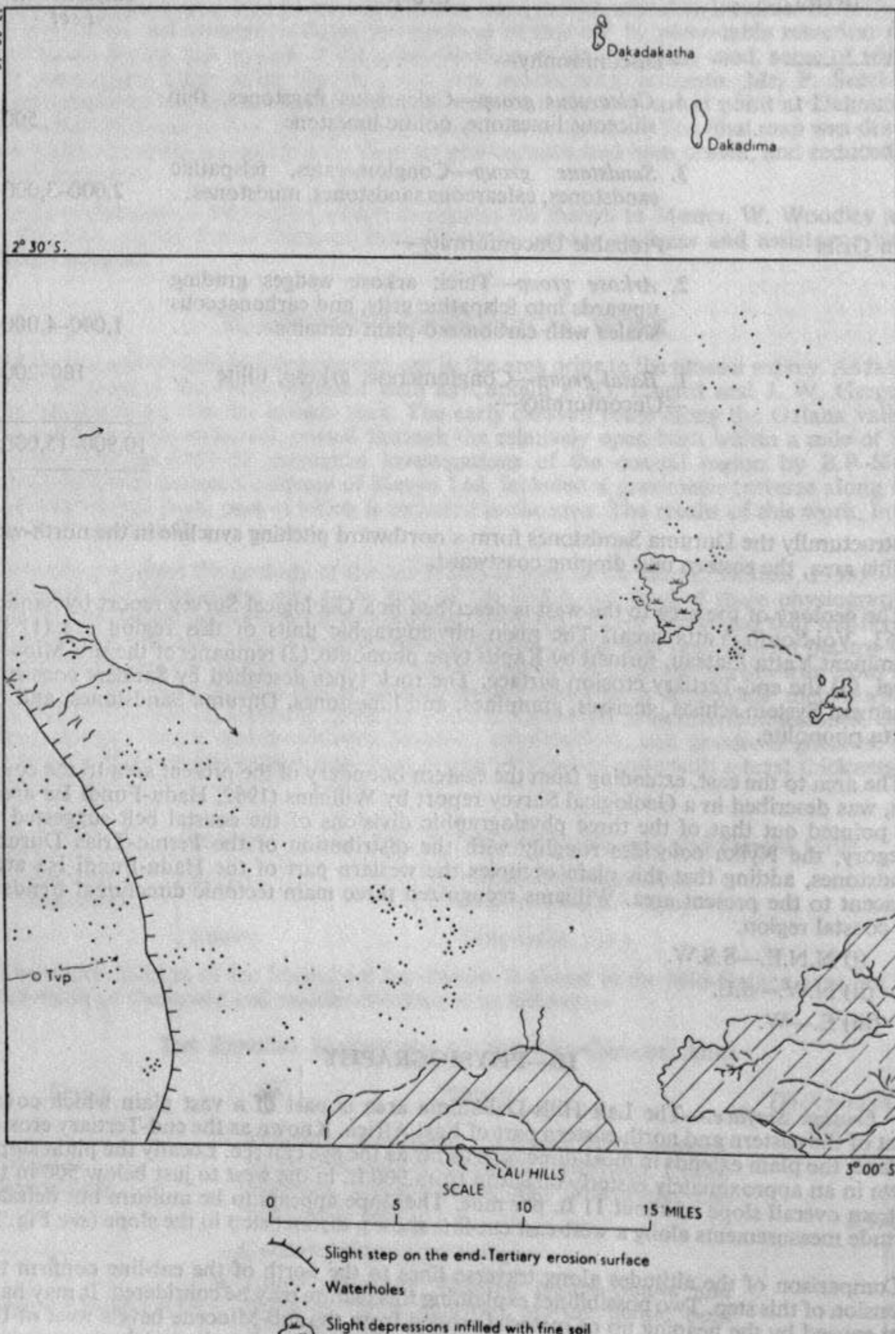


Fig. 1.—Physiographic sketch map of the Lali Hills-Dakadima area.

Drainage.—With the exception of the indistinct valley which curves around the northern slopes of Lali, and a few barely recognizable river courses in the south-eastern corner of the area, the region is devoid of recognizable outflowing drainage. Moreover the minor valleys mentioned are recognizable only on air photographs. In the field they can be detected only because of a change in the type of soil from the typical coarse, buff-coloured sandy soils covering most of the area, to a fine grey powdery type of valley infilling, typical of valley deposits in most arid parts of East Africa.

Numerous water-holes in the area form localized centres of internal drainage. The water-holes are concentrated along broad zones which may represent primitive valleys infilled with soils. In general appearance these water-holes resemble the pans described by Thompson and Dodson (1958, p. 3) in the Derkali area of north-eastern Kenya. They are roughly circular in shape and occupy the centres of local depressions, receiving the surface run-off from the gently sloping sides of the depressions. The water-holes vary from about 10 yds. to 200 yds. in diameter, the largest holding water in favourable conditions for as long as four months after the rainy seasons, Growth of these "pans" is greatly assisted by visits from wild animals. As the water in each hole dries the pools become muddy, attracting numbers of animals such as elephant and rhinoceros. The animals after wallowing in the holes carry off a considerable amount of mud plastered on their bodies.

On some air photographs discolouration of the vegetation can be detected as irregular light or dark patches. Most of the patches could be recognized in the field as depressions containing soil similar to the valley soils, but in some cases field examination failed to provide an explanation for the change of vegetation, the surface soils showing no variation.

IV—SUMMARY OF GEOLOGY

With the exception of a small exposure of phonolite outcropping in the Lali Hills—Mutha road superficial deposits of soil cover the underlying rock formations of the area. Rocks of the Basement System are neither exposed nor present as float. Examination of the sands derived from the Basement System rocks exposed in the Galana valley to the south proved to be of assistance in tracing the extent of the Basement System in the present area. Rocks of the Duruma Sandstone series, while not exposed in the area, are found as blocks of float in the south-western corner and on the northernmost slopes of the Lali Hills. In addition two hills, Dakadima and Dakadakatha, to the north of the area, are composed of the upper division of the Duruma Sandstones. The exposed phonolite is of the Kapiti type, and it is believed to have been extruded during the volcanic phase responsible for emplacement of the Yatta Plateau.

The superficial deposits in the area consist mainly of reddish to buff sandy soils, grey powdery valley soils, and secondary limestone nodules.

V—DETAILS OF GEOLOGY

1. Basement System

No Basement System rocks are exposed in the present area but to the south Sanders (1959, pp. 8–12) described a succession of calcareous, pelitic, semi-pelitic and psammitic rocks which are exposed as an upfaulted block, best seen in the Galana valley. Judging from the characteristics of the local soils, this wedge of Basement System rocks extends northwards for some distance. Examination of soils known to be derived from Basement System rocks indicates that by comparison with soils derived from the Duruma Sandstones they are characterized by a higher felspar content, slightly greater angularity of quartz grains, and a relative abundance of garnets. The soils are usually dark reddish coloured, the colour being due to an abundance of iron oxide. The continuation of the wedge of Basement System rocks is to a certain extent confirmed by the results of geophysical traverses carried out along a cut line a few miles north of the southern boundary (p. 12).

2. The Duruma Sandstones

There are no outcrops of the Duruma Sandstone series in the area. Dakadima and Dakadakatha, two hills just north of the area, and Lali to the south, are however composed of sediments of this series. It is believed that Duruma Sandstones occupy most of the area overlain by superficial deposits.

The Duruma Sandstones can be correlated with the Karroo system of Southern Africa and the Sakoa Coal Measures, Sakamena Group and Isalo Sandstones of Madagascar. The Duruma Sandstones are divisible into three major lithogical divisions (Sanders, 1959, p. 14),

Duruma Sandstones	Upper	4. Mazeras Sandstones
	Middle	3. Mariakani Sandstones 2. Maji ya Chumvi Beds
	Lower	1. Taru Grits

(1) The Lower Duruma Sandstones

The northermost slopes of the Lali Hills extend across the southern boundary of the area. The blocks of float found in this region belong to the arkose group described by Sanders (1959, p. 16). They are typically brown to yellowish arkose, coarse-grained felspathic sandstones, and grits. A float specimen of finely banded folded rock was found in the shallow valley west of Lali. The specimen was found in an area believed to be occupied by Basement System rocks and since it was small, weighing approximately 3½ oz., it must have been transported from its original source. In texture and composition the rock resembles the felspathic grits of the Taru Grits, exposed in the Lali Hills section. The banding is produced by alternation of brown to whitish laminations, showing no textural variation. In thin section 61/141* the only apparent difference between the two types of layer is enrichment of iron oxide in the darker bands.

The cause of the folding is not clear. Slumping of the Taru Grits, described by Sanders (1959, p. 16), may be responsible for the compact folding, provided the movements took place prior to consolidation of the sediments.

(2) The Middle Duruma Sandstones

Several float blocks, identifiable with horizons exposed in the Galana valley to the south, were found in the Bereito Wasania area. The specimens consist of flagstones, argillaceous sandstones, shales and limestones, belonging to the middle and upper members of the Maji ya Chumvi Beds. Specimen 61/150 is a pale mauve flaggy calcareous sandstone composed of sorted, subangular to rounded grains of quartz and felspar cemented in a fine grained semi-calcareous matrix. Heavy residue minerals extracted from the rock are apatite, hematite, magnetite, zircon and rare rutile. Typical of the calcareous horizons of the Maji ya Chumvi Beds, specimen 61/151 is a dirty brown fine-grained limestone with patches of lighter coloured recrystallized calcite. Angular fragments of quartz and felspar are set in the calcite matrix.

Several slabs of highly weathered shale were found scattered about the Bereito Wasania region. The shale occurs mostly as rectangular flags, the shape being determined by laminar partings and a well defined jointing system. The specimens examined varied in size from about 2 in. to about 15 in. long. Typically the shales are pale fawn to greyish coloured friable slabs, in general appearance similar to the Ecca Shales of southern Africa.

(3) The Upper Duruma Sandstones

The two hills Dakadima and Dakadakatha, which are situated to the north of the present area, are composed of Mazeras Sandstone. (The relationship between Mazeras Sandstone and the underlying middle member of the Duruma Sandstones is not apparent at Dakadima but Caswell (1956, p. 12) and Thompson (1956, p. 15) have shown that the contact between the Mazeras Sandstones and the Mariakani Sandstones is unconformable).

At Dakadima the exposed section is as follows:—

4. Massive kaolinised felspathic sandstone with claystone nodules and lenticles	>170 ft.
3. Compact flaggy sandstone	± 8 ft.
2. Laminated micaceous sandstone	± 20 ft.
1. Maroon coloured argillaceous flagstone	± 42 ft.

*Numbers 61/141, etc. refer to specimens in the regional collection of the Mines and Geological Department, Nairobi.

The maroon flagstone tends to be massive, showing only faint laminar bedding towards the upper part of the horizon. In hand specimen it is a fine-grained argillaceous rock and varies from dark maroon to pale yellowish with unevenly distributed light brown blotchy patches across the bedding planes. The weathering characteristics of this rock are distinctive. Numerous variable sized cavities, from 1 in. to approximately 15 in. in diameter, are formed across the bedding planes. In some exposures cavities have coalesced to form a highly uneven surface. The rock is composed of grains of quartz, felspar, iron ore, and rare flakes of muscovite set in a fine argillaceous matrix.

The laminated micaceous sandstone is maroon coloured and characterized by fine laminations, about 2 mm. thick, of alternating dark and lighter coloured material. The light coloured lamellae are composed of quartz and felspar grains set in a fine argillaceous matrix, the dark lamellae being finer-grained and intimately stained by iron oxide. The mica present is mainly concentrated in partings between the lamellae.

The micaceous sandstones grade into a narrow horizon of compact flaggy sandstones. These sandstones erode to form rectangular flags, their shapes being determined by two sets of vertical joints and partings along the bedding planes. Specimen 61/146, an example of this rock, consists of narrow layers of sub-angular to rounded grains of quartz and felspar, alternating with thin argillaceous bands. The coarser layers attain a maximum thickness of about 5 mm.

The uppermost sediments exposed at Dakadima are massive coarse-grained kaolinitic sandstones, with inclusions of claystone. The sandstone varies from pale buff to pale grey and consists almost entirely of quartz and kaolinised felspar. The claystone inclusions occur in a variety of forms, the most common being lensoid. The inclusions are usually rimmed with a marginal staining of iron oxide. Specimen 61/43, a coarse-textured sandstone from the southern tip of Dakadima, is composed of rounded quartz grains, kaolinised felspars and somewhat altered grains of iron ore. The claystone inclusions are composed of fine aggregates of clay minerals. Numerous manganese-rich nodules are scattered about the base of Dakadima. The manganese is undoubtedly derived from the Mazeras Sandstones as small patches of manganese enrichment can be detected both in the sandstone and as staining in joint partings, or fault-lines.

Dr. P. Glover of the Veterinary Department discovered fossil plant remains identified by P. V. Caswell as *Dadoxylon* in the small gorge towards the northern end of Dakadima. Specimens of silicified wood in the McKinnon Wood collection were identified as *Dadoxylon sclerosum*, a fossil wood recorded from the Upper Triassic Molteno Beds of South Africa. (McKinnon Wood, 1930, p. 214).

The Mazeras Sandstones bear strong lithological resemblance to the Mansa Guda Sandstones of north-eastern Kenya, described by Thompson and Dodson (1960, pp. 15–18). Both the Mansa Guda formation and the Mazeras Sandstones are coarse textured, pale coloured, kaolinitic sandstones with claystone inclusions. The Mansa Guda Sandstones underlie Lower Jurassic limestones.

3. Tertiary—Kapiti Type Phonolite

Kapiti type phonolite outcrops in a shallow valley on the northerly branch of the Mambrui-Mutha road. Judging from the extent of the fine textured reddish soil in that region, the lava body is considerably greater than is immediately apparent from the exposed rock. The phonolite is probably related to the volcanic phase responsible for the eruption of the Yatta Plateau lava and the nearby volcanic plugs described by Sanders (1963, pp. 24–25).

The lava conforms with the Kapiti type phonolite of the Yatta Plateau, described by Dodson (1953, p. 17), and Sanders (1963, pp. 24–25). It is a porphyritic dark grey rock, with abundant phenocrysts of porcellaneous white to light grey anorthoclase, smaller and less common waxy dark brownish nepheline crystals, and rare amygdales. The anorthoclase phenocrysts have an average length of about 1 in. Unlike the phonolite of the Yatta Plateau the phenocrysts are not directionally orientated along a flow direction, but are haphazardly scattered through the groundmass.

In thin section specimen 61/142 is seen to consist of a groundmass of anorthoclase, nepheline, aegirine, aegirine-augite, augite and the soda-amphiboles kataphorite and cossyrite, with phenocrysts up to 4 mm. long. The longest phenocrysts consist of a zeolitic core surrounded by a rim of anorthoclase. The margin between the zeolites and anorthoclase is sharply defined, indicating that the original phenocryst was zoned, the inner core being more susceptible to zeolite replacement. Within the clear outer rim patchy zeolite replacement has taken place on a small scale only.

4. Superficial Deposits

With the exception of the two hills Dakadima and Dakadakatha, the Lali Hills and a small exposure of Kapiti phonolite, the entire area mapped is covered by superficial deposits of soil. In the south-western corner of the area the soil, believed to have been derived mainly from phonolite, is a dark reddish fine-grained type, locally tending towards a clay-like composition. This soil is comparatively fertile, and supports a dense growth of vegetation. In the Bereito Wasania region the soils are derived from shale. This shale is a pale grey powdery type and contains nodules of secondary limestone or *kunkar*. In many parts of Kenya the occurrence of secondary limestone nodules is associated with the so-called black cotton soils. The superficial deposits at Bereito Wasania however are lighter coloured, finer grained and less clay-like than typical black cotton soil. Other fine textured soils were deposited in depressions and in the shallow valleys of the south-eastern part of the area. These soils vary from pale buff to pale grey in colour and include a high humic content. They support a luxuriant grass covering but the growth of bush is discouraged by periodic flooding. The most extensively occurring superficial deposit is a buff coloured sandy soil composed mainly of coarse quartz grains. The sandy soils are subject to colour variation between orange-brown and pale grey, depending on the degree of leaching they have undergone, the colour being almost entirely due to the presence of iron oxide. These soils are derived from both the Basement System rocks and the sandstone members of the Duruma Sandstones, those overlying Basement System rocks having a higher felspar, garnet and iron ore content.

VI—GEOPHYSICAL INVESTIGATIONS

Introduction.—In view of the scarcity of rock outcrops in the area it was decided to carry out a series of geophysical traverses, using both gravimetric and magnetometer methods, to assist in the interpretation of the geological features underlying the extensive superficial deposits which cover the area.

Method.—Three magnetometer and two gravimeter traverses were carried out (*see* Fig. 2). The most southerly of the magnetometer traverses followed the Mutha-Mambrui road, stations being chosen at one mile intervals to coincide with surveyed bench mark levels on this road. The greater portion of the road section lies beyond the southern limits of the area but since the geology of the Galana Valley to the south is known (Sanders, 1959) the results of this traverse are considered to be of value for comparison with the other traverses which are aligned over regions completely covered with superficial deposits. A straight line was cut from the surveyed bench-mark 98 in an approximate west-east direction as a magnetometer and gravimeter traverse line, stations being chosen at one mile intervals. Finally, magnetometer and gravimetric readings were taken at one or two mile intervals along the Lali Hills-Dakadima track.

To calculate the final values of the magnetometer readings, allowance was made for drift and instrument temperatures. To compensate for drift a single station was selected for which all readings were adjusted, allowance being made for hourly and daily magnetic variation drift. The final figures were then plotted as gamma values against miles. (*see* Fig. 3.) To calculate the relative bouguer values from data obtained from the gravimeter allowance was made for gravital drift, altitudes of each station, the degree of latitude and, where applicable, for the terrain. To obtain correction for drift all gravity readings were based on a single station, chosen for convenience as the bench-mark level 98. After taking gravimetric readings at this base station for three consecutive days a graph was drawn to show the average hourly gravity variation. The allowance for daily gravity variation drift was calculated from readings obtained at bench mark 98 both before and at the close of each traverse. Only two stations required slight allowance for the influence of terrain:— station 45 at Kona Lali, just north of the Lali Hills, and station 63 at Dakadima Hill. In each case the required allowance for topography was small. The gravimeter values were converted to relative bouguer values and plotted against miles (*see* Fig. 4)

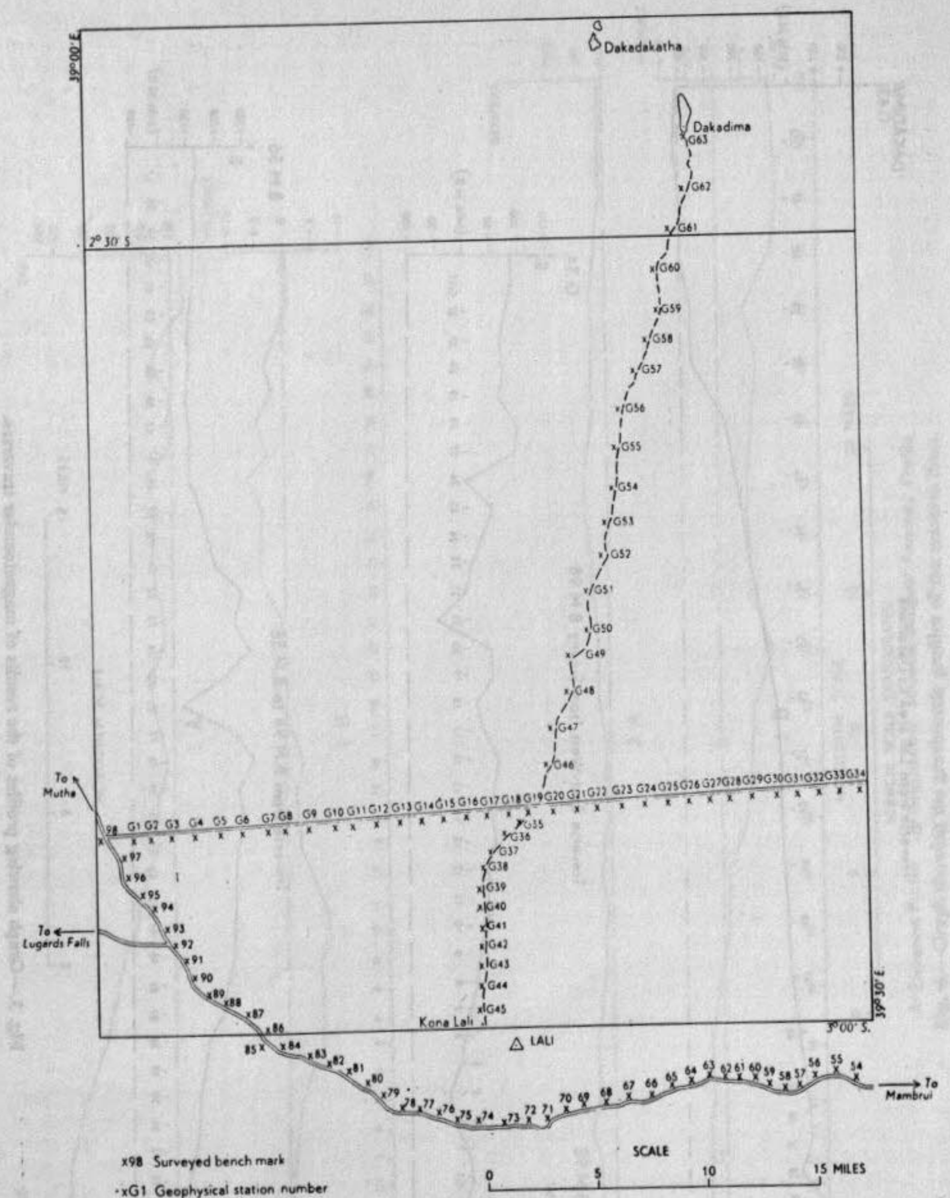


Fig. 2.—Map showing the geophysical traverses carried out in the Lali Hills-Dakadima area.

Conclusions.—The results of the magnetometer traverses proved to be of considerable value as an aid to interpretation of the geological features in the area. In general Basement System rocks are slightly more magnetic than sediments of the Duruma Sandstones, while superficial deposits are less magnetic than any of the rock types. Results of the gravimeter traverses are considered to be less significant. In calculating the bouguer gravimetric values, the main difficulty experienced was the inability to calculate the altitudes of the geophysical stations sufficiently accurately to allow for the exact altitude corrections.

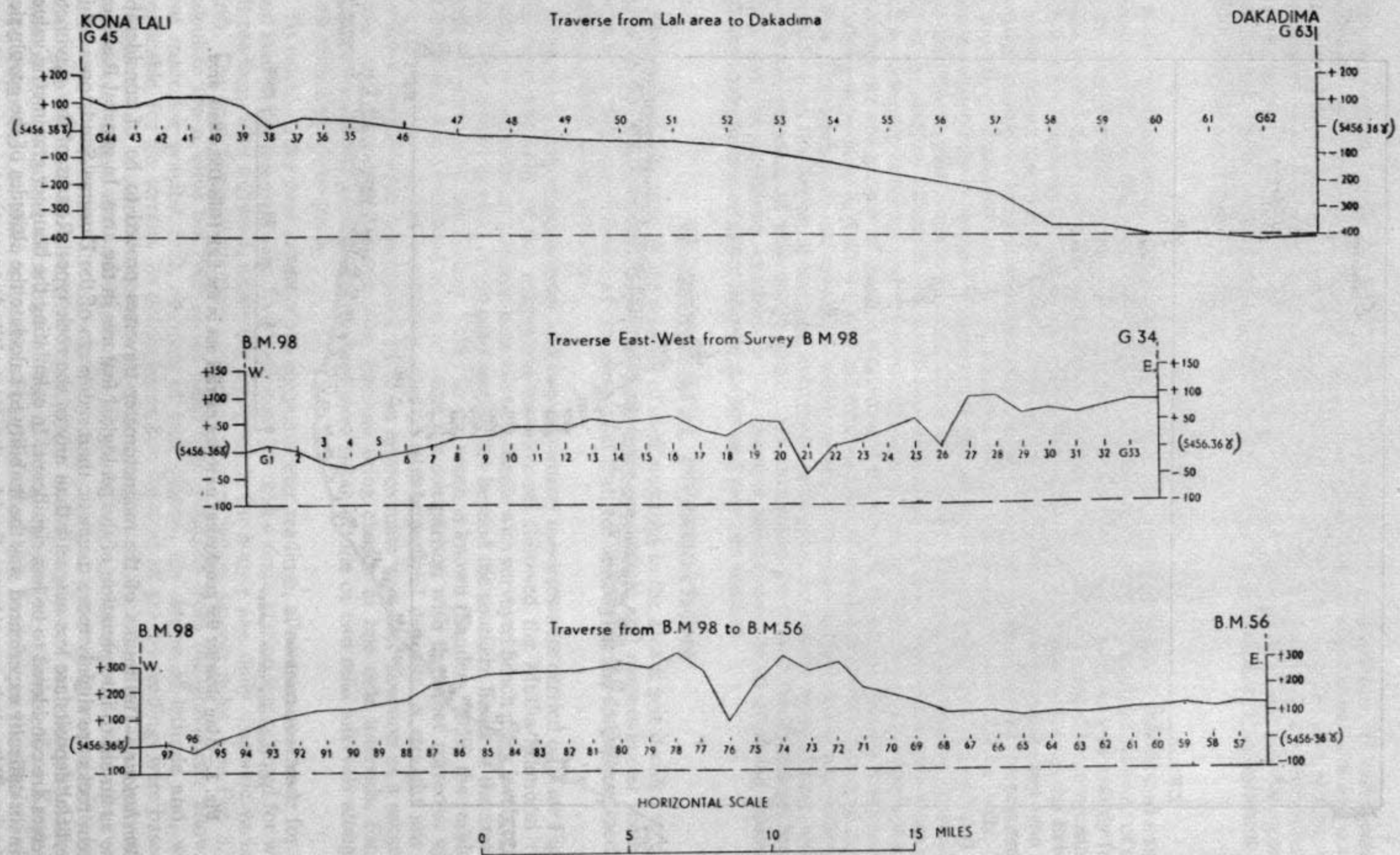
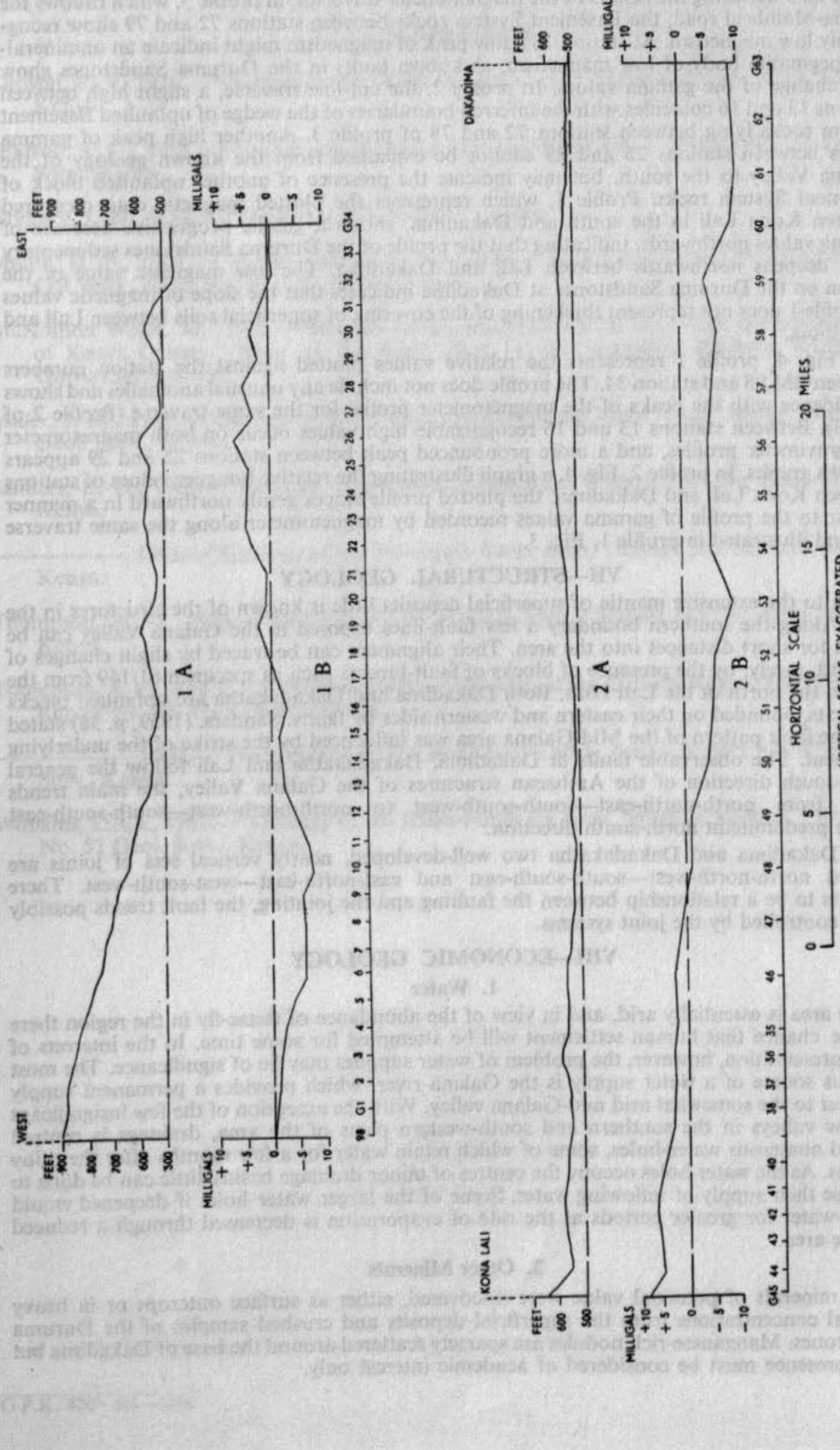


Fig. 3.—Graph showing profiles of the results of magnetometer traverses.



A–Elevation Profile B–Gravimetric absolute Bouguer Anomaly Profile

Fig. 4.—Graph showing the gravimetric profiles of the traverse lines.

In Fig. 3 depicting the results of the magnetometer traverses, in profile 3, which follows the Mutha-Mambrui road, the Basement System rocks between stations 72 and 79 show recognizably low magnetism. At station 76 a low peak of magnetism might indicate an unmineralized pegmatite body of low magnetism, as known faults in the Duruma Sandstones show little change of the gamma values. In profile 2, the cut-line traverse, a slight high between stations 13 and 16 coincides with the inferred boundaries of the wedge of upfaulted Basement System rocks lying between stations 72 and 78 of profile 3. Another high peak of gamma values between stations 25 and 29 cannot be explained from the known geology of the Galana Valley to the south, but may indicate the presence of another upfaulted block of Basement System rocks. Profile 1, which represents the plotted magnetic data measured between Kona Lali in the south and Dakadima, shows a gentle, progressive decrease of gamma values northwards, indicating that the profile of the Duruma Sandstones sedimentary basin deepens northwards between Lali and Dakadima. The low magnetic value of the station on the Duruma Sandstones at Dakadima indicates that the slope of magnetic values in profile 1 does not represent thickening of the covering of superficial soils between Lali and Dakadima.

In Fig. 4, profile 1 represents the relative values plotted against the station numbers between BM 98 and station 34. The profile does not include any unusual anomalies and shows coincidence with the peaks of the magnetometer profile for the same traverse (Profile 2 of Fig. 3). Between stations 13 and 16 recognizable high values occur on both magnetometer and gravimeter profiles, and a more pronounced peak between stations 25 and 29 appears on both graphs. In profile 2, Fig. 4, a graph illustrating the relative bouguer values of stations between Kona Lali and Dakadima, the plotted profile slopes gently northward in a manner similar to the profile of gamma values recorded by magnetometer along the same traverse line and illustrated in profile 1, Fig. 3.

VII—STRUCTURAL GEOLOGY

Due to the extensive mantle of superficial deposits little is known of the structures in the area. Along the southern boundary a few fault-lines exposed in the Galana Valley can be traced for short distances into the area. Their alignment can be traced by slight changes of soil and, rarely, by the presence of blocks of fault-breccia such as specimen 61/149 from the area to the north of the Lali Hills. Both Dakadima and Dakadakatha are upfaulted blocks or horsts, bounded on their eastern and western sides by faults. Sanders, (1959, p. 38) stated that the fault pattern of the Mid-Galana area was influenced by the strike of the underlying basement. The observable faults at Dakadima, Dakadakatha and Lali follow the general north-south direction of the Archaean structures of the Galana Valley, the main trends being from north-north-east—south-south-west to north-north-west—south-south-east with a predominant north-south direction.

At Dakadima and Dakadakatha two well-developed, nearly vertical sets of joints are aligned north-north-west—south-south-east and east-north-east—west-south-west. There appears to be a relationship between the faulting and the jointing, the fault trends possibly being controlled by the joint systems.

VIII—ECONOMIC GEOLOGY

1. Water

The area is essentially arid, and in view of the abundance of tsetse-fly in the region there is little chance that human settlement will be attempted for some time. In the interests of game preservation, however, the problem of water supplies may be of significance. The most obvious source of a water supply is the Galana river, which provides a permanent supply of water to the somewhat arid mid-Galana valley. With the exception of the few insignificant shallow valleys in the southern and south-western parts of the area, drainage is centred around numerous water-holes, some of which retain water for a few months after the rainy seasons. As the water-holes occupy the centres of minor drainage basins, little can be done to increase their supply of inflowing water. Some of the larger water holes if deepened would retain water for greater periods as the rate of evaporation is decreased through a reduced surface area.

2. Other Minerals

No minerals of potential value were discovered, either as surface outcrops or in heavy mineral concentrations from the superficial deposits and crushed samples of the Duruma Sandstones. Manganese-rich nodules are sparsely scattered around the base of Dakadima but their presence must be considered of academic interest only.

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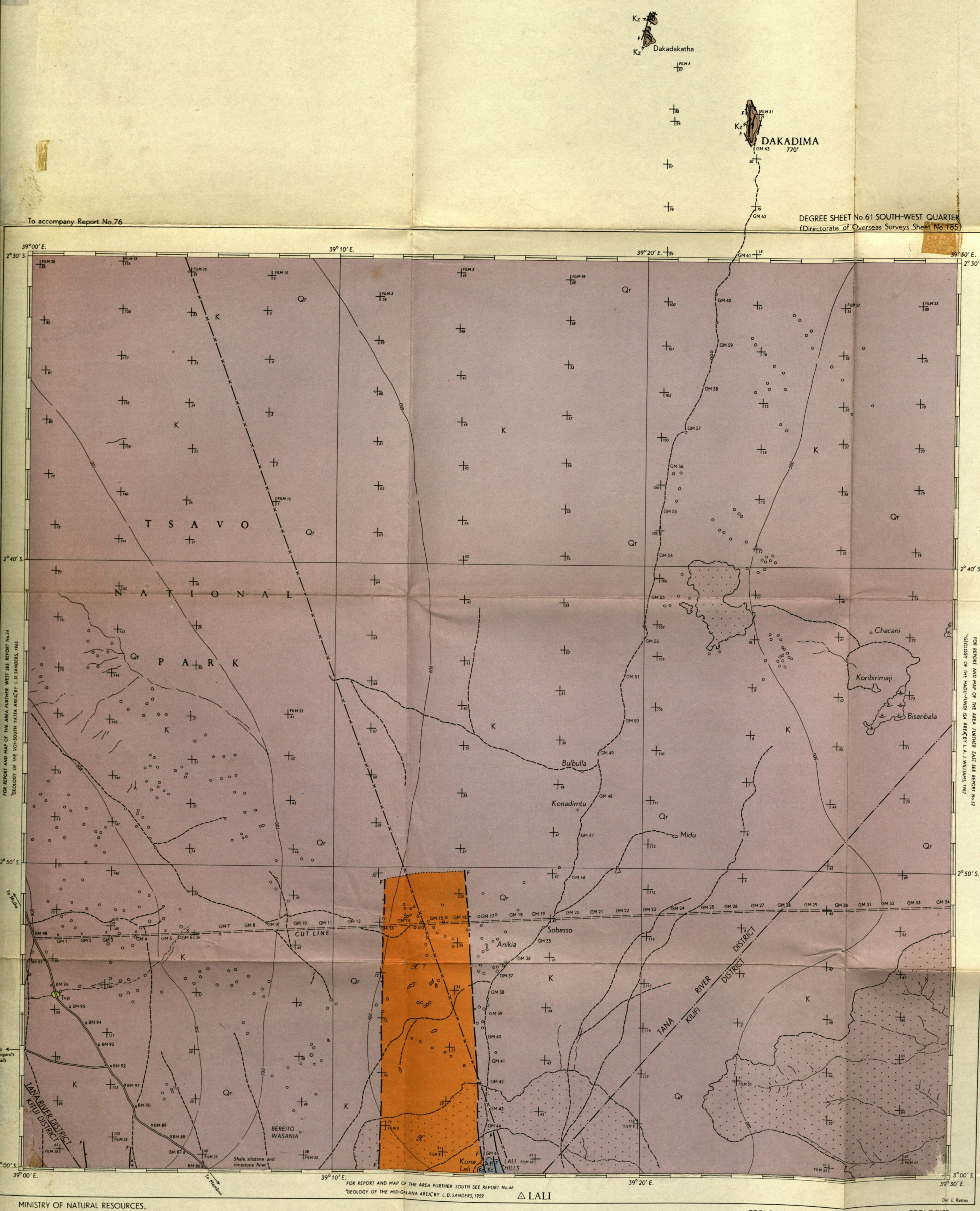
G.P.K. 420—1m—2/66

GEOLOGICAL MAP OF THE LALI HILLS — DAKADIMA AREA

To accompany Report No. 76

DEGREE SHEET No. 61 SOUTH-WEST QUARTER
(Directorate of Overseas Surveys Sheet No. 185)



EXPLANATION

QUATERNARY — Qr — Red sandy soils (superposed on formation colour)

MIOCENE — Tvp — Phonolite

DURUMA SANDSTONES

TRIAS TO CARBONIFEROUS — K — Duruma Sandstones overlain by fine grey soil; K — Duruma Sandstones

MAZERAS SANDSTONES

TRIAS — Kz — Mottled felspathic sandstones with intercalated shales

TARU GRITS

PERMIAN — Kt — Grits

BASEMENT SYSTEM

PRECAMBRIAN — X — Rocks of the Basement System

- Geological boundaries, approximate
- Geological boundaries, inferred
- Faults, with tick on downthrow side
- Fault breccia
- Road
- Foot-tracks
- Form-lines at 100 ft. vertical intervals
- A.P. Astral fix point
- Principal points of aerial photographs
- BM 92 Bench marks with distances in miles from Mambrui on the Coast
- GM 30 Geophysical stations
- Water-holes
- District boundaries
- Tsavo National Park boundaries

Topography based on plane-table and altimeter survey

Magnetic declination approximately 3° West

KEY

AIR PHOTO. FLIGHT DIAGRAM

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MINISTRY OF NATURAL RESOURCES, 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 = 1·973 miles or 1·014 inches = 2 miles

GEOLOGICALLY SURVEYED BY R. G. DODSON, GEOLOGIST,
Between April and October 1958