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GEOLOGICAL SURVEY DEPARTMENT

THE GEOLOGY OF THE SOUTH LILONGWE PLAIN AND DZALANYAMA RANGE

by

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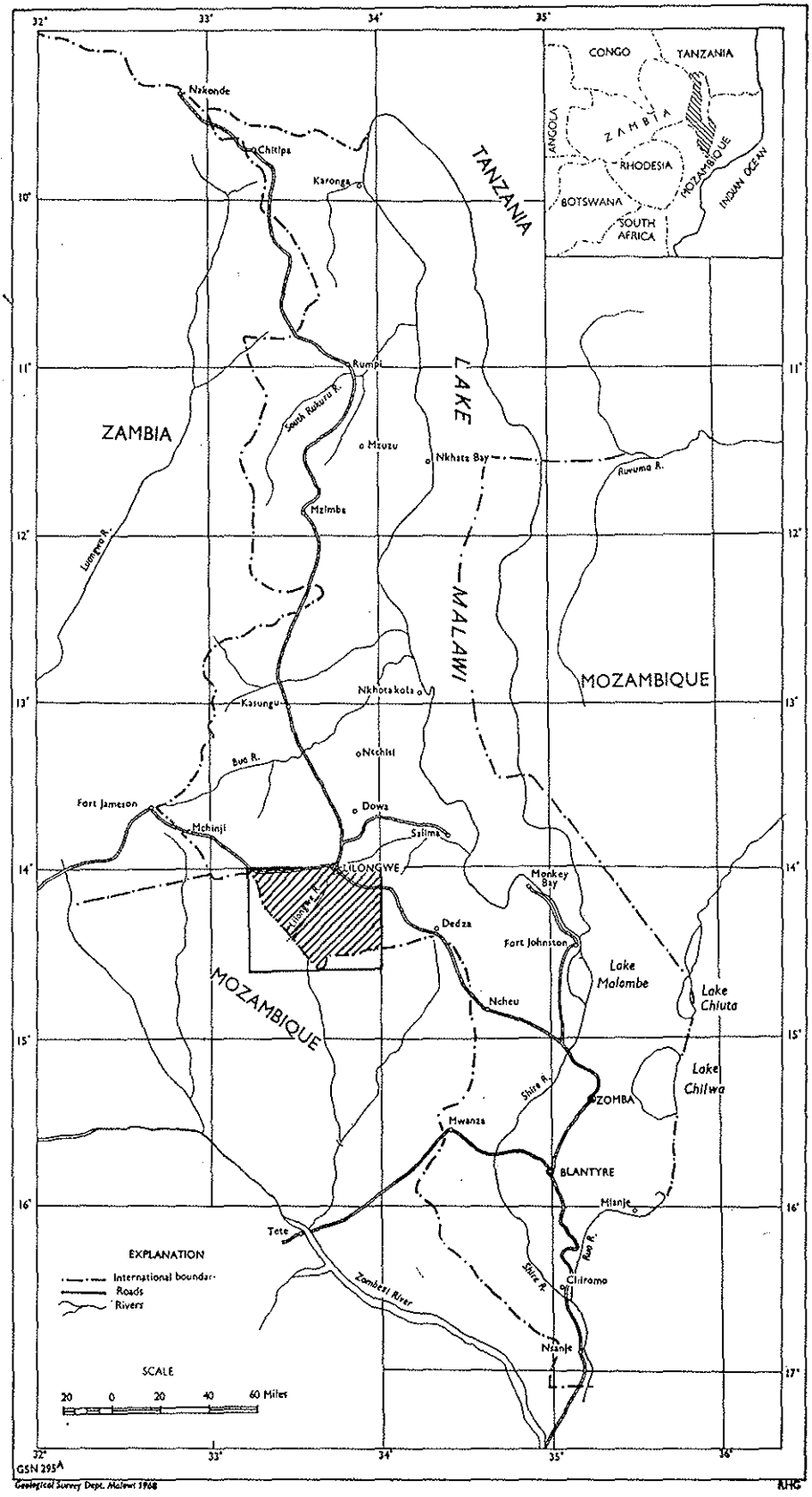


FIG. 1. Location map

II. PHYSIOGRAPHY

(a) Relief

The greater part of the area is occupied by the gently undulating *South Lilongwe Plain*, defined by Brown and Young (1965, p. 30) as a natural region, *i.e.*, a part of the earth's surface in which the physical environment possesses the same major features, and in which individual environmental factors have a limited range of variation. This area has also been called the " Central Region Plateau " (Pike and Rimmington, 1965). However, to avoid confusion with the higher level residual plateaux which also occur in the Central Region (Dedza and Chongoni mountains) the former term, which is in more general usage, will be used. The level of the plain shows a gentle southward rise over a distance of 35 miles from an elevation of 3,750 feet at Lilongwe to 4,250 feet on the Mozambique border. Slight rises also occur towards the eastern and western margins of the plain.

In the north, occasional low inselbergs, *e.g.*, Malingunde (4,108 feet) and Kachawa (4,073 feet), rise from the surface of the plain along interfluves. Towards the east, more prominent inselberg features, notably Bunda (4,626 feet), Ngala (5,100 feet) and Chekhoma (4,556 feet), become increasingly well developed and are surrounded by lower hills which stand at 4,100-4,200 feet above sea level. In the extreme north-east there is an abrupt change to a more rugged and dissected topography: Chitupa (3,950 feet), Zowe (4,072 feet), Mkunza (4,100 feet), Namicila (4,073 feet) and Mphanda (4,150 feet) being the more prominent hills; while in the west the plain is bounded by the steep eastward-facing slopes of the Dzalanyama Range. This north-west-trending range of hills is some five miles in width and has a mean elevation of about 4,950 feet. The Malawi-Mozambique border follows the watershed, the highest points of the range within Malawi being Kazuzu (5,426 feet), Pomvi (5,300 feet) and Kampambe (5,063 feet).

The principal physiographic features of the map area are shown in Figure 2.

(b) Drainage

The area is drained by three major river systems which flow north-eastwards from their sources in the Dzalanyama Range to Lake Malawi. The Lilongwe River, with its five main tributaries, the Likuni, Katete, Lisungwe, Manjiri and Nathenje, drains the western, central and north-eastern parts of the area; the Namitete River, a northward flowing tributary of the Bua River, drains the north-western part and the Diampwe River and its major tributary, the Lifidzi, drains the south-eastern segment.

The headwaters of these rivers form a complex network of deeply dissected valleys which frequently follow joint directions, shear zones and foliation within the Dzalanyama Granite. This drainage pattern is remarkably expressive of the solid geology of the area. Small *dambo* lie at the source of each tributary stream and rarely dry up as all but the smallest streams in the Dzalanyama continue to flow throughout the year.

At the foot of the Dzalanyama Range there is a marked change in drainage pattern due to the abrupt change in gradient. The streams become sluggish and all flow ceases for long periods in the dry season. Thick alluvial and colluvial outwash fans have been deposited along the edge of the hills and the narrow marshy strips which fringe the stream courses act as reservoirs or areas of impeded drainage for part of the year.

On the Lilongwe Plain itself, only the major rivers have well defined channels, the course of the tributary streams being marked by the interconnected shallow grassy depressions of seasonal swamps (*dambo*). Near their confluences with major rivers, these depressions become comparatively deep and narrow and the actual stream courses become better defined. Outcrops of rock and laterite, which are normally restricted to *dambo* margins, are here revealed by the increased erosional power of the streams.

South and east of Kachawa Hill, incised meanders occur along the course of the Likuni River which cuts back into the flat valley floor to form cliffs up to eight feet in height in which laterite and alluvium are exposed. On the Lilongwe River rock bars are common, forming small rapids between 10 and 15 feet in height, and are often pot-holed.

Geological control of the drainage pattern in the South Lilongwe Plain can be readily detected only along the course of the Lilongwe River. The long, straight stretch of river south of Likuni Mission is almost certainly controlled by the strike of the gneisses or by strike-joints. The ENE.-trend shown in the Malingunde area and east of Likuni Mission is clearly joint-controlled but the abrupt right-angled bends shown by the Lilongwe River east of Malingunde, and by the Diampwe River at Bisai Village, cannot easily be explained in terms of the underlying geology because of lack of exposures. It is, however, possible that the latter feature is an old elbow of capture.

In the more rugged north-eastern part of the area, particularly north of Chitupa Hill, the stream courses are largely joint-controlled. This can be clearly seen on the aerial photographs.

The Diampwe River lies at about 3,850 feet above sea-level, whereas the Lilongwe River has cut down to 3,400 feet at its lowest point. The northern tributaries of the Diampwe are conspicuously short in comparison with the southern tributaries of the Lilongwe, the Nathenje and Nanjiri, the headwaters of which are actively eroding southwards. If the present rate of erosion is maintained by these streams, eventual capture of the upper part of the Diampwe River seems likely.

(c) Geomorphology

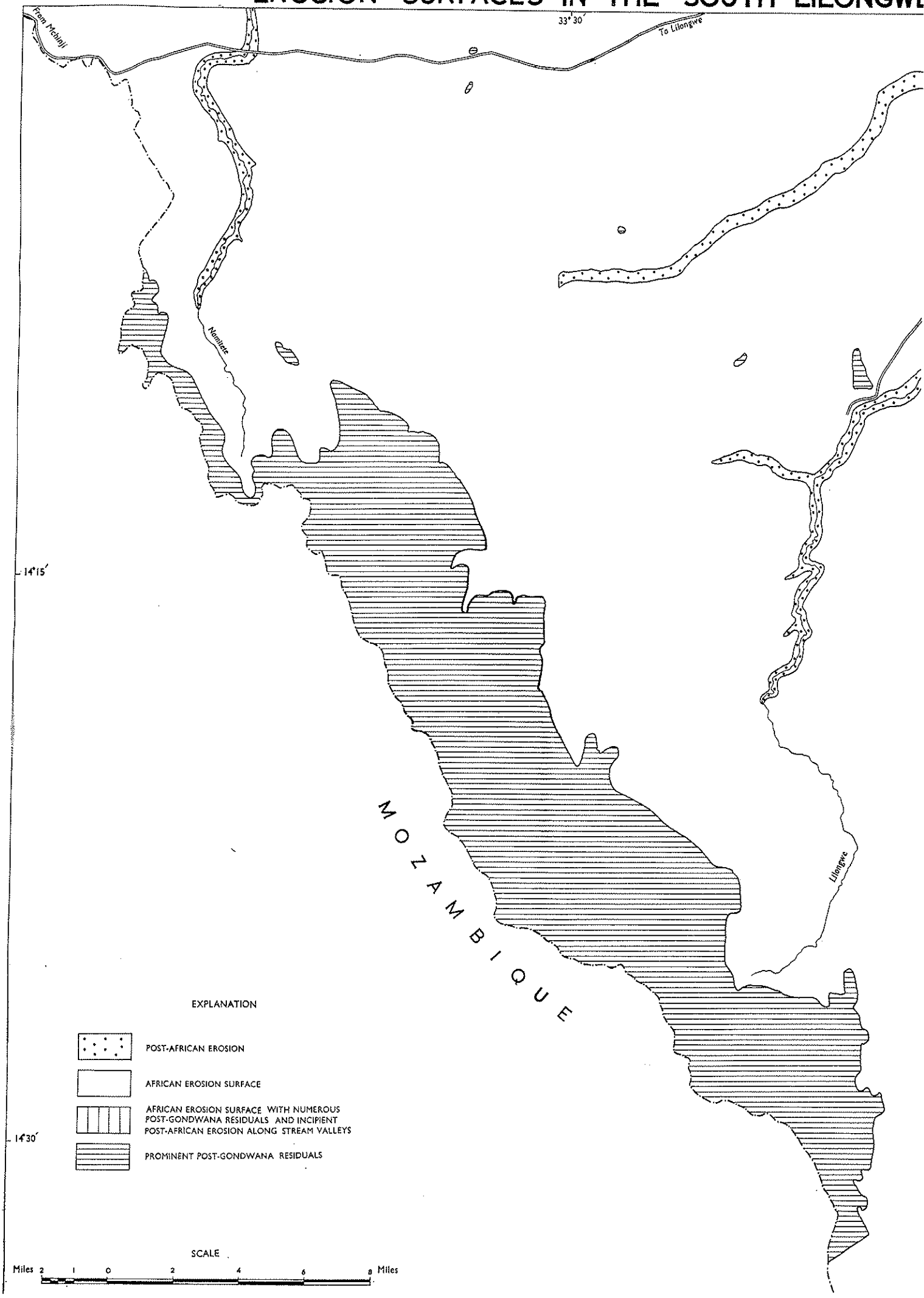
Three major erosion surfaces have been recognised in this area (Lister, 1968), their distribution is shown on Plate I.

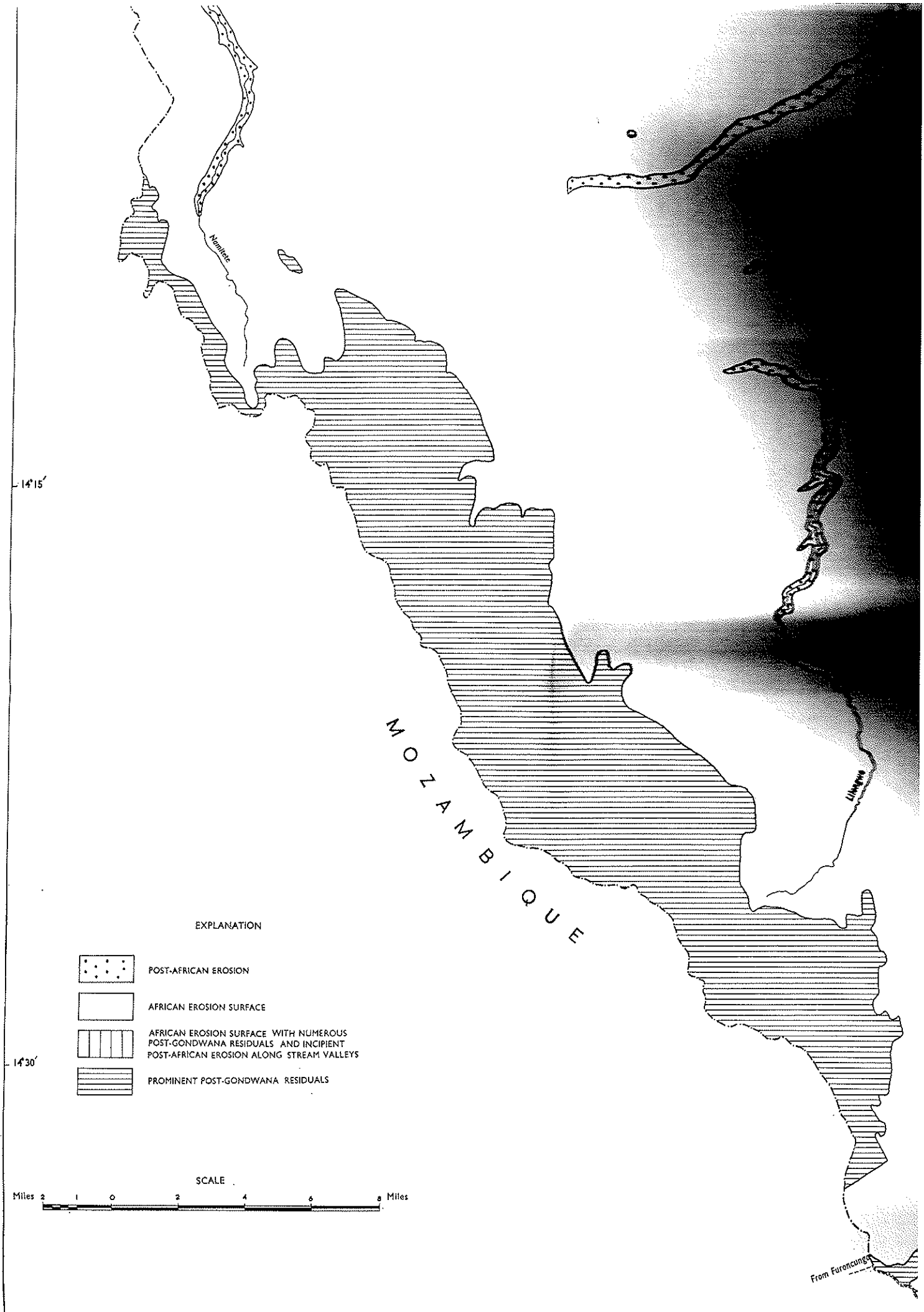
The oldest of these, the *post-Gondwana* surface of early and mid-Cretaceous age (King, 1963) is now merely represented by the residuals (inselbergs) which rise above the level of the surrounding plain. The *African* cycle of erosion, which occurred in late Cretaceous – early Miocene times, formed an extensive plain in the Central Region of Malawi of which the South Lilongwe Plain is but a part (*see* frontispiece). This surface reached a state of extreme old age, characterised by its monotonous flatness, before the *post-African* cycle of erosion was initiated in late-Miocene times.

The summits of the high level residuals, which include the Dzalanyama Range, are thought to be near the original level of the post-Gondwana surface. The lower residuals have been considerably reduced by erosion, at a differential rate dependent upon their areal extent, and some are now in their last stages of removal. Even when allowance has been made for the material removed by erosion, it would appear that the variations in summit levels shown by the major residuals results from a distinctly uneven original surface (Lister, *op. cit.*, p. 16).

The mature African surface is slightly downwarped in the vicinity of Lilongwe, this feature possibly being associated with Rift Valley faulting in the area to the east. Incipient post-African erosion has penetrated along the floors of the major river valleys and in places a composite surface results, the African and post-African surfaces merging gently and indiscernibly on the interfluves. The incised meanders, rock bars and degrading streams at the mouths of *dambo*, all indicative of small

EROSION SURFACES IN THE SOUTH LILONGWE





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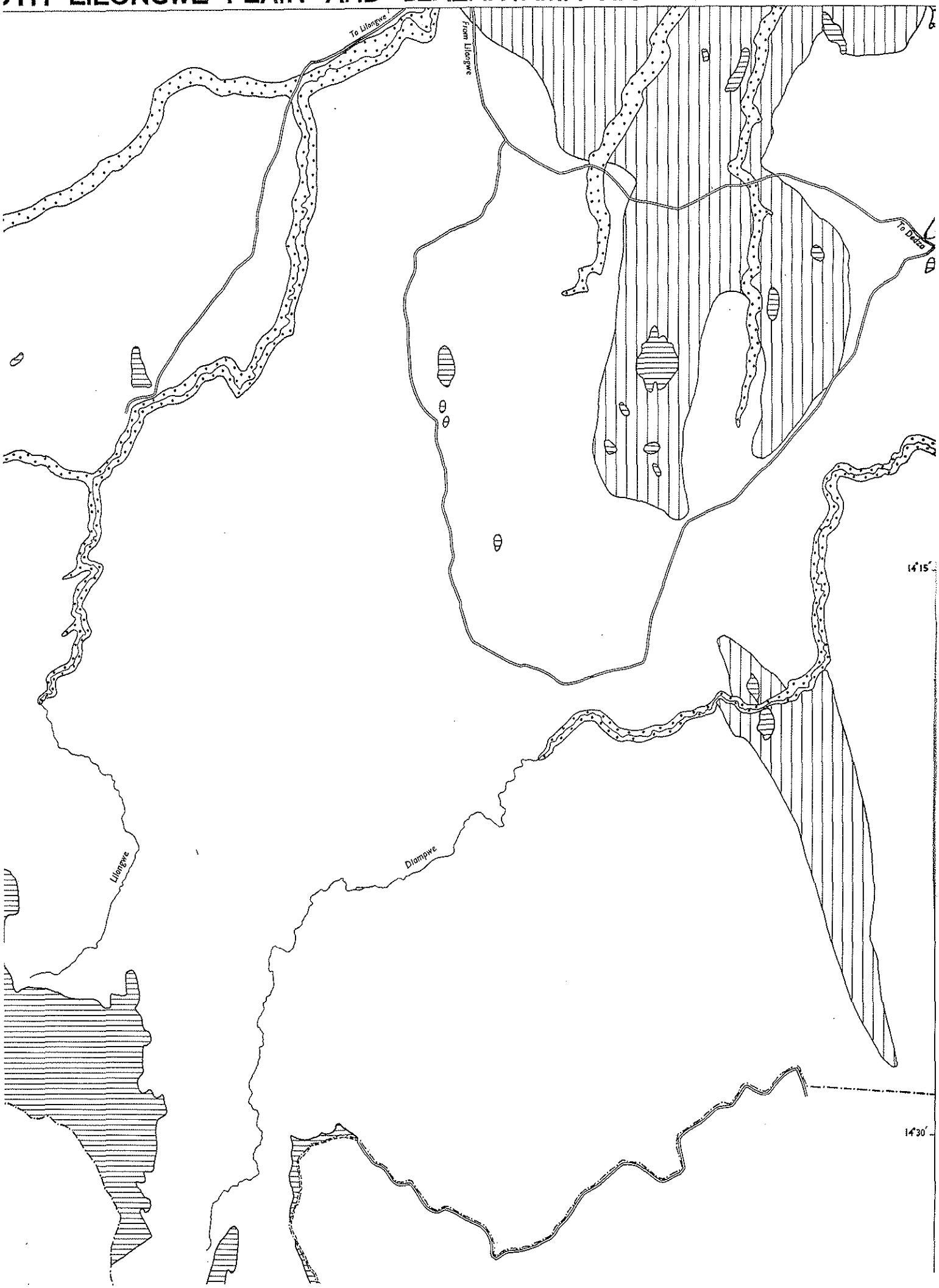
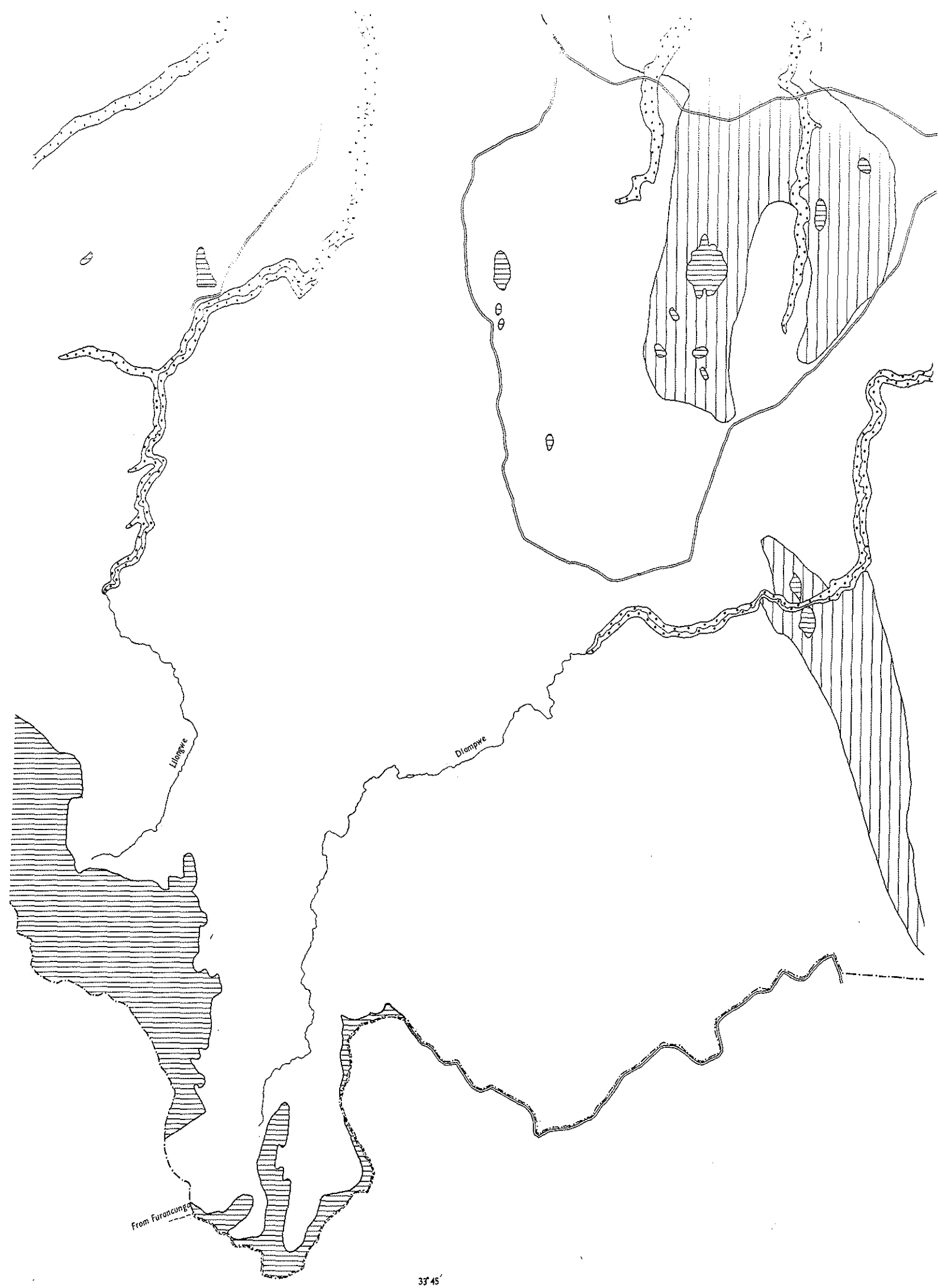
JTH LILONGWE PLAIN AND DZALANYAMA RANGE

PLATE 1




Lilongwe
Dlampwe
From Furancungo
33°45'

phases of rejuvenation, are probably features of the post-African cycle of erosion.

In the dissected area south-east of Lilongwe township, the African surface is at a much higher level than at Lilongwe (up to 300 feet higher) and post-African erosion has been more intense. It is probable that this increased dissection has resulted from an upwarping of the African surface associated with the faulting along the western edge of the Rift Valley; the slight complementary downwarping of this surface near Lilongwe has been noted above. If this is so, the movements which have produced the warping occurred after the completion of the African cycle of erosion and must, therefore, be of post-early Miocene age.

(d) Climate and vegetation

The Central Region experiences a tropical continental climate and about 85 per cent of the annual rainfall is precipitated during a single rainy season which lasts from December to March. Detailed temperature and rainfall figures are published by the Meteorological Department.

The climate has been discussed at length by Brown and Young (1965). The greater part of the South Lilongwe Plain lies within their " warm, dryish " climatic region which has a mean annual temperature of 65°-75° F. and a rainfall of 30-40 inches. Part of a " warm, dry " climatic region is believed to be present in a narrow belt which commences south of Lilongwe and extends SSE. to the Mozambique border. Mkwinda and Kampini markets are included in this zone in which rainfalls of below 30 inches *per annum* are regularly recorded.

No figures are available for the Dzalanyama Range but this probably lies within the " cool, wettish " region in which the average temperature is 63°-67° F. and the annual rainfall between 35 and 50 inches.

The generally fertile soils of the Lilongwe Plain are intensively cultivated except in the Dzalanyama and Bunda Forest Reserves and the area is densely populated for an essentially agricultural community. Maize is the chief crop and the Lilongwe-Dowa-Dedza plain is regarded by Brown and Young (*op. cit.*, p. 37) as being the granary of Malawi. Tobacco and groundnuts are grown as cash crops in most parts of the area while the *dambo* grasslands, which constitute about 10 per cent of the land area of the plain, are extensively exploited for the rearing of cattle and the cultivation of sugar cane and, in places, vegetables. The importance of agriculture in this area is demonstrated by the fact that the Farmers Marketing Board maintain five markets within it. There is a large agricultural school at Lukini and a new agricultural college at Bunda.

The natural vegetation has been extensively modified throughout the area by human occupation. The *Combretum-Acacia-Piliostigma cultivation savanna* characteristic of the more fertile plain soils is now restricted to a few small relict patches amid the fields. It is probable that this community, consisting of a limited number of species, was formerly a deciduous woodland of medium height (Brown and Young, *op. cit.*, p. 13). It is a valuable indicator of the more fertile ferruginous soils which are derived in part from graphite-bearing schists rich in iron sulphides and in part from hornblendic rocks. Patches of less fertile sandy soil, including that part of the Dzalanyama Forest Reserve which encroaches on to the plain, carry a natural *Brachystegia-Julbernardia plateau woodland*. This is always in a highly degenerate state due to late burning and exploitation by the local population (Hursh, 1960).

The thin sandy and stony soils of the Dzalanyama Range support a *Brachystegia-Julbernardia hill woodland*, a few small patches of low montane grassland and montane evergreen forest also occur.

The thin upper soil horizons of the *dambo* support only shallow-rooted plant species such as grasses and reeds. In its natural state the *dambo* grassland is tall, but in this area it is usually closely cropped by cattle.

(f) Building materials

Aggregates have been obtained from two places. The Nchesi Quarry, a few miles south-east of Lilongwe, is at present operated by the Ministry of Works and Supplies but the rock, a biotite-hornblende-migmatite, is not ideal for use either as an aggregate or for tarmacadam. Aggregate for the Kamuzu Dam was quarried from the Kaphirikanjuzi quartzo-feldspathic granulite which was found to be the only workable rock free from pyrite in the area. It is considered to be unsuitable for tarmacadam but makes quite a good concrete aggregate. Many other suitable quarry sites are available in the area, especially near Ngala Hill.

Sand suitable for building purposes is available in the upper parts of many *dambo* (" *dambo*-head " sands) and along the major rivers (alluvial sands). *Dambo* clays and red-brown lateritic clay soils (such as those in the Malingunde area) are often suitable for brick- and tile-making.

(g) Water supplies

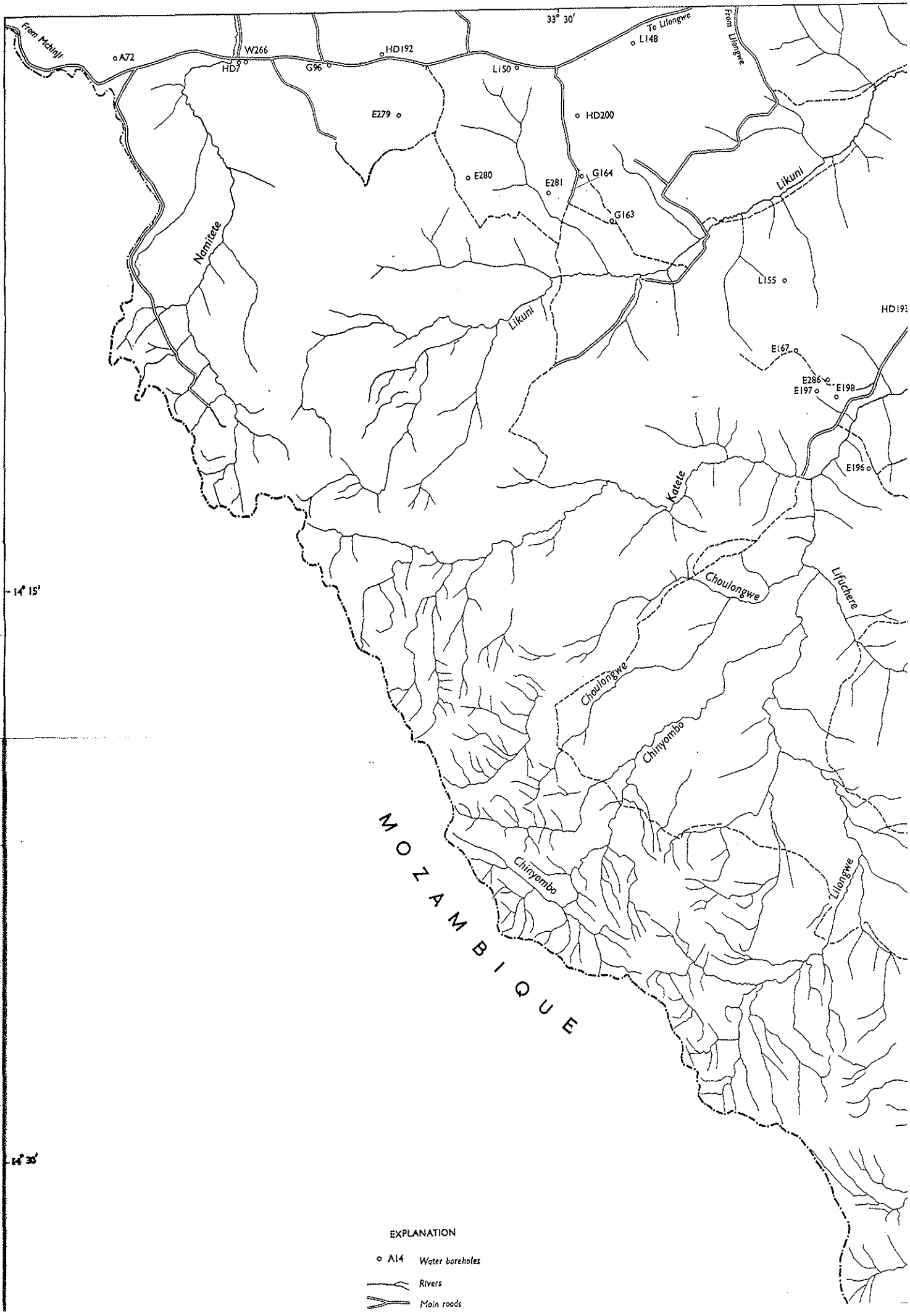
In spite of the relatively high seasonal rainfall the *dambo* of the South Lilongwe Plain, which together with the major rivers are the chief sources of water for the inhabitants of this densely populated area, frequently dry up completely. Adequate water supplies are therefore essential to the further development of the area and numerous boreholes have been drilled by the Geological Survey Department and, in more recent years, the Water Development Department to augment the rural supply.

The resistivity methods initiated by Cooper (1965) have been used with considerable success on the Lilongwe Plain where the residual deposits of sands and clays are thick. Difficulties have, however, been encountered in areas underlain by thick laterite horizons whose high resistivity tends to mask the underlying aquifers. The anomalously low resistivities associated with bands of graphite-gneiss have not proved dangerously misleading as these rocks almost invariably carry a good supply of water.

Siting of boreholes has proved more difficult in the eastern part of the area where the superficial cover is thin. In spite of this, adequate supplies of water can generally be found within fracture-zones or weathered rocks close to the required point.

Details of the 79 boreholes known to be located in the South Lilongwe Plain area and drilled between 1951 and 1966 are given in Table VI. Others may well exist in this area but their exact location is not known and so they are not recorded here. They were drilled to a mean depth of 115 feet and show measured yields ranging from 120 to 1,500 gallons per hour with a mean of 655 gallons per hour.

WATER BOREHOLES IN THE SOUTH LILONGWI



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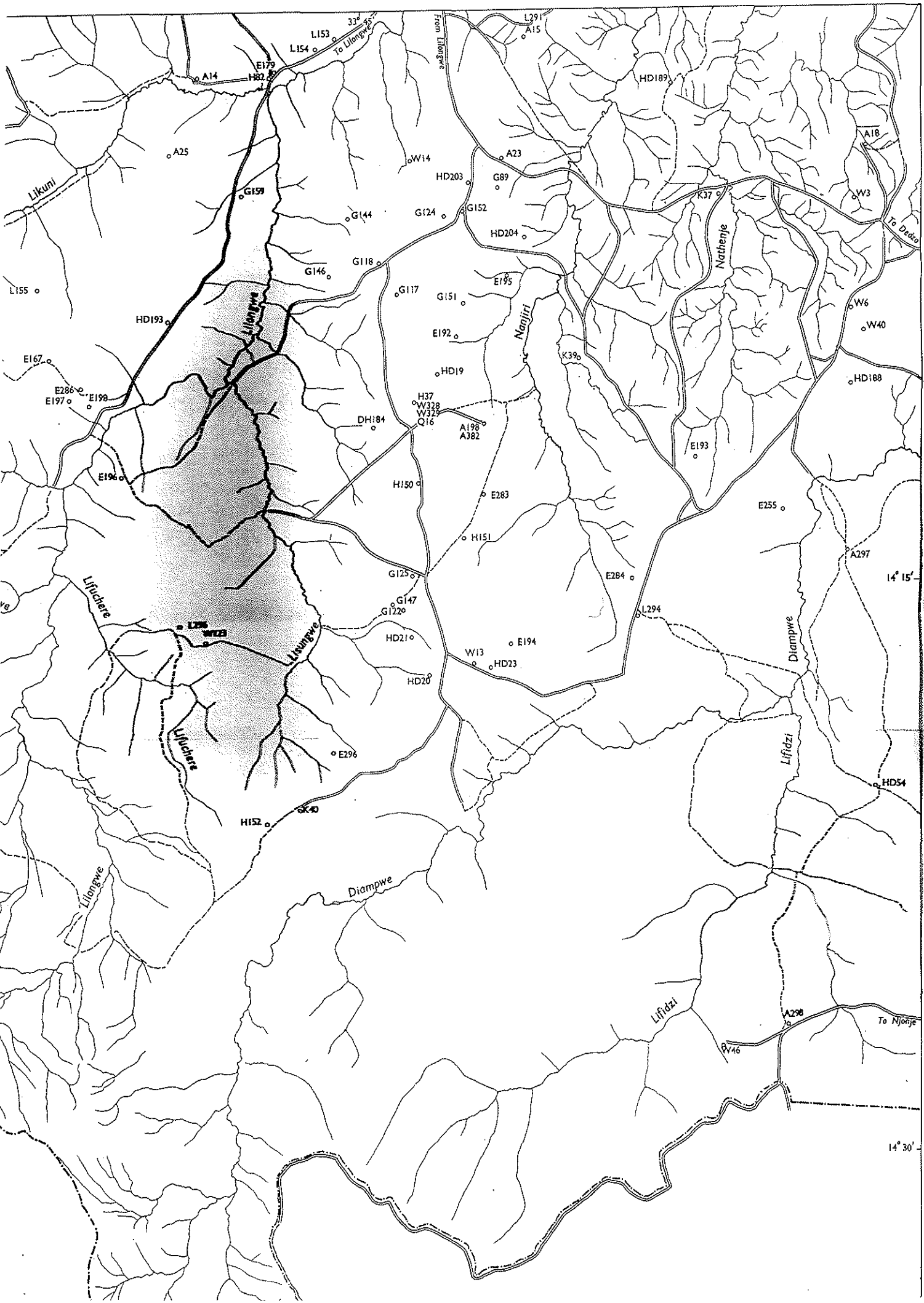
LILONGWE PLAIN AND DZALANYAMA RANGE

PLATE VI




A23
W14
HD203
G89
A23
G159
G144
G124
G152
K37
W3
HD204
Nathenje
G146
G118
E195
G117
G151
HD193
Lilongwe
W6
W40
E192
Najiiri
E167
K39
HD19
E286
E198
E197
HD188
H37
W328
W329
Q16
DH184
A198
A382
E193
E196
H150
E283
E255
H151
A297
Choulongwe
Lifuchere
G125
E284
G147
G122
L296
W23
L294
Lisungwe
HD21
E194
W13
HD23
Diampwe
HD20
Lifuchere
E296
Lifidzi
H152
K40
Lilongwe
Diampwe
Lifidzi
A298
W46
From Furancungo
33° 45'

TABLE VI

BOREHOLES SUNK FOR WATER SUPPLY IN THE SOUTH LILONGWE PLAIN AREA BETWEEN 1951 AND 1966

Ref. No. of Borehole	Locality	Depth in feet	Yield G.P.H.	Rocks penetrated	Year drilled
G89	N. A. Kalumba	115	750	Graphite-mica-gneiss	1951
G96	Chileka Dispensary	120	200	Garnet-mica-gneiss	"
G124	Nkukwe	83	360	Biotite-gneiss	"
G144	Mliu	65	300	" "	"
G118	Chipili	150	550	" "	"
G117	Chiseko	88	760	" "	"
G146	Maunda	95	320	" "	"
G152	Chalendewa	104	600	" "	"
G151	Mwenda	110	510	" "	"
G163	Nkanga	105	900	Syenite	1952
G164	Tumani	100	330	Graphite-biotite-gneiss	"
HD7	Namitete Trading Centre	65	300	" -gneiss	"
HD19	Bunda Forest Reserve	110	800	Biotite-gneiss	"
G159	Malili	95	500	Graphite-gneiss	"
G125	Mitundu Market	100	880	" "	"
G147	Patsonkonda	100	1,200	Not known	"
G122	Mongoti	105	1,500	Graphite-kyanite-gneiss and dyke	"
HD23	Kambolanje	100	600	Biotite-gneiss	"
HD20	Chikanda	80	300	" "	"
HD21	Chidika	100	600	" "	"
HD54	Chidwere	80	250	" "	"
K40	Simeon Mlinde	75	750	Sandy drift	1954
K37	Nathenje Trading Centre	120	750	Hornblende-biotite-gneiss	"
K39	N. A. Chadzamkwenda	120	600	Garnet-biotite-gneiss	"
L150	Nsundwe	110	750	Basement Complex gneiss	1955
L148	Mtandula	100	480	" " "	"
L153	Chinsapo	180	520?	" " "	"
L155	Mkungula	136	520?	" " "	"
HD103	Malindi	110	520?	" " "	"
HD184	Mkwinda	100	660	" " "	1956
HD183	Kanduna	101	1,000	Graphite-gneiss	"
HD192	Ndebvu	88	900	Basement Complex gneiss	"
HD188	Chimango	75	400	" " "	"
HD200	Munyayika	102	500	" " "	"
HD203	Chapata	110	550	" " "	"
HD204	Kalumbi	100	600	" " "	"
L291	Tsabango's Court	90	520	Shallow *dambo*	1957
L294	Katswatswata	110	850	Basement Complex gneiss	"
E194	Mkaka	120	900	Sand and clay over decomposed gneiss	1958
E192	Mwenda I	90	1,000	" " " " " "	"
E195	Msampha	100	900	" " " " " "	"
E179	Likuni Mission	114	600	" " " " Basement Complex gneiss	"
E193	Katunga	137	1,200	" " " " decomposed gneiss	"
E255	Khuzi	92	1,200	" " " " " "	"
E167 (E199)*	Ngongonda	103	900	" " " " " "	"
L156 (E198)*	Mkungula	124	600	" " " " " "	"
E286	Malingunde Trading Centre	124	264	*In dambo*	"
L296	Dickson	120	600	Weathered gneiss	"
E284	Nkhosa	103	440	Basement Complex gneiss	"
E296	Mtaya	116	440	Clay over weathered gneiss	1959
E283	Kalumba	100	660	Weathered gneiss	"
E279	Jalusa	125	1,056	" "	"
E280	Mphunda	120	880	" "	"
W3	Mkanda	114	440	Clay over biotite-gneiss	"
W6	Undi	152	880	" " weathered gneiss	"
W40	Tsoyo	135	440	" and sand over weathered gneiss	—
W14	Buluzi	116	880	*Dambo* sands and gravel over weathered gneiss	"
W46	Ndebvu	86	1,000	Laterite over weathered gneiss	—
A15	Tsabango's Court	116	480	Weathered biotite-gneiss	1961
A23	Chimutu	83	720	" " "	"
A18	Mazengera's Court	80	1,200	" " "	"
A25	Chimbayo	106	720	*Dambo* deposits	"
W123	Chiwale	96	400	Weathered Basement Complex gneiss	"
A14	Likuni Farm Institute	127	480	" biotite-gneiss	"
W266	Namitete Police Post	—	—	—	—
A72	Selombe	137	580	Deeply weathered gneiss	1962
A198	Bunda Estate	162	528	Weathered Basement Complex gneiss	1963
A382	" "	145	440	Clay over gneiss	"
A298	Mikondo	120	847	" " "	"
A297	Kaname	84	120	" " "	"
H37	Bunda Training Centre	184	880	Weathered gneiss	1965
W328	" " "	171	1,000	" "	"
W329	" " "	135	1,500	" "	"
H82	Likuni Mission	264	380	" "	1966
H150	Nsabwe	160	880	Colluvium over gneiss	"
H151	Chizenga	150	990	" " "	"
H152	Kambanizithe	125	440	" " "	"
Q16	Bunda Farm	103	754	Weathered gneiss	"

* Number of geophysical survey shown in the Annual Reports of the Water Development Department where different from that indicated on the borehole.