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GEOLOGICAL SURVEY DEPARTMENT

THE GEOLOGY
OF THE
DEDZA AREA

by

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II. PHYSIOGRAPHY

(a) Topography

There is a wide variety of topography in the Dedza area with elevations ranging from a little less than 1,650 to over 7,200 feet above sea level (*see* Plate I). Five different topographic units can be identified: the South Lilongwe Plain, the Dedza Hills, the main Rift Valley fault scarp, the lower shelves (Livelezi and Lifisi Shelves) and the Lakeshore Plain.

The west and south-west part of the area is occupied by the South Lilongwe Plain which is a gently undulating pediplain lying at 3,900–4,300 feet above sea level. It is part of a much larger plain occupying much of the Central Region. Apart from a few low residual hills and ridges such as Ngalagombe (4,598 feet) and Nchinji Hill (4,422 feet), it consists of gently convex or level interfluves and gently concave marshy valleys with maximum slopes of 2½°–4°.

The Dedza Hills are a complex topographic unit consisting of large hills with intervening areas which appear flat from a distance but on closer inspection are seen to consist alternatively of river valleys and flat-topped interfluves. The broadly convex interfluves occupy most of the land surface. In the south the valley slopes are gentler, the convexities increasing progressively to 10° or 15°. The inner parts of valleys to the south have slopes up to 25° but towards the north-east they often become very steep-sided and gorge-like as the scarp zone is approached. Patches of plainland occur in the south of the area amongst the hills, *e.g.*, near Bembeke Mission, but these lie at higher level (4,800 to 5,200 feet) than the South Lilongwe Plain. There are numerous hills rising up to 2,600 feet above the general level of the surrounding interfluves. Dedza Mountain (7,212 feet) and Chongoni Mountain (over 6,900 feet) have small plateau remnants lying at about 6,000 feet. Mlunduni Mountain (6,746 feet) has a long, relatively level crest at approximately 6,500 feet, but this consists of a narrow rocky ridge with no plateau remnants. There are numerous other hills either occurring as " hogs-back " ridges, *e.g.*, Dzenza Hill, Mithanthwe Hills, Chilenje, or isolated conical features, *e.g.*, Mlanda, Nkhoma and Bunda hills. Several hills in the Chongoni Forest Reserve form flat-topped features (*e.g.*, Ciwawo and Cibenthu hills) due to irregular sub-horizontal jointing.

The Rift Valley scarp consists in the south-east of a single fault scarp trending north-north-westwards. It rises from the Livelezi Shelf at 2,200 feet (Dawson and Kirkpatrick, 1968) to about 5,000 feet above sea level and has a mean angle of slope of 25°–30°. North of latitude 14° 15′S. the scarp swings around to the west to meet the Nadzipulu River. This section of the Rift Valley scarp has not been strongly dissected by stream erosion, except by the major rivers such as the Balitsa, Naminkokwe and Nadzipulu which form deep gorges cutting back into the scarp along joints in the underlying gneisses.

North of the Nadzipulu Gorge the Rift zone is wider, more complex and deeply dissected. As far north as the Ngodzi River the main scarp trends north-north-east rising above the Livelezi Shelf, but to the west and north-west of Tsekwere Estate it is interrupted by a number of WNW.-trending scarps which also mark the northern end of the Livelezi Shelf. From latitude 14° 03′S. northwards there is again a single main fault scarp trending north-westwards. For a short distance this rises directly from the Lakeshore Plain (here at 2,100 feet) but for most of its length it rises above the Lifisi Shelf (2,250 to 2,400 feet) to about 3,500 to 4,000 feet above sea level. There appears to be a progressive lowering of the scarp summit, from south (5,000 feet) to north (2,500 feet) across the area.

The Livelezi Shelf extends from the Ncheu–Balaka area where it is called the Nsipe–Livelezi Shelf (Walshaw, 1965) across the edge of the Cape Maclear-Lower Bwanje Valley area (Dawson and Kirkpatrick, 1968) into the Dedza area. It is bounded on the west by the main Rift fault scarp and on the east and north by the lower Rift fault scarps. The latter also decrease gradually in elevation towards the north. In the present area the Livelezi Shelf is at 200 to 600 feet above the general level of the edge of the Lakeshore Plain (1,800 feet). Its surface is moderately dissected and shows a rectangular drainage pattern. As in the Dedza Hills, the interfluves form most of the land surface and the valleys are narrow and steep-sided. A few small residual hills rise above the general level of the shelf. The lower fault scarp is quite strongly dissected along most of its length and there are no signs of rejuvenation.

The Lifisi Shelf in the north-east is a similar, but less well developed feature. It rises about 200 to 300 feet above the general level of the Lakeshore Plain and is deeply dissected.

Part of the Lakeshore Plain lies in the extreme north-east. It forms a relatively flat surface with occasional low inselbergs lying between 1,650 and 1,950 feet above sea level and slopes gently to the north-east. Towards the base of the Rift Valley fault scarp it becomes increasingly strongly dissected and the plain is gently undulating.

(b) Drainage

The western half of the area is drained mainly by the Linthipe River system (*see* Plate I). The Linthipe rises on Dedza Mountain and flows south for a few miles before turning west and then north-west along the edge of the Chongoni Forest Reserve. Below Linthipe Trading Centre it joins the Diampwe River which drains the area to the west, and then turns north-eastwards towards Lake Malawi. Both the Linthipe and the Diampwe flow throughout the year.

The South Lilongwe Plain is drained mainly by a system of broad *dambo* and sluggish streams. *Dambo* cover about 10 per cent of the land area on the plain. Streams to the north-east of the Tuma-Nkhoma-Lilongwe road drain into the Lilongwe River system and the north-central part of the area is drained by the Lifisi River system. The Lifisi is a perennial river which flows north-eastwards joining the Linthipe River just before it reaches the lake near Salima.

The eastern parts of the area are drained by a large number of fairly short streams and rivers with small catchment areas which flow eastwards either directly onto the Lakeshore Plain or into the Livelezi River. The most important of these are the Balitsa, Naminkokwe, Nadzipokwe, Nadzipulu and Ngodzi rivers. All the latter cut deep gorges in the Rift Valley scarp and provide excellent dam sites at the points where they emerge onto the Livelezi Shelf or the Lakeshore Plain. All these rivers are known to be perennial except the Ngodzi which sometimes dries up for short periods after a poor rainy season.

Streams in the extreme north-east dry up for long periods in the dry season and this area is very badly off for water supply. Many of the smaller streams do not reach the lake but sink into their own alluvial deposits on the Lakeshore Plain.

Flow in all rivers is strongly influenced by the marked seasonal rainfall. In the southern and western parts of the Dedza Hills area most streams and their tributaries have small *dambo*, either at their source or along parts of their length, which assist in maintaining a steady though reduced outflow for much of the dry season.

Drainage patterns in the Dedza Hills, the Rift Valley scarp and the Livelezi Shelf are strongly influenced by the underlying geology. This is particularly apparent where the rocks are paragneisses and charnockitic granulites. Larger streams usually follow strike directions and tributaries are often parallel to joints at right-angles to the strike; this forms a reticular drainage pattern which is particularly conspicuous in the deeply dissected north-eastern area. Streams draining the Rift Valley scarp frequently follow joint directions, they have steep cliffs on the hanging wall sides and gentler slopes on the footwall side of dipping joints. Streams crossing areas of perthitic rocks are usually less expressive of the underlying geology although they often follow the strike trend and prominent joint features.

(c) Erosion surfaces

No post-Palaeozoic sediments are known to occur in the Dedza area and the dating of erosion surfaces can only be carried out by correlation with adjacent areas both within and outside Malawi. Lister (1967) states that five principal erosion surfaces (see also King, 1963) occur in Malawi:

Gondwana (Jurassic)
post-Gondwana (early and mid-Cretaceous)
African (late Cretaceous to early Miocene)
post-African (later Miocene and Pliocene)
Quaternary (end-Pliocene until the present day).

The post-Gondwana, African and post-African surfaces can all be identified in the present area. Remnants of the Gondwana surface and transitions to the Quaternary surface may also be represented (*see* Plate II).

As in the rest of Malawi, the African surface is the most extensive having reached a very mature state of development. It is best represented by the gently undulating South Lilongwe Plain in the west and south-west which lies at just over 4,000 feet and is the south-east corner of a very extensive erosion surface extending northwards as far as the Vipya and Nyika plateaux and westwards to the Mchinji Hills. Towards the east it has been upwarped along the edge of the Rift Valley and near Dedza lies at around 5,000 feet sloping away gently towards the north. Here it has been deeply dissected by post-African erosion which has penetrated along all the major river valleys and streams. The flat-topped interfluves represent the African surface and the stream valley floors the youthful stage of the post-African erosion cycle.

The high level residual plateaux of Dedza and Chongoni mountains are believed by Lister (*op. cit.*) to be of similar age to the plateaux on Mlanje and Zomba mountains, *i.e.*, of post-Gondwana age. Since this cycle was initiated just after the intrusion of the syenites forming the latter mountains (Upper Jurassic to Lower Cretaceous), the peaks reflect the initial surface of the newly intruded material. However, the syenites of Dedza and Chongoni are probably of Precambrian to Lower Palaeozoic age and the peaks may be the merest remnants of the Gondwana erosion cycle.

The numerous hills rising above the general level of the African surface throughout the area are probably remnants of the post-Gondwana surface, the peaks of the highest hills (*e.g.*, Nkhoma and Mlunduni) lying at or around the same level as the plateaux on Dedza and Chongoni mountains. These residuals are much larger and more numerous in the dissected area bordering the Rift Valley scarp which indicates that Rift movements took place in late Cretaceous times resulting in elevations of the post-Gondwana surface. There are considerable variations in the elevations of residuals amongst the Dedza Hills; gneiss and charnockitic granulite lie at a generally lower level than those composed of syenite, perhaps indicating that the post-Gondwana surface was distinctly uneven in this area.

The Livelezi Shelf (2,000–2,400 feet) was interpreted by Walshaw (1965) as a fallen fault splinter of mid-Tertiary (African) age formed in a similar manner to the Neno, Mwanza and Chileka steps of southern Malawi. It carries a few low post-Gondwana residuals and has been dissected by post-African erosion, although to a lesser extent than the country above the main fault scarp. The faulting and upwarping of the African surface must, therefore, be of post-Oligocene age. Lister (*op. cit.*) believes that, because the degree of post-African dissection is markedly greater with each progressively higher step, the faulting took place when (or soon after) the post-African cycle was generated, *i.e.*, during the Miocene.

The colluvium-covered Lakeshore Plain lying at below 1,800 feet in the north-east is continuous with the Bwanje-Liwawadzi Valley to the south. Dixey (1941, A and B) believed the Rift Valley floor, including the Bwanje Valley, to be a resurrected pre-Cretaceous surface (King's Gondwana) from which the Cretaceous valley infillings have been removed by erosion. This was because certain pebble beds lying on this surface, *e.g.*, the Matope Beds, had been correlated by him with the Cretaceous Lupata Series. As Bloomfield (1965A) points out, the only evidence concerning the age of these beds is that they are pre-Quaternary and he believes that they may be of Tertiary age. Lister (1967) states that the flat floor of the Bwanje Valley is characteristically African and since no lake deposited sediments are known from this valley the flatness of its surface is essentially an erosional feature. It carries occasional low residuals of the post-Gondwana cycle. A few small pockets of sandy alluvium in the extreme north-east may be of lacustrine origin and continuous with the Lakeshore Plain *sensu stricto* of Quaternary age.

(d) Climate

As may be expected from the wide range of altitudes and topography in the Dedza area there are correspondingly wide variations in climate and vegetation. In common with the rest of Malawi the area experiences a tropical continental climate with a single rainy season. The rainy season is moderately hot and typically lasts from December to March or April. In addition, a cool, dry season (May to August) and a hot, dry season (September to November, or early December) can also be identified. Brown and Young (1965) have identified four climatic regions on the Dedza area as follows:—

A. Warm, dryish. This region includes the South Lilongwe Plain and low hills rising above it. Mean annual temperatures are 65°–70°F. and rainfall 30–40 inches. Mean monthly temperatures range from 60°F. in June and July to 75°F. in November with a mean diurnal range of 20°–25°F. In any particular year there is a 10 per cent chance of rainfall less than 20 inches. 85 to 90 per cent of the rainfall occurs in four months and from May to October there is almost complete drought.

B. Cool, wettish. This includes the Dedza Hills with temperatures around 63°F. and rainfall 35–50 inches. The rainy season is longer than in other regions with convectional showers commencing in November and light rains continuing into May. Cloudiness is greater and mist more frequent than at lower altitudes. While the author was working in the area no month was completely rain-free.

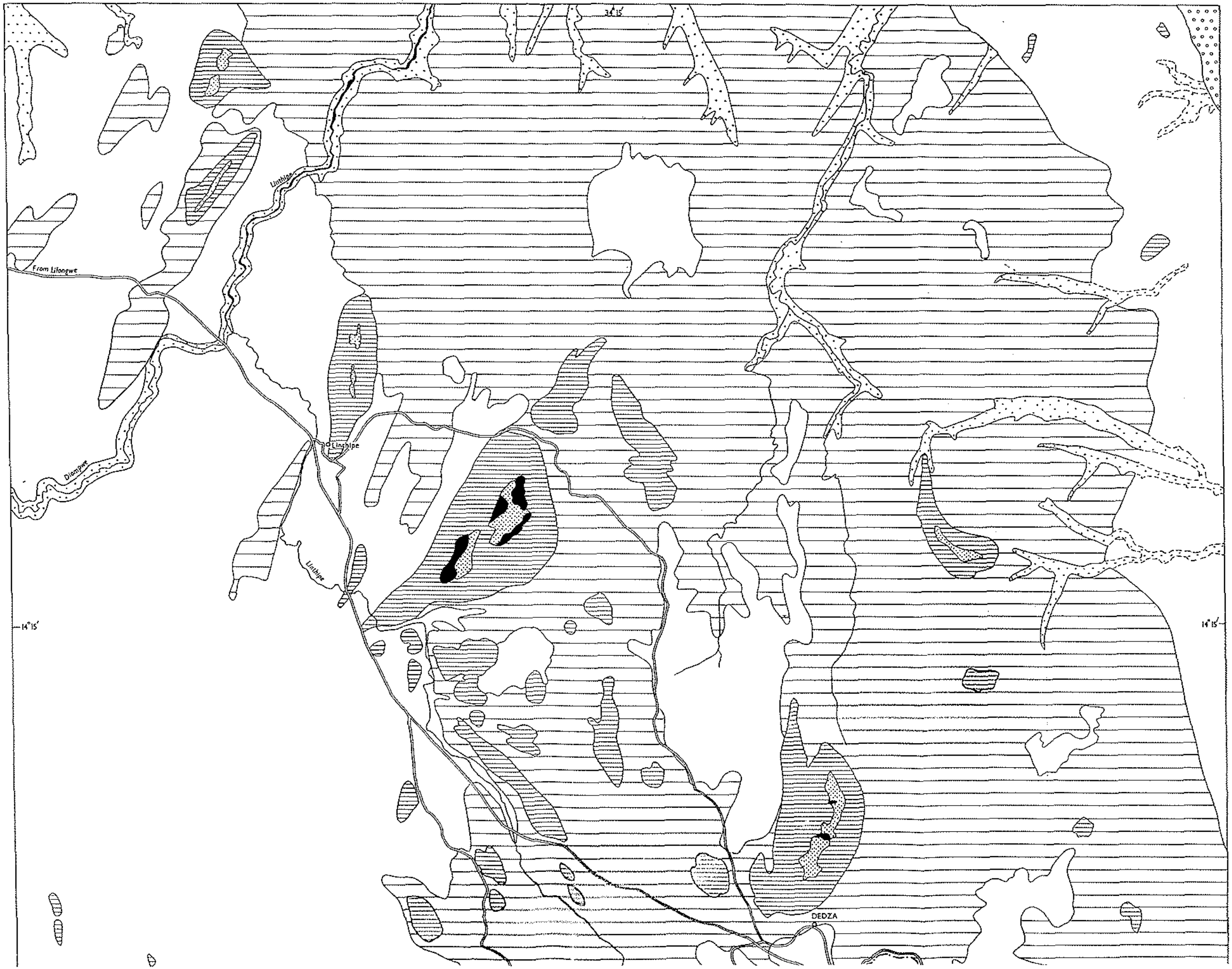
C. Warm to hot, wettish. This is found in the Rift Valley scarp area. Temperatures range from 65°–75°F. and rainfall from 40–60 inches.

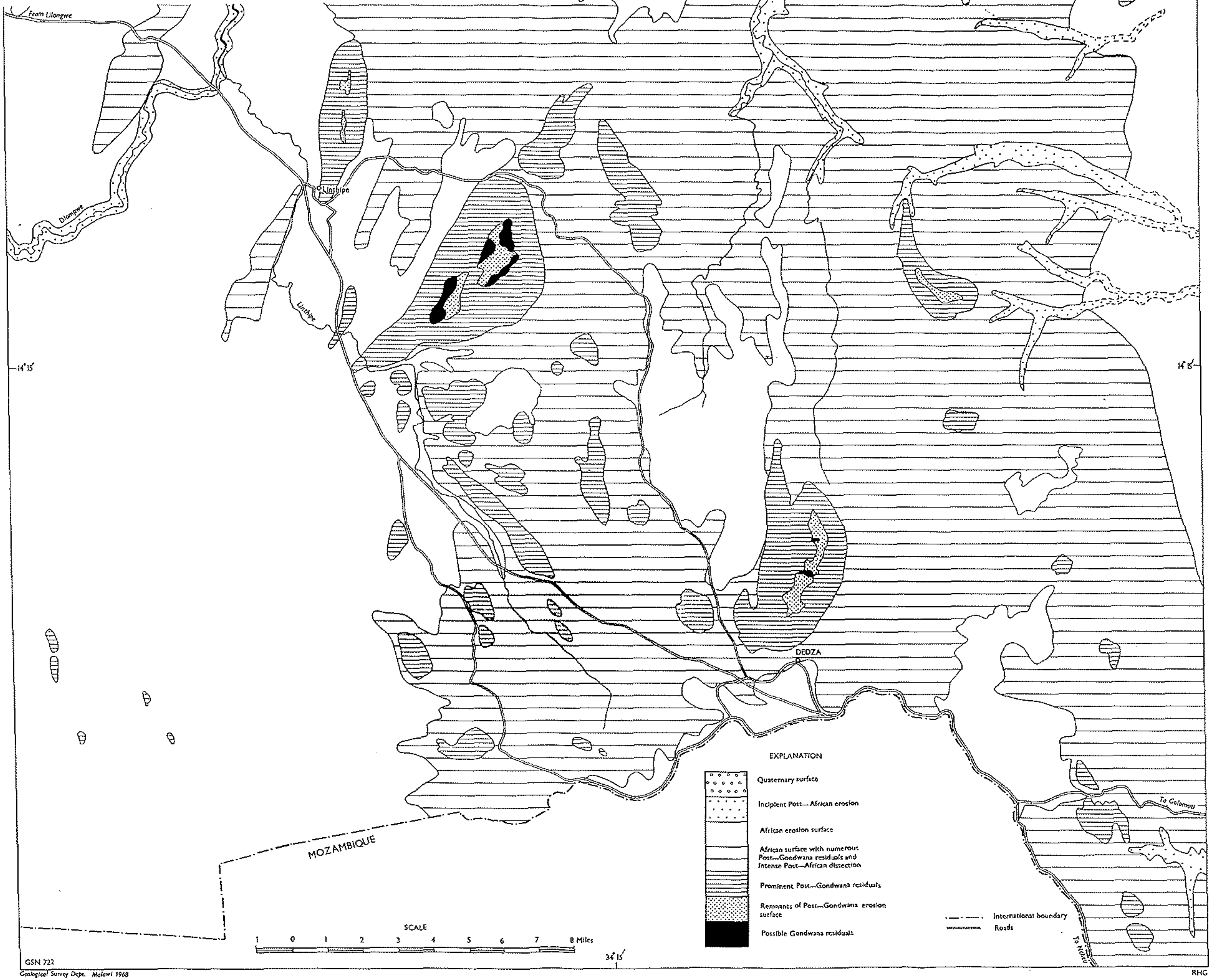
D. Hot, dryish. This occurs on the Lakeshore Plain and scarp foothills with temperatures 74°–76°F. and rainfall 30–45 inches. Rainfall is low in April and there is almost complete drought from May to October.

(e) Vegetation and agriculture

The South Lilongwe Plain has a natural *Brachystegia-Julbernardia savanna woodland.* The area is extensively cultivated and the woodland typically shows formations characteristic of regrowth following cultivation. The composition varies widely but is dominated by species of *Brachystegia* and *Julbernardia* during the early years of growth following the abandonment of a cultivated area. *Julbernardia paniculata* is frequently dominant. A few patches of *Combretum-Acacia-Piliostigma cultivation savanna* were also noted on more fertile soils. The

EROSION SURFACES IN THE DEDZA AREA




From Lilongwe
Linthipe
Diamphwe
Linthipe
14° 15′
14° 15′
DEDZA
EXPLANATION
Quaternary surface
Incipient Post—African erosion
African erosion surface
African surface with numerous Post—Gondwana residuals and Intense Post—African dissection
Prominent Post—Gondwana residuals
Remnants of Post—Gondwana erosion surface
Possible Gondwana residuals
International boundary
Roads
To Golomoti
To Ncheu
MOZAMBIQUE
SCALE
1 0 1 2 3 4 5 6 7 8 Miles
34° 15′
GSN 722
Geological Survey Dept. Malawi 1968
RHG

(f) Water supply

At present ground-water is the main source of water for human consumption in the Dedza area. Small perennial streams and rivers are common over most of the hilly and dissected parts of the area except for the lower slopes of the Rift Fault scarps, the Lifisi and Livelezi Shelves and the Lakeshore Plain where there is very little human habitation.

On the South Lilongwe Plain and also in hilly country where villages occur in watershed areas far from active drainage, boreholes have been drilled for local water supply and list of these is given in Table V. The resistivity methods described by Cooper (1965) have been used successfully for locating aquifers.

Underground water is plentiful over much of the area, although it is often confined to local troughs or narrow aquifers. Aquifers parallel to the strike are common in the charnockitic granulites underlying the South Lilongwe Plain. Some have given anomalously low specific resistivities, *e.g.*, at Nthala and Tete Market and are believed to be located in graphite-gneisses. Narrow, cross-cutting water-bearing zones parallel to joint directions are also common, especially in areas

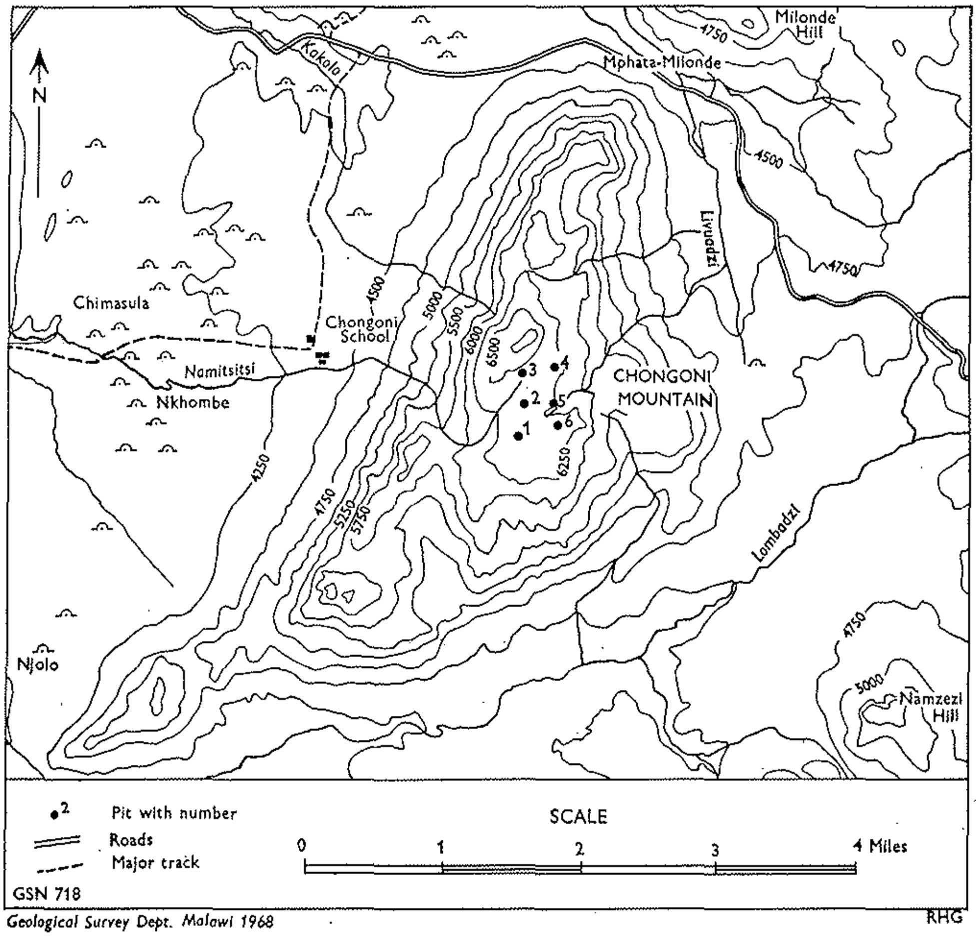


FIG. 5. Location of pits dug by B.S.A. Co. on Chongoni Mountain.

underlain by perthitic gneiss, syenites and monzonites. Anomalously high resistivities were occasionally noted over weathered syenite, *e.g.*, at Kanyama; the reason for this is not fully understood.

TABLE V

BOREHOLES SUNK FOR WATER SUPPLY IN THE DEDZA AREA BETWEEN 1952 and 1966

Ref. No.	Location	Depth in feet	Yield G.P.H.	Rocks penetrated	Year drilled
L75	Tete	94	1,000	Graphite-biotite-gneiss	1952
HD25	Linthipe	90	1,300	Alluvium on biotite-gneiss	,,
HD29	Kaphuka	66	540	Syenite	,,
HD40	Kasina	70	1,000	Biotite-gneiss	,,
L77	Maguza	84	960	Graphite-biotite-gneiss	,,
L76	Lobi	100	2,000	,, ,, ,,	,,
HD26	Livinza	45	1,500	Biotite-gneiss	,,
HD30	Mjonja	66	960	,, ,,	,,
HD31	Maonda	84	1,200	,, ,,	,,
HD34	Kankombe	65	150	Syenite	,,
HD37	Kankhomba	85	1,000	,,	,,
HD38	Mpalale	80	900	,,	,,
HD39	Kankande	80	1,500	,,	,,
HD54	Chidwere	80	250	Biotite-gneiss	,,
HD53	Njati II	84	1,800	,, ,,	,,
HD43	Kapitapita	60	1,200	Graphite-gneiss	,,
L83	Kanyesi	85	650	Syenite-gneiss	,,
L78	Kafotokoza	100	540	,, ,,	,,
L174	Chongoni Research Station	128	800	,, ,,	1955
L162	Kamphate	95	520	Basement Complex gneiss	,,
K38	Chimpamphale	95	750	,, ,, ,,	,,
L385	Bembeke Mission II	91	660	,, ,, ,,	1956
K177	Bembeke Mission I	116	300	,, ,, ,,	,,
E18	Kanyama	90	660	Coarse syenite	1957
E19	Mpati Trading Centre	110	1,000	Decomposed syenite	,,
L386	Kamenya-Gwaza	87	529	Not known	,,
L52	Customs Post	150	700	Thick drift	,,
E246	Dedza Township	204	1,607	Biotite-gneiss	1958
L293	Mwankhundi	100	800	Weathered gneiss	,,
E247	Dedza Township	218	2,365	*Dambo* sands over weathered syenite-gneiss	1959
E17	Mayani Dispensary	170	600	Weathered syenite-gneiss	,,
E302	Kwakwe	61	900	,, ,, ,,	,,
E303	Mbinzi	130	1,000	,, ,, ,,	,,
W11	Gome	110	600	,, ,, ,,	,,
W10	Nyombe	100	600	*Dambo* sands over biotite-gneiss	,,
W47	Themuka	85	600	Laterite over weathered gneiss	,,
W48	Nthaka	109	1,500	Graphite-gneiss	,,
W50	Kangulu	140	1,000	Laterite over weathered gneiss	,,
W49	Falikire	100	900	Weathered gneiss	,,
A24	Malaza	80	150	*Dambo* deposits	1961
E339	Chaluma	115	720	Weathered gneiss	1964
E348	Makanjila	116	960	Black clay	,,
E349	Mkundi	94	1,028	Not known	,,
E320	Chingeti	145	660	Alluvium	,,
H49	Chongoni Forestry School	No data	available		1965
H133	Maonde	90	800	Weathered syenite-gneiss	1966

Yields are generally high throughout the area. Over 40 per cent of the successful boreholes gave yields of over 1,000 gallons per hour, two at Lobi and

Dedza Township, for example, yield over 2,000 gallons per hour. The 47 boreholes were drilled to a mean depth of 103 feet and show an average yield of 917 gallons per hour.

The future for water supply in the Dedza area is good, provided it can be controlled and soil erosion dealt with. There are several excellent dam sites in the Rift Valley scarp zone where small dams could be used to provide hydro-electric power and irrigate large areas of the Lakeshore Plain and the lower fault shelves.

(g) Geochemical drainage reconnaissance

(i) *Introduction*

During regional mapping of the Dedza quarter degree sheet, 6,158 geochemical samples and 113 panning concentrates were collected under the author's supervision. In addition, 1,162 geochemical samples and 15 panning concentrates were collected from the Lower Bwanje Valley area (covered by quarter degree sheet 1434B) as far east as the railway line; this area was geologically mapped by A. L. Dawson (Dawson and Kirkpatrick, 1968) but the geochemical results are summarized here. The distribution of samples between the different 15-minute sheets is shown in Figure 6.

The majority of the geochemical samples come from active streams or *dambo* with some bank and residual soil samples. The samples from active streams were taken mainly from the centre of the stream channel, as near bedrock as possible, whilst the *dambo* samples were collected at depths of twelve inches. The distance between sample points is about half-a-mile. Duplicate samples were taken at each point and, after drying, light crushing and sieving through −80 mesh bolting silk, the fine fractions were forwarded to the Geological Survey laboratories for analysis.

The samples were analysed for some or all of the following ten elements: copper, lead, nickel, chromium, silver, tin, molybdenum, arsenic, zinc and niobium. Seven elements, copper, chromium, lead, molybdenum, nickel, silver and tin, were analysed spectrographically by J. Boulton, other elements were analysed under the supervision of P. T. S. Sandon. Arsenic was determined by a modified Gutzeit method and the method used for niobium follows that of Hunt, North and Wells (1955). Zinc and copper (again) were determined by atomic absorption spectroscopy.

All relatively high values were re-analysed and values greater than the following were re-checked: copper and lead (100 ppm), nickel (200 ppm.), tin and molybdenum (10 ppm.) and silver (0.5 ppm).

(ii) *Results*

The analytical results were summarized and compiled by G. S. Carter and are reported in unpublished Economic Mineral Reconnaissance Report No. 2 (GSC/2) of the Geological Survey Department.

The object of the compilation was twofold:

(i) To detect significant anomalies caused by mineralization.

(ii) To outline regional geochemical patterns which may also delineate more attractive areas for further prospecting.

The calculated geochemical data include the mean, the estimated threshold value and a frequency distribution for each element. The mean is the average of all sample values, excluding erratic high results. The threshold values are arbitrary and are estimated as being the value exceeded by 2½ per cent of the samples excluding erratic, high results. Between 5 and 10 per cent of the relatively high values were plotted to try to detect significant groupings or patterns.