REPORT

ON THE

GEOLOGY OF WESTERN TOGOLAND,

WEST AFRICA,

BY

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UNDER THE DIRECTION OF

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PUBLISHED UNDER THE AUTHORITY OF

HIS EXCELLENCY
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INTRODUCTORY REMARKS BY THE DIRECTOR OF THE GEOLOGICAL SURVEY OF THE GOLD COAST.

This report is a valuable one. It adds materially to the knowledge of the geology, physiography and domestic water-supply of Togoland, especially with regard to the rocks of the Buem and Togo series. The work has been done with keen insight and energy by Mr. Robertson, much of it under difficult conditions during the wet season, and the period when the severe epidemic of influenza was sweeping across the country.

The report amplifies, and in the main is in agreement with, that made by Dr. Koert, as published in *Das Deutsche Kolonialreich.*

In the early part of 1918 I made a rapid journey through the Kpandu, Misahohe, Agu, Lome, Batome and Ho districts, so have had the opportunity of comparing the geology of this part of Togoland with that of the Gold Coast.

Of the interesting geological problems of these Colonies two of the more important are the relations between :—

1.—(*a*) The wide belt of foliated crystallines, embracing mainly metamorphosed igneous and sedimentary rocks, which occur along the coast eastward from Accra, and extend north-eastward through Togoland, and (*b*) the less highly metamorphosed sediments—quartzites, schists of various kinds, phyllites, sandstones and grits—forming the Akwapim series of the Gold Coast (the Togo series of Togoland) which bound the former on the west.

2. (*a*) This Akwapim (Togo) series, and (*b*) the Birrim series of the Gold Coast (Buem of Togoland) lying to the west of it. In the Gold Coast the latter comprises sedimentary and volcanic rocks, both tuffs and lavas, with intrusions of basic and acidic rocks. All of these are considerably altered, and where intruded by later plutonic masses—principally of granitoid character—are highly altered by contact metamorphism.

As opportunity offered the Gold Coast Geological Survey has made rapid traverses across the approximate boundaries of these series, but no actual contact has been noted and nothing definite seen regarding their mutual relations. Observations made in 1913 suggested to me that the rocks of the eastern crystalline series may be merely the more highly metamorphosed forms of rocks of the Akwapim and the Birrim series, and that they were originally composed of a greater proportion of plutonic, hypabyssal and volcanic rocks than are comprised in the Birrim series. It seems to me not improbable that the extreme metamorphism of these rocks may be due to a great batholith, extrusions from which are represented now by isolated hills or groups of hills, such as Mt. Krobo and the Shai Hills. The series contains metamorphosed sediments, such as paragneisses, quartz-schists, quartzites, marble and amphibolite derived from limestone. The simpler view is that these crystalline rocks are of much greater age than those to the west of them, and it is preferable for the present so to regard them. As regards 2, the opinion has been steadily strengthening that the Akwapim (Togo) and the Birrim (Buem) are parts of one great series.

In Togoland, however, the rocks of the Buem series do not as a rule show nearly the same degree of metamorphism. The most altered rocks that are recorded are cherts and jaspers.

This absence of plutonic intrusions is probably the reason for the remarkable paucity of gold in the Buem area of Togoland, for there is no doubt that to these intrusions of granite, with their associated dykes of pegmatite and veins of quartz, the Gold Coast owes a large proportion of its auriferous deposits.

The evidence in the Gold Coast dispels the doubt regarding the relations between the Buem and the Oti series. It is clear that the Oti series is much the younger. In many places rocks of this series lie horizontally, or nearly so, on highly inclined rocks of the Buem series.

Mr. Robertson has proved the occurrence of several volcanic necks in the Volta basin, thus adding further examples to those found by the Gold Coast Geological Survey along the Volta river in 1915. It is probable that these volcanic necks are post-Buem and pre-Oti in age.

Mr. Robertson supports Dr. Koert regarding pene-planation of the country to the east of the Togo Range. This was the view that I also held, but the evidence furnished in the Gold Coast of successive up-lifts of the coast has now convinced me that the physical character of that country is due to marine erosion. Further, evidence is steadily accumulating which suggests that the character of the lower portion of the basin of the Volta is also due to marine action, and that the gorge of the Volta, where it cuts through the Akwapim Range was formerly a narrow strait, determined by a powerful fault. Further, that the tectonic movements still in progress raised the coast line by successive stages, thus draining this great gulf and creating the present lower Volta River.

A. E. KITSON.

Axim, Gold Coast.
23*rd February*, 1921.

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GEOLOGY OF WESTERN TOGOLAND.

GENERAL OUTLINE OF THE TOUR.

The work reported upon below was done during a tour of twelve months, from August, 1918, to July, 1919, in the British zone of Togoland, and its object was to furnish information regarding the mineral resources of the country. The method employed was to cover as much as possible of the country by means of a network of traverses. This was so designed as to allow of nearly every district being visited within the allotted time, whilst additional attention was devoted to those areas which seemed most likely to yield results of economic value. The accompanying map shows on a small scale the routes followed (Map No. 1).

As illustrating the proportions of the time spent in the various districts the following generalised table may be useful :—

August, 1918.—The eastern side of the Togo Range from Pode to Misahöhe.

September and October, 1918.—Visits to localities known to have occurrences of useful minerals : (1) Djeti Chromite deposit ; (2) Chra Marble deposit ; (3) Agu Bauxite deposit ; (4) Akpafu Ironstone deposit. Also several short traverses in the Togo Range, South of Misahöhe.

November, 1918.—The Togo Range North of Misahöhe and the low country immediately to the East thereof.

December, 1918.—The main road from Misahöhe to Kete Krachi, and the Volta River from Kete Krachi to Akroso.

January, 1919.—The Tutukpene Range, the Adele Highlands, and the Oti plains East of Kete Krachi.

February, 1919.—The Northern portion of the Krachi district and the Yendi district.

March, 1919.—Return to Misahöhe from Kete Krachi, and traverses in the Kpandu and Nkunya districts.

April, 1919.—The Kpandu and Nkunya districts.

May, 1919.—The country North and West of the Nkunya Range.

June, 1919.—The Togo Range South of Misahöhe, and the portion of the Dayi River basin to the West thereof.

The examination was mainly geological, but as various small notes were made from time to time on other matters connected with the country and its inhabitants, it is proposed to insert such notes in this Report, as they may not be wholly devoid of interest.

Attention may be drawn here to the maps of Togoland, published by Germany. The chief of these were—

1. Scale 1 in 200,000. In ten sheets. The geographical positions of many places throughout the country were determined, and the detail was filled in by prismatic compass traverses. It was a compilation from observations made by a large number of travellers—not the work of an organised survey party.

2. Scale 1 in 500,000. In two sheets. A reduction from the 1 in 200,000 map.

3. Scale 1 in 50,000. Special large scale maps of the Nkunya Range and of Agu Mountain—chiefly the work of Dr. Grüner.

In each of these the topographical features are shown by hachures in brown, with slight shading, and frequent levels are given along the main roads.

Having regard to all circumstances it must be admitted that the maps are of a considerable order of excellence and proved very useful in the field. Only in one instance—the Dayi Plateau—did they turn out to be really unreliable.

The area under discussion is shown on Map No. 2. It is about 280 miles in length from North to South, and varies in breadth from 20 to 70 miles. For most of the length it is bounded on the West by the Volta River and by its tributary, the Daka River. On the eastern side a line bearing no relationship to the geographical features of the country, marks the boundary between the British and the French zones of control during 1918 and 1919.

The dominating geographical feature is the range of mountains running diagonally across the country in a direction approximately North and South, swinging round to N.N.E—S.S.W. to the South of Misahöhe, and continuing on the West of the Volta towards Accra as the Akwapim Range. The Togoland portion of this range was usually called the Togo Mountain Range by the Germans, and will be referred to in this Report by the same name. North of Misahöhe it gradually broadens out into a plateau, two portions of which—the Dayi Plateau and the Adele Highlands are included in the British zone. South of Misahöhe the range splits into two lines of peaks, the Eastern of which practically dies out South of Ho whilst the Western branch continues over the Gold Coast border as the Peki Range. The highest point attained is about 3,000 feet above sea-level. This is in the neighbourhood of Misahöhe.

A parallel chain of hills runs North and South about twelve miles West of the Togo Range, but does not attain at any point a height of over 2,800 feet (usually much lower), and is discontinuous. The different portions (named from South to North) are referred to below by the following names :—Kpandu Hills, Nkunya Hills, Tapa Hills, and Tutukpene Hills. The ground between the Togo Range and the Kpandu and Nkunya Hills is drained by the Dayi River—that between the Togo Range and the Tapa and Tutukpene Hills by the Asuokoko and its tributary the Menu.

North-west of the high country is the broad undulating valley of the Oti River—an Eastwards extension of the Gold Coast Northern Territories, whilst to the South-east of the Togo Range a low stretch of plain drained by the Kalagba, Todshi, Shio and Haho Rivers extends to the coast. This latter is dotted over with isolated hills and small lines of peaks, the most important being Agu Mountain, a small residual group of peaks roughly circular in outline, standing out above the surrounding plain and reaching an altitude of over 3,000 feet above sea-level.

We have thus three district geographical divisions: (1) the Valley of the Oti in the North-west, (2) the Hill Country running diagonally across the middle, and (3) A plain in the South-east with isolated mountains.

Geologically, the country is divisible into different sections which correspond in great measure to the geographical divisions.

1. The Oti Series, a group of nearly horizontal sandstones, conglomerates, mudstones, etc., occupies the low-lying Oti Valley and stretches from beyond the Northern boundary of the British zone Southwards to the mouth of the Asuokoko River. Westwards it extends into Gold Coast territory, and Eastwards reaches the bottom of the Tutukpene Hills. A straight line joining Akroso and Tutukpene shows approximately the limit of its Eastwards extension.

2. The Buem Series, altered sandstones, conglomerates and mudstones, with associated volcanic rocks, covers the ground between the Oti Valley and the Western scarp of the Togo Range, *i.e.*, the hill chains West of the Togo Range and the valleys of the Asuokoko, Menu, Konsu and Dayi Rivers.

3. The Togo Series, chiefly altered sedimentaries, *e.g.*, quartzite and phyllite, forms the hills of the Togo Range. The Ho branch of the range is an outlier of Togo rocks surrounded by crystalline metamorphics.

4. The Crystalline Metamorphic Series, gneisses and schists with associated intrusive igneous rocks of various types, occupies the remainder of the country from the Togo Mountains South-eastwards to the sea.

The names Oti, Buem and Togo were given to the respective Series enumerated above by the German geologists* and are retained provisionally for use in description. They do not necessarily indicate natural divisions.

The following table indicates the geological sequence in Togoland, as far as at present ascertained.

1. *Recent Alluvium.*
2. *Tertiary.*—Eocene Limestone exposed in the French zone to the East. Not known in the British zone, but may exist under the coastal deposits.
3. *Oti Series.*—Age unknown.
4. *Buem Series.*—Age unknown. Probably pre-Oti.
5. *Togo Series.*—Age unknown. It has not been definitely shown that the Buem and the Togo rocks are not different portions of the same sedimentary series.
6. *Crystalline Metamorphic Series.*—Underlying the Togo Series. Partly of igneous, partly of sedimentary derivation.

GENERAL OBSERVATIONS UPON THE COUNTRY.

The low country, with its island mountains, which stretches from the base of the Togo Scarp to the sea is partly covered with dense forest, partly with more open park-land. This latter is not quite so open, however, as the more typical stretches of park land further North, possibly due to the somewhat moister conditions which prevent, to some extent, the annual burning of grass which is such a feature of the Northern Territories. Many of the hill slopes are covered with dense forest, and similar conditions prevail along the banks of most of the streams, even those which only flow during the rainy season. Relief is afforded, however, in the intervening areas by the park land with shea trees and Borassus palms. Yams, cassava, coco-yams, plantains and maize are grown for food. Groundnuts are not grown extensively in most places. Coconut palms are fairly numerous. Oil palms and cocoa trees are cultivated very largely. Out of the flat and unexciting plains there rise some very arresting peaks and lines of hills. Two of the most notable are Adaklu and Agu. Adaklu is a very remarkable hill, rising quite suddenly out of the plains to a height of 1,940 feet above sea-level. It seems to be composed principally of white quartzite, which forms precipitous cliffs standing out as a fine feature in the sun. This hill was not visited during the tour, but only seen from a distance. It is about 8½ miles S.E. of Sokode (Pode-Palime road). Lat. 6° 30′ N., Long. 0° 30′ E.

Agu is a more bulky mass, also rising abruptly from the plains, about 7 miles E.S.E. of Palime. Lat. 6° 53′ N., Long. 0° 45′ E. It is a group of hills roughly circular in outline, and attaining a maximum height of about 3,360 feet above sea-level. It is partly covered with dense forest, partly with tall elephant grass. A large proportion of the slopes is cultivated, and native villages are perched on the Southern side of the mountain at various heights up to 2,600 feet above sea-level. This side of Agu is well seen from the Lome-Palime railway line, and it is on the low ground to the South and West that the Agu plantations are situated.

North of Agu, in the Kpele district, are several small hill ranges running in a North and South direction, all showing conical-shaped peaks, such as indicate possibly a late stage in the reduction of a land surface to its base-level. This point, however, will be noticed later on. Looking Eastwards from the top of the Togo Mountain scarp these stretches of plain are seen as a patchwork of forest and park land; with here and there conical hills of various sizes, either isolated or in groups or chains, relieving the monotony of the gently undulating low ground. South-east of Agu and Adaklu, however, practically no prominences of any kind are to be seen. If, on the other hand, we look Westwards and North-westwards from any of the island hills of the plains, especially from Agu or from the hills further North, we see the Eastern side of the Togo Range standing out as a well defined scarp, fairly uniform in height, with breaks here

* Das Deutsche Kolonialreich.

and there, *e.g.*, the Todshi River gap and the François Pass. During the rains numberless cascades of all heights and sizes form attractive streaks of white on the face of the scarp, but only one—the Seva Falls—was observed to last through the dry weather. The thick forest, however, conceals other falls, some of which continue to flow during the period of drought, though in greatly reduced volume.

There is a good deal of game in the low country, chiefly antelope of various kinds, and elephants are known to come as far South as the country East of Agu during the early part of the wet season.

The François Pass forms a natural break between the two parts of the Togo Range which are included in the Southern portion of the British zone. North of it the range commences to broaden out gradually into a plateau which attains a width of over thirty miles in the Akposso district, whilst Southwards it breaks up into several chains of peaks with quite low ground in between. The Southern end is relatively more advanced from the denudation point of view, whilst further North the streams have not yet done more than commence to eat down into the surface of the plateau except in the cases of the larger rivers, such as the Dayi and the Amu, tributaries of the Volta and of the Monu respectively.

At the François Pass the Togo Range is about seven miles broad, from East to West, and consists of two fairly well defined ridges, both running in a N.N.E—S.S.W. direction. Eight miles further South the range splits up into two portions, a single line of peaks on the West, running S.S.W. to Kpeve and Anum, and a double line on the East running approximately Southwards to Ho and Sokode. For convenience we may call these the Kpeve and the Ho Range respectively. They are six to seven miles apart, and the intervening plain is drained by the Dsawöe River. South of Kpeve this river forms the boundary between the Gold Coast and Togoland for some distance. The Western range is quite continuous from the François Pass to the boundary at Kpeve. Two distinct breaks occur in the Eastern range, one at Kpatave, about eight miles South of Misahöhe, through which the Todshi River flows Eastwards, and the other at Sokode, some eighteen miles further South. Beyond Sokode other hills carry on the line of the range, but they become progressively lower to the South, and almost die out before the boundary is reached.

The Togo Mountains South of the François Pass do not, as far as it is possible to judge, attain at any point a height of 3,000 feet above sea-level. The Moltkespitz at Misahöhe is about 2,700 feet in height, and is the highest point on the Eastern side of the region. On the Western side several peaks reach a height of about 2,800 feet, but the highest of these was not ascended. The majority of the peaks in the Avatime highlands are over 2,400 feet high.

South of where the range splits into two portions the hills are lower. At Sröe, on the Kpeve branch, the ridge is not much over 2,000 feet high, whilst the hills above Kpeve only attain a height of 1,600 feet. On the Ho branch the hills in the Matse and Taingbe districts rise in some cases to 1,600 feet. At Ho, six or seven miles further South, the height is a little over 1,000 feet. Beyond this Southwards no data were obtained, but beyond Sokode there does not appear to be any hill much over 1,000 feet in height.

The Dayi Plateau is that portion of the Togo range between Misahöhe and the Anglo-French boundary West of Sodo. The Dayi River rises in the North of this region and drains most of it except the Southern portion. It attains a breadth of about thirty feet by the time it descends into the Buem country to the West. The German 1 in 200,000 (approximately 4 miles to an inch) map of this district is unreliable. At about a third of the way from Misahöhe to the Anglo-French boundary a pass traverses the range dividing it into two distinct portions. The Northern part is chiefly undulating country with a distinct range of hills along the West side, cut through in one place by the valley of the Dayi River on its way into the plains below. The average height of the plateau is about 2,500 feet above sea-level, rising to about 3,000 feet in the hills. The country is fairly open park-land in most places, with belts of thick forest along the river courses.

South of the François Pass the major portion of the high ground is covered with forest, although a good many of the quartzite hills in the Ho Range are mainly grass-covered, with patches of denser growth here and there. The valley of the Dsawöe has many stretches of park-land with shea trees and Borassus

palms. The inhabitants of the Ho branch of this hill-tract are apparently of the same stock as the people of the plains to the East, but in the Avatime and Logba highlands we meet a different race with a different language, though most individuals also speak one of E/e dialects. According to the Germans they belong to a race which has been displaced by the present inhabitants of the low country.

Along the whole stretch of the Togo Range from the François Pass Southwards cocoa farming is carried on to a considerable degree. Coffee and rice are also grown in several districts—the former introduced by the German missionaries—but not to any great extent. The two most important trade routes are those running Southwards from Palime to Ho and to Kpeve respectively. The former follows the Eastern side of the Togo Range and enters Gold Coast territory at Pode. The latter passes Westwards into the Dsawöe valley through the gap at the North end of the Ho Range and follows the Eastern side of the Kpeve Range to Todome, thence crossing the hills to Kpeve and making for Anum. Another important route comes down the West side of the Kpeve Range.

The inhabitants of the Dayi Plateau seem to be of the same race as those of the low ground to the South-east, in the Kpele district. Rice, yams and cassava are the principal crops, also a little maize. Plantains and bananas are hardly grown at all—possibly owing to the altitude and consequent lower temperature at some seasons. Oil palms are cultivated, but not to the same extent as further South.

The best months of the year on the plateau country and in the Avatime highlands are from September to November—the latter part of the wet season. At other times it is inclined to be foggy. The dense growth of vegetation hides what might otherwise be very attractive scenery, for some of the rivers have cut fairly deeply into the surface of the plateau, and there are numerous small waterfalls. Precipitous scarps have their sharp corners rounded off with dense bush in an annoying way, and as native paths follow the line of least resistance it is quite seldom that a really good general view is obtainable. Only small antelope were seen on the Dayi plateau, but monkeys are numerous. With reference to the above remarks on vegetation it should be noted that there is much risk of excessive deforestation, as the natives, if not strictly watched, destroy acre after acre of forest land for new farms.

The valley of the Dayi, West of the Togo Range, brings us back to the general conditions of the low country—muddy streams instead of the clear water of the hills, undrained swamps, park-land with shea trees and Borassus palms. The hill ranges West of this are mainly forest-covered and show few cliffs, except along the West side of the Nkunya Range, which is in places quite precipitous. The inhabitants have much more in common with the Kwahu and Ashanti peoples than with the E/e tribes on the opposite side of the Togo Range. Beyond Kpandu and Wurupong the E/e element practically dies out. In the Akpafu hills, however, there seems to be something similar to what we have in the Avatime highlands, a small group which has kept fairly distinct from the peoples of the low country round about. It is noteworthy, however, that in both districts there is of recent years a very strong tendency for the hill-peoples to desert their old villages and make new ones in the valleys below. Borada and Santrokofi are examples of this in the Buem country, and Akpafu threatens to do likewise.

In connection with the distribution of the various tribes in this region it should be noted that the Volta River has no significance as a racial boundary.

The usual crops are grown in the region in question, and there is much rice cultivated in the Nkunya and Akpafu Hills. Guinea corn and allied grains do not figure much in the diet of the natives until one gets well into the Krachi district. The two main trade routes from the North come respectively down the West and East sides of the Nkunya Range, making for Kpeve and the Gold Coast on the one hand and for Palime and the railway line on the other. On the Western side Wurupong, Kpandu, and Kpeve are the principal towns, whilst on the East side are Jasekang (Ojasekan) and Hohöe (Chochoe, Pekipong).

Once we get away from this region out on to the Oti plains to the North we find a change for which we are prepared by the fine panorama visible from the Tapa Hills. Looking Northwards from this point, over the Asuokoko River in the

immediate foreground, there is little but broad plain-land to be seen, with a few low ranges of hills in the hazy distance. Strips of forest lie along the river courses, but the rest of the country is park-land with game really plentiful—antelope of many kinds, large and small, elephant and buffalo. Lions are rare in the Krachi district, but are known to exist. Monkeys abound along the Volta and Oti, and the higher reaches of the latter river have many hippopotami.

The most easily detected change along the main road from Kpandu to Krachi is the displacement of the oblong-shaped native hut with ridged roof by the round type with central pole, as soon as the Oti country is reached. This type of country extends right to the extreme North of the British zone, and during the dry season only a few muddy pools are left in the stream channels except in the case of the Oti and Volta. Even the Daka frequently does not flow throughout the Harmattan. During the wet season the Oti is flanked by large stretches of flooded ground, and much of the low country becomes impassable. Farther North the country becomes gradually barer, and shades into grass-land with only a tree here and there. The inhabitants belong to branches of tribes known in the Northern Territories of the Gold Coast. Krachis in the Southern portion of the Krachi district, Nanumbas in the Northern portion, and Dagombas in the Yendi district, are three of the principal types. Yendi itself is the town of the paramount Dagomba chief. The Konkombas along the Oti Valley in the Yendi district are a very different race, wearing only the scantiest of clothing and always going about armed with bows, poisoned arrows and short curved knives. Yams figure to a fair extent in the food of the natives, but Guinea corn, millet, and several kinds of beans are also grown.

Rafia and other types of basket work are an industry in various places, but the main road to Krachi, with its endless line of cattle, sheep and heavily laden donkeys (not to mention the owners on exceedingly scraggy and disreputable-looking horses) carrying the produce of the French country further North, is the principal indication of activity. Amongst other things a large amount of shea butter is brought South.

Travelling Eastwards across the Oti plains from Danbai, which is about twenty-eight miles North-east of Krachi, we come at Tutukpene (Dutukpene) to a hill range rising suddenly out of the flat ground to a height of over 1,000 feet. This Tutukpene Range is six to seven miles broad, and runs North and South. It is for the most part thickly wooded. It ends abruptly about nine miles North of Tutukpene, whilst to the South it joins the group of hills round Adum-adum, about twenty miles distant from Tutukpene. East of this range a stretch of low ground about seven miles broad extends to the foot of the plateau country which is a continuation Northwards of the Togo Mountain range. This low ground is partly covered with forest, partly with park- and grass-land. At its Northern end it is drained by the Chai (Tschai) River with its tributaries; at the Southern end by the tributaries of the Asuokoko.

The Adele plateau country to the East, in the centre of which is Bismarckburg, is reached by a narrow and steep pass leading up from Dadiasi in the plains below to Peleu (Dikpeleu). The principal rivers in this region are the Yege and the Kalabo, both flowing South. They join about ten miles South of Bismarckburg and form the Asuokoko, which finally cuts through the hills Westwards and flows into the Volta at Akroso. The country is well wooded in the valleys, but most of the hills are covered with grass.

The Adele district is naturally more directly connected with Atakpame than with Krachi, and rubber, which is collected by the natives from the numerous rubber-producing trees in the forest-covered areas, is mainly taken to Atakpame for sale. The Adele natives have at times proved very truculent. The health of the people of this district does not seem to compare favourably with that of most parts of the country; cancer and leprosy seem common as far as could be judged during a brief visit.

The scenery on the Adele plateau is not striking, but a little further North at Shiare, where the country is not so much buried in forest, it is more rugged in appearance and the deep narrow valleys show to advantage. Yams are cultivated and also Guinea corn. A good deal of tobacco is also grown.

DETAILED DESCRIPTIONS OF TRAVERSES.

We next proceed to detailed descriptions of the various traverses made in the different parts of the country. For convenience they are grouped under several areas, as under:—

1. The Country East of the Togo Range.
2. The Togo Range South of Misahöhe.
3. The Dayi Plateau.
4. The Adele and Tutukpene Highlands.
5. The Dayi Valley.
6. The Nkunya and Kpandu Volcanic Area.
7. The Oti Basin.

It should be noted that there was no opportunity to go deeply into the matter of the spelling of place names, and consequently it has been considered advisable to adhere as closely as possible to the spelling on the German maps—eliminating to some extent the Teutonic tinge. Where there is much discrepancy the pronunciation obtained from the natives is given with the German map name following it in brackets. Experience with the German maps has brought the conviction that their orthography and accentuation is, in the main, self-consistent. The modified "f," as in the word usually spelt "Ewe" in English, is indicated by "vh" on the German maps. It seems important enough to merit the use of a definite symbol, and throughout this Report is indicated by the sign "*f*."

Heights in the Togo Mountain and Adele Highlands areas are based respectively upon assumed altitudes above sea-level of 1,540 feet for Misahöhe Political Station bungalow, and 2,120 feet for Bismarckburg Political Station. These are the heights given on the German maps.

1. The Country East of the Togo Range.

The main road from Pode (Pora) to Sodo, running N.N.E. along the Eastern side of the Togo Range, marks out roughly the boundary between the Togo Series and the Crystalline Metamorphic Series which occupies the flat country to the East. Going along this road we pass alternately across the sandstones, phyllites, and quartzites of the former series and the gneisses and mica-schists of the more highly altered Eastern rocks. Complications due to intrusions of igneous rocks along the contact appear here and there, and as these intrusions are sometimes themselves foliated the task of placing any given crystalline rock is not easy. Though there are many local variations in the level of the foot of the Togo Scarp the ground does not vary very much from the general mean all the way from Pode to Sodo. Usually, the view presented on the road is that of grass- or forest-covered hills to the West and low undulating forest country, with a few isolated hills, to the East. Now and again, as at Deti, Nyive (Njiwe) and Kpatave, the route passes behind some of the foot hills of the Togo Range. These foot hills are usually composed of quartzites of the Togo Series, but sometimes of intrusive igneous rocks, as in the case of *f*eto, North of Akata.

The Southern portion of the country, from Pode to Palime, is drained by the tributaries of the Kalagba and Todshi Rivers. Northwards, from a few miles beyond Palime to Sodo, the country lies in the basins of the Shio and Haho Rivers. The tract from Sodo Northwards to Atakpame is drained by the Amu and the Amuchu, tributaries of the Monu River.

Commencing at the Southern end, we find in the bed of the Dsawöe River at Pode exposures of mica-schist, dipping at about 30 degrees to the East, showing that we are here on the crystalline metamorphic series. There is practically no exposure between this and the Dewu Hills, beside Klöe. The only rock seen *in situ* in the intervening area is a quartz lens at Komlako*f*e, 3 to 4 feet thick, striking N.E.—S.W. Numerous fragments are to be found along the route however. Some of these are of quartzite and some of gneiss[1]; others, gathered at different points along the road between Kwasiko*f*e and Komlako*f*e, are of pyroxenite.[2] Only two stream beds had water in them in this area when it

[1], [2] Further details about the rocks numbered thus are given in Appendix I.

was traversed. One, at Mumikoʃe, gave no gold on panning, but a good deal of garnet. The other, just South of the Dewu Hills, gave only scanty black sand. Thence to Sokode, the road is over rocks of the Togo Series. The principal rock is quartzite, with subordinate phyllite. Both of these are seen standing vertically with strike N.N.E.—S.S.W. in a stream just South of Agove. On panning, this stream gave scanty black sand, moderate zircons, etc., but no gold. The Eʃle River, about three miles further North, gave almost no concentrate. At Sokode, and half a mile further North, a mica-schist (with pink felspar eyes) dipping at 35 degrees to the South-east is exposed. Associated with it, but not found *in situ*, is a compact igneous rock of granitic structure, medium-grained, consisting of plagioclase (labradorite) with hypersthene, augite, biotite and quartz. About half the slide is plagioclase, with pyroxene, biotite and quartz making up the other half in approximately equal quantities, the pyroxene slightly predominating. It may be a quartz mica norite[3]. From here to Ho the road is on the crystalline metamorphics. In the Mbeji River schists striking N.E.—S.W. are seen, and just beyond this are boulders of a quartz-free mica gneiss[4]. This rock was not seen *in situ* here, but was got later at Matse, on the other side of the Ho Range. It is grey in colour, and medium to coarse in grain. At Banköe a mica gneiss is exposed, also striking N.E.—S.W. The pink felspars are not so plentiful here as at many other places in the gneisses and schists. Pannings between Sokode and Ho gave only scanty black sands and zircons. On the hill at Ho Station, about 300 feet above the gneiss exposure at Banköe, are altered, sheared sandstones of the Togo Series, showing minor folding. Shear planes strike N.E.—S.W. as in the gneiss. The contact is not seen.

Between Ho and Avonhui nothing is seen but sandstone and quartzite fragments on the road. At Ajati a fragment of a quartz-free mica gneiss was obtained, similar to that got between the Mbeji River and Banköe. About two miles further on sheared micaceous sandstone is exposed striking N.E.—S.W., dip not seen. A little further on a reddish micaceous sandstone is seen dipping at 40 degrees to the East. Here we are on the Togo Series, but near the base, as fragments of mica gneiss[5], and of a dark green schist[6] consisting almost entirely of hornblende in elongated crystals, are found. Shortly after this garnetiferous rocks begin to appear, and a fragment of eclogite was picked up. About two miles South of Tokwe a stream which was panned had many garnets of $\frac{1}{8}$th to $\frac{3}{8}$ths of an inch in diameter in its gravel. No gold, but a moderate amount of black sand was found in it. A quarter of a mile further on mica-schist with foliation planes striking N.E.—S.W. is exposed, and the Eklemu River, in which it is seen, gave abundant black sand on panning, but no gold.

North of Tokwe more eclogite[7] fragments are to be seen on the road, and the rock itself is found *in situ* a little to the West, on the Tokwe-Ave (Awe) road. This road was afterwards followed from Ave to Tokwe. At Ave itself flaggy quartzites are exposed with no definite dip showing. Nothing more is to be seen until about three miles North of Tokwe, where schistose rocks are exposed dipping at a very variable angle to the South-east. They continue to appear at intervals for a distance of about a mile and a half. The chief component of this schist is a green amphibole accompanied by abundant garnet. Quartz is also present, sometimes in large amount. Examination shows it to be an eclogite[8]. Between this and Tokwe flaggy quartzites are exposed, dipping generally to the South-east. Nothing of note was observed in the concentrates from the streams in this area.

Going North from Tokwe along the Palime road a gneiss appears about one mile South of Nyive with foliation planes striking in the prevailing direction, and dipping Eastwards at 40 degrees. The Todshi River at Nyive gave moderate black sand, garnets and zircons, but no gold, on panning. Going Westwards from Nyive to Ave the Todshi River is crossed immediately West of Nyive. In the stream bed about 50 feet of micaceous quartzites are exposed, dipping S.E. at 60 degrees. A mile further on dark green eclogite[9] is exposed, and a little beyond this a biotite gneiss is seen *in situ*. It has large porphyritic crystals of felspar. Two miles on there are extensive hummocky exposures of fine-grained grey schist[10] with foliation planes dipping South-east at between 20 and

(3), (4), &c. Further details about the rocks numbered thus are given in Appendix I.

30 degrees. Quartz, felspar and biotite seem to be the chief constituents, with some garnet. Nothing more is to be seen between this and Ave.

Half a mile North of Nyive on the Palime road micaceous sandstone again appears, dipping at 75 degrees to the East. Further on a hornblende-schist occurs, and schistose rocks seem to underlie the country thence to Yevieʃe (Jewievhe). The hornblende-schist[11] consists of predominant green hornblende with subordinate felspar, biotite and interstitial quartz. North of Kpatave micaceous sandstones again appear. Several pannings between Nyive and Kpatave gave similar results—scanty black sand, moderate zircons, but no gold.

Some 500 yards West of Kpatave on the Amedzoʃe road appears an epidote schist[12] with foliation-planes dipping to the East at moderate angles. Travelling West from this point we pass through the gap at the northern end of the Ho range. To within about 3 miles of Toji (Todje) (at the foot of the Avatime Hills) quartzites and phyllites of the usual Togo type are exposed. Then members of the crystalline series appear, medium-grained biotite gneisses[13], grey in colour.

Returning to Kpatave and travelling Northwards towards Palime, the hills immediately to the North of Kpatave are found to be composed of Togo sandstones, somewhat micaceous. In the lower ground beyond, biotite gneiss[14] is exposed, *e.g.*, in the channels of the Bla and Aha Rivers, strike of foliation N.E.—S.W. The Bla, on panning, gave moderate black sand, but no gold. The Aha gave one or two specks of gold, with moderate black sand and zircons.

West of Palime on the Haingba road the Aha River shows exposures of biotite gneiss[15], whilst above, on the face of the Togo Scarp, there are Togo phyllites and quartzites. This will be discussed later (p. 16).

In the flat country between Palime and Agu the principal rock is a gneiss similar to those mentioned. It is seen between Palime and Dalave on the road.

Agu Mountain is mainly built up of a garnetiferous gneiss[16], sometimes rich in hornblende, sometimes in hypersthene. It was called a gabbro by Dr. Koert, the German geologist, but this commits one to a definite view of its origin and seems hardly justified without further investigation. The strike of the foliation-planes is usually about N.N.E.—S.S.W. More will be said about the capping of bauxite on Agu when the question of lateritisation in Togoland is approached.

Between Dalave and Abessia (on the Palime-Lome Railway route) a phyllite is exposed in the Adeje River. Its relationship to the gneiss is not clear. Between Abessia and Palime the gneiss appears in several places, in one case much veined with quartz. This occurrence is a biotite gneiss[17] with much titanite scattered through it as well formed envelope-shaped crystals. The same rock[18] is seen on the Palime-Sodo road, between Palime and Poji (Podji). There it has large pink porphyritic felspars. A finer grained and more acid portion at the same place has a larger development of sphene in large envelope-shaped crystals up to $\frac{3}{4}$ inch in length. A stream on this road, just outside Palime, gave, on panning, abundant epidotes and zircons, with magnetite and rutile.

The Togo quartzites and phyllites appear again immediately the road touches the foot of the scarp, North of Poji. At Tomegbe (Tongbe) for a short distance phyllites are seen dipping North at from 10 to 15 degrees. Nothing more is seen till North of Seva. Several streams between Poji and Seva, on panning, gave moderate black sand and zircons, but no gold. At the Aka Falls, North-west of Seva, a thickness of nearly 700 feet of Togo sandstone is exposed. The dip at one point is N.N.E. at 20 degrees.

In the low ground between Seva and Lavie the gneiss appears once more. At Lavie quartzites and indurated sandstones are seen, probably in part the same as those at the Aka Falls. Two miles further on, at Akata, soft purple phyllites dip gently South-eastwards.

A mile and a half North of Akata is a basic intrusion. It seems to be intruded into the Togo Series. It forms a conspicuous rounded hill called Jeto below the Togo Scarp. The summit of this hill is about 550 feet above the level of the country to the East. The intrusion is composed entirely of pyroxenite[19] (as far as was observed). In section the rock shows nothing but pyroxene, roughly half

(11), (12), &c. Further details about the rocks numbered thus are given in Appendix I.

diallage and half hypersthene, generally fairly fresh. Along certain lines serpentinisation has taken place to a small extent. The shape of the intrusion in cross section appeared to be roughly oval, as far as could be seen, with long axis North and South. The area covered is probably between ¼ and ½ square mile. On the road East of this, is an outcrop of a Togo quartzite, dipping North at 30 degrees. It contains veins and patches of ilmenite[20], probably genetically connected with the intrusion. The quartzite is much sheared and sericitic.

Several of the streams between Akata and Gudave (Gudewe) gave minute specks of gold on panning, with moderate black sand and zircons.

At Gudave the gneiss[21] appears again, at an altitude about 200 feet below the exposures of quartzite and sandstone at Ɔeto. To the North of Gudave almost nothing was seen *in situ*. The whole country is covered with sandstone blocks and sand derived from the rocks of the Dayi Plateau to the West. At Agote a few fragments of a dioritic rock suggest the neighbourhood of a dyke or other intrusion, whilst North of Agbango phyllites and bluish quartzites of the Togo Series are exposed, with a dip of about 65 degrees to the West. Beyond this to Sodo white sand covers most of the surface. The streams between Gudave and Sodo gave almost nothing of high specific gravity on panning.

Beyond Sodo on the Atakpame road no regular observations were made, but the same types of rock were seen to occur as to the South of Sodo. Between Sodo and Amlame fragments of tremolite gneiss[22], quartzite, and amphibolite[23] were obtained. Between Amlame and Atakpame chiefly mica and hornblende gneisses[21] were seen *in situ*, whilst just about a quarter of a mile from Atakpame market place there is an exposure of zoisite schist[25], a spotted rock consisting of elongated crystals of zoisite and green hornblende surrounding eyes of felspar (an intermediate plagioclase).

Atakpame itself is on quartzites and phyllites of the Togo Series. On the road Southwards from Atakpame to Glei sandstones and quartzites are exposed until we reach Avete. Near Agbonu there is at one place a good deal of kyanite along the shear-planes in the quartzite. South of the Amuchu River mica gneiss[20] is exposed similar to that seen along the base of the Togo Scarp. It is at places garnetiferous.

Similar gneiss[27] is seen along the bush path leading from Glei to Gudave, which was followed as far as the Chra River (Achla River). Here there are several beds of white marble exposed, a more detailed description of which is given in a later section (p. 42). The strike of these beds, and also the strike of the foliation planes in the gneisses mentioned above is approximately N.N.E.—S.S.W. Similar gneisses are exposed in the valley of the Amu River between Glei and Amukpa. (It may be mentioned that in reality the word "Amu" means "river" or "water" in at least one of the Eʃe dialects.) South of Amukpa, on the South side of the Amu a line of conical topped hills runs North and South, and the northernmost of these is composed of serpentine, with chromite. This is apparently an intrusion in the gneisses of the crystalline metamorphic series and is described in greater detail further on (p. 43).

2. The Togo Range South of Misahöhe.

Taking the route from Palime to Liati, via the François Pass, we find that there are no exposures of the crystalline metamorphics on the road between Palime and Yo. This area is, however, probably occupied by them, as they are to be seen in the bed of the Aha at Palime and on the Palime-Poji road as mentioned above. They are also seen on the slopes of the hills West of Haingba-Aʃegame. Immediately beyond Yo phyllites dipping to the North-East at moderate angles are exposed in a stream, and similar rocks, together with flaggy quartzites are shown at intervals right up to the summit of the pass. They are in every case folded and sometimes very finely puckered, but the general direction of dip is towards the N.E. Such also is the case with outcrops of light quartzite which are seen on the sides of the hills to the North. The phyllites are frequently purplish or reddish in colour. Just East of Misahöhe Station, and at some other points they are graphitic. The Hausberg, overlooking Misahöhe from the North and about 2,400 feet high shows

[20], [21], &c. Further details about the rocks numbered thus are given in Appendix I.

flaggy quartzites on its summit, dipping North-east at about 20 degrees. The summit of the pass is about 1,900 feet above sea-level.

Between this and Tomegbe (Tongbe) there are frequent exposures of rocks similar to those of the Misahöhe side, the dip being generally to the North-east at a varying angle. Tomegbe itself is situated in the valley between the two main branches of the range, and the exposures of quartzite on the road immediately to the West of the town are very ferruginous. There is also much limonitic breccia about. The same kind of material is seen at Kpoeta-Ashanti in the same valley about five miles further South, and again at Kpedse, some six miles further on, at the head of the Todshi gap. These three localities are in a straight line and almost certainly indicate a fault line running N.N.E.—S.S.W. This is probably the structural element which has produced the Tomegbe-Kpedse valley.

Nothing more of importance is to be seen on the road between Tomegbe and Liati. The exposures along the road are mainly of quartzite, dipping Eastwards and folded. Three streams panned on this section of the road yielded nothing but a trace of gold, with scanty black sand and zircons. Bogli hill, about one and a half miles East of Liati, is a prominent ridge running North and South and about 2,000 feet above sea-level in maximum height. It presents a precipitous scarp of bleached quartzite on the western side and a steep slope on the eastern. The dip could not be found with certainty, but is almost undoubtedly to the East at a high angle. West of this nothing is exposed of the Togo Series. At Liati and beyond fragments of jaspery quartzite, like that seen in the Buem rocks of the Akpafu and Nkunya districts, are found, along with quartzites more like those of the Buem district than of the Togo Range.

On the road from Liati to Adshaköe—along the western side of the range—there is only one exposure of rock, namely, near Fiape, where quartzite, much veined with silica, is exposed. It was not possible to say whether this belongs to the Togo Series or not—assuming for the present that the Togo and the Buem Series really are distinct. Three streams panned on this route yielded nothing but scanty zircons.

From Adshaköe the range was crossed in a West to East direction, to Kpoeta and Haingba. From Adshaköe to Tota, a distance of about three miles, there is a climb up of about 1,000 feet. The exposures on the hill slopes are chiefly weathered phyllite, brown in colour and a good deal folded. There seems to be a general Eastward or South-eastward direction of dip. The phyllite is in some places seen to be chloritic, but is usually much decomposed. In it are numerous quartz lenses. Flaggy quartzites are also exposed. At Tota itself the strata exposed are flaggy quartzites, undulating irregularly but fairly flat. There are numerous small faults and folds, but they show no definite system. Between Tota and Kpoeta there are few exposures. Here and there flaggy quartzites are to be seen, in one case definitely dipping South-east at moderate angles. The road reaches at one point a height of 2,800 feet above sea-level. Two streams on the road yielded nothing but scanty black sand and zircons. About half a mile West of Kpoeta the limonitic breccia[24] mentioned above as in line with the Tomegbe and Kpedse occurrences is seen. In several places around Kpoeta-Ashanti crystalline boulders are to be found, but none was traced to its source. Some are similar to those of the mica gneisses[20] of the low ground to the East. Another boulder was much finer grained and grey in colour. It is possible that, because of the faulting and subsequent erosion, the bottom of this valley is down upon rocks of the crystalline metamorphic series at some points. The boulders in question may quite as well, however, have been brought some distance by the natives.

From Kpoeta-Ashanti roads go respectively North-east to Misahöhe via the Moltkespitz and East to Palime via Haingba. The Moltkespitz road, about three and a half miles long, lies on the West side of the Eastern ridge of the Togo Range. Quartzites and phyllites (at some places graphitic, at others hematitic) are the only rocks exposed. The dip appears to be to the East at a high angle. The Echatoe River, half a mile North of Kpoeta, yielded no gold, but moderate black sands and

[23], [20]. Further details about the rocks numbered thus are given in Appendix I.

zircons. Some tourmaline, rutile and kyanite also appeared. The zircons are dark grey in colour. Two streams further North gave nothing on panning.

The Kpoeta to Palime road crosses the Eastern ridge of the range. The West slopes of this ridge show soft phyllites with flaggy quartzites higher up, but nothing was seen *in situ*. On the Eastern side, facing Palime there is a prominent scarp. The top portion of this is of white quartzite (an altered sandstone) dipping towards the North-east at moderate angles. Below this appears what is possibly the same rock, much sheared and foliated, a light grey granulitic quartzite with a good deal of very fine sericite. Softer bands alternating with it may be altered argillaceous material. There is a thickness of 200 feet, or rather more, of this. Downwards it passes, apparently gradually, into a biotite gneiss[30], very siliceous and probably of sedimentary derivation. About a mile further on, in the bed of the Medeko River flaggy sericitic quartzites are seen dipping Eastwards at about 40 degrees. The only other outcrops are at about half a mile from Palime, where, as mentioned above, gneiss is visible in the Aha River.

The general impression given by the above is that the mica gneiss of the lower portion of the scarp belongs to the Togo Series and is distinct from the gneisses of the metamorphic series to the East. A gradual increase in the intensity of the metamorphism is observed on going from the quartzites above through the phyllites and more intensely altered quartzites below to the entirely recrystallised material. The alteration takes place within a distance of about 500 feet at the most, and the assumption of underlying intrusive rocks provides as reasonable an explanation as any. The appearance of quartzites in the Medeko River at a lower level seems more likely due to faulting than to any other cause.

At Toji, on the Kpatave-Amedzo/e road, much limonitic breccia[31] is to be seen, this locality being in line with Tomegbe and Kpoeta. Immediately to the West of Toji the road to Amedzo/e begins to ascend the hills and flaggy quartzites are to be seen *in situ*. About half a mile further on, and at a higher level, gneiss appears in a series of exposures. The topmost of these exposures is about 100 feet vertically below the last exposures of the quartzites which form the hills above it. The gneiss[32] is a hornblende one, light in colour and may be of sedimentary derivation. The quartzites below may be due to an irregular surface of the gneiss. No phenomena which might be definitely attributed to contact-metamorphism were observed. This is noteworthy in comparison with the Kpoeta-Palime exposures referred to above.

On the hills above Toji the prevailing dip is Eastwards, the principal rocks being white quartzites with subordinate phyllites, sometimes graphitic, but more usually reddish or grey in colour. The same rock types are to be seen on the Amedzo/e-Akome road, whilst between Akome and Toji many fragments of gneiss are visible, but there are no exposures.

West of Amedzo/e there is slight overfolding of the strata, the peaks being formed by the hard quartzite anticline-crests or by portions of them (Fig. 1). The ridges run North and South, and are bounded on the West by precipitous quartzite scarps. At Bialkpa also, in the valley to the South-west of Amedzo/e, the dip of the quartzites is towards the East. In the low ground to the West, between Adshakoe and Agame there was no exposure of any kind seen. The hills along the West side of the Togo Range all rise abruptly out of the Dayi Valley. None of the streams in this area yielded anything on panning but scanty zircons.

Another traverse was made Southwards, from Amedzo/e to /ane and Safie/e and then over the Kpeve Range Westwards to Sroe and Etoi. Immediately on descending from /ane into the low country to the South we again encounter gneiss and igneous fragments. One of these is a gabbro[33], medium-grained, composed chiefly of augite and plagioclase. Nothing was seen *in situ*, however, in the low ground between /ane and Safie/e, except in the bed of the Onimi River, where there is a grey, fine-grained igneous rock, with felspar laths visible. This has not been examined further, but may come from a dyke in the metamorphic series. The streams here gave no gold, but only scanty black sand and zircons, except in the case of the Beinve River, which gave plentiful magnetite, a fair amount of zircon (some of it pink), and staurolite. Turning Westwards at Safie/e the road

[30], [31], &c. Further details about the rocks numbered thus are given in Appendix I.

to Etoi runs over the hills via Sroe. Nothing but bleached quartzite is to be seen on the East side of the range, which consists of a single ridge a little over 2,000 feet high, flanked by rather lower hills on either side. No definite dip could be distinguished. On the descent Westwards to Etoi phyllites are exposed at several places, dipping East or South-east at moderate angles. On the low ground just West of Sroe a dark grey phyllite is to be seen dipping South-east at about 75 degrees. Whether this belongs to the Togo Series or not is doubtful.

The next traverse crossed both the Ho and Kpeve Ranges. The Ho Range was crossed at Taingbe and Matse. Thence the road Westwards across the Dsawöe Valley was followed and the Western Range crossed just North of Kpeve.

The road from Tokwe to Matse across the Ho Range passes first of all up the Eastern quartzite scarp of the range, which rises to a height of about 600 feet above the Ho-Palime road. The whole of the Eastern ridge at this point is composed of ribbed sericitic quartzite. This appears to be nearly vertical, striking N.E.—S.W. and probably has a dip, if any, to the South-east. The descent to Taingbe is over similar material. In the Taingbe Valley the streams yielded no gold but plentiful black sand and zircons, with some kyanite, tourmaline and garnet. This suggests the proximity of the crystalline series, and possibly that it is exposed in some portion of the valley. The middle ridge of the range, between Taingbe and Matse, is also of quartzite, similar in character to the last mentioned. On the Western slope, above Matse, the dip is to the West at about 50 degrees. On this same side of the ridge, however, about 200 feet below the highest point on the road is a fairly coarse-grained gneiss, the foliation planes appearing to dip to the West at a moderate angle. It is a muscovite and biotite gneiss[34], poor in quartz. Much of the felspar is full of inclusions of rutile. It might be the result of the intrusion of an acid magma into an argillaceous rock. Whether it is to be looked upon here as intrusive in the Togo Series, or as belonging to the crystalline metamorphic series is doubtful. Folding of these two series together is quite enough to have brought a part of the latter into the position of this exposure.

The streams in the Matse Valley yielded no gold, but plentiful black sand, zircons and garnets, with tourmaline and kyanite.

The ridge immediately to the West of Matse is of white quartzite, with dip at moderate angles to the East or South-east. Just at this point there is a break in the ridge through which the Eia River flows Westwards to join the Dsawöe. This break is on a line of fracture, as much fault-breccia is to be seen along the stream-channel. The fault runs East and West.

Leaving the Ho Range the Dsawoe Valley was crossed Westwards towards the Kpeve Hills. All the low country shows crystalline metamorphics, usually coarsely crystalline gneiss[35] composed of quartz, felspar, hornblende and biotite. Such is the type exposed in the Gule, Labo and Agotoe Rivers, and on the ground between them. Frequently the quartz content is very low. Some of it may be derived from a mica-diorite. In the Labo channel there is a dark, fine-grained band in the gneiss, about 4 feet wide and running East and West. It seems to be a lamprophyre dyke[30] traversing the gneiss. Panning in the streams gave plentiful black sand and zircons, but nothing of value. Laterite is patchy and not abundant. It was noticed only on the Western side of the valley.

At Tshome hills are reached again, composed as usual of quartzite, saccharoidal in appearance at one or two localities. Such quartzites appear again on the Kpeve Range about two miles further West. The intervening ground round Bogame shows outcrops of gneiss here and there, similar to that in the streams further East. The same rock[37] appears at Syama, and at Todome, a little further South, where the strike of the foliation-planes is approximately North and South, and the dip high to the West. A basic block at Anfoi appears in section to be an altered gabbro[38]. The Eastern side of the Kpeve Range shows a prominent scarp. Half a mile South of Todome the road crosses the hills to Kpeve. Quartzites and grey schists of the usual Togo type appear all the way up the Eastern side, at one place dipping East at about 30 degrees. On the Western side similar exposures are to be seen. The base of the hills on the Kpeve side, as elsewhere to the North, yielded no clue to the structure of the region.

[34], [35], &c. Further details about the rocks numbered thus are given in Appendix I.

3. The Dayi Plateau.

Climbing up to the plateau from Siko (about four miles South-west of Gudave), the chief rocks seen are white indurated and veined sandstones, and graphitic phyllites. They are folded and sheared, particularly the phyllites, but no major structural element was made out. The strike seems to be generally N.E.—S.W. as in the quartzites of the low country. On reaching the plateau the road leading North was taken. The Tonyo River, a tributary of the Dayi, crosses the road about three miles further on. It is about 15 feet wide, and has grey phyllites, dipping at 35 degrees to the North-west exposed in the banks. Similar phyllites appear at intervals for the next two miles to the town of Basagbe. The Tonyo gave no gold on panning, and very scanty black sand.

About two miles West of Basagbe is the Dayi River, here flowing South. A mile or two further on it turns Northwards and maintains that direction for about four and a half miles, after which it descends Westwards into the Buem plains. Between Basagbe and the Dayi River quartzites and sandstones of the Togo Series are seen in several places, dipping a little to the South of East at 30 to 50 degrees. In the Dayi itself, which gave no gold and almost nothing else of high specific gravity, Togo quartzite and phyllites are exposed and are seen to be folded gently in a series of synclines and anticlines, with axes running N.E.—S.W. In one case a definite pitch to the South-west at a low angle is visible. The phyllites are usually finely puckered, and in one place are graphitic. The quartzites are usually very compact, and smooth on the weathered surface (see Fig. 2).

About five miles East of Basagbe is the Eastern edge of the plateau, and Gudave lies about two miles farther East. Leaving Basagbe by the Gudave road brown weathered phyllites are seen just outside the town. A little farther on altered micaceous sandstones are exposed, whilst frequent outcrops of broken quartz mark the positions of quartz lenses and reefs. The Tonyo River, flowing South, is crossed about two miles from the town. It gave a trace of gold and a little black sand on panning.

Micaceous sandstones are seen again on the edge of the plateau, dipping West at 30 degrees. Lower down the sandstones are less micaceous, and the weathered surface has a ribbed appearance due to variations in hardness of the rock, the ribs running in the direction of its strike. The low ground between the foot of the scarp and Gudave is covered with white sand. The return journey to Basagbe was made from Govie, South of Gudave. Here also the chief rock on the scarp face is a micaceous sandstone, dipping Westwards at about 40 degrees. Several much contorted beds of pyritic-phyllite (practically mica-schist) are exposed about a half to three-quarters of the way up. On reaching the plateau sandstones and phyllites are seen dipping West at a low angle, and nothing more outcrops between this and Basagbe.

The towns of Atilololome and /eto lie respectively nine miles North and seven miles North-east of Basagbe. On the Basagbe-/eto road nothing of interest is seen. Here and there micaceous sandstones are exposed, dipping North-West at from 15 to 20 degrees. Two rivers panned here yielded nothing but very scanty black sand. Just North of /eto sandstones are to be seen dipping flatly to the East, but further on towards Atilololome micaceous sandstones appear, dipping gently West. The Dayi at Atilololome is 8 to 10 feet wide and gave no gold or black sand on panning.

About five miles North of Atilololome is Atilakuse Hill, just South of the Anglo-French boundary. The road thither passes over sandstones and quartzites the whole way, and the hill itself is made up of the same rocks. As in the Dayi West of Basagbe, there is a series of gentle symmetrical folds, the axes pitching N.N.E. at about 10 degrees. The Eastern summit of Atilakuse is formed by the crest of an anticline (Fig. 3). The next anticline to the West is denuded on its Western limb, and the Eastern limb forms the Western summit of the hill. Five streams panned on this route gave very little black sand, only a few zircons and rutiles, and no gold.

On returning to Basagbe from Atilololome the direct road South was taken. Very little of importance was seen. Much of the country is covered with grass. Micaceous and phyllitic sandstones appear at various points along the route,

dipping South-east at from 10 to 60 degrees. Much of the sandstone is liberally veined with quartz. A stream just North of Dsogbega gave plentiful black sand, but no gold.

From Basagbe the traverse was continued to Dsogbe, just North of the steep-sided Ta/la Valley, which cuts the plateau into two parts. At Basape there is an outcrop of soft sandstones, dipping to the South-east. Two miles further on at Ndigbe micaceous sandstones dip North-west at 25 degrees, whilst reddish phyllites near by dip at 55 degrees in the same direction. A short distance South-east of Dsogbe more red phyllites are exposed, dipping East at 50 degrees.

From Dsogbe the road to Kakpa-Toji on the Southern portion of the plateau was taken. About a mile South of Apedome red micaceous sandstones make their appearance, dipping North-west at 50 degrees. Similar but white sandstones dip in the same direction on the Northern side of the Ta/la Valley. The view from the opposite side of the valley shows that these belong to a limb of an anticline, for the beds further East are seen to flatten out. Over 200 feet of strata are exposed. The Southern side of the valley is composed of phyllites, apparently dipping South at about 35 to 40 degrees. As, according to the evidence of the Northern side, sandstone should be in the position occupied by these phyllites it is probable that the valley is along a fault line.

From Kakpa-Toji a path leading South-east was taken. Until reaching the scarp the only exposures to be seen are of soft micaceous sandstone, first dipping at 35 to 45 degrees Eastwards, then at 55 degrees Westwards, then at 35 degrees to the South-east. Near the edge of the scarp graphitic phyllites are exposed, dipping E.N.E. at 30 degrees. Below this, on the road down, is massive quartzite showing no orientation. About one mile South of the graphitic phyllite exposure, on the summit of the hill above Dagbali, are quartzites dipping East at 30 degrees. On the low ground between the foot of the scarp and the Palime-Sodo road no exposure is to be seen, the ground being covered with sandstone and phyllite fragments. Just North of this is the /eto intrusion.

The whole plateau seems to be built up of a series of nearly symmetrical folds with axes running N.N.E.—S.S.W., and with no appreciable pitch. The folds are usually quite gentle, and in the central portion of the plateau the distance between adjacent crests is usually about 50 to 200 yards. Along the Eastern side the distance between crests seems to be much greater—up to one or two miles, the folds being flatter in proportion. The Western scarp was not touched at any point.

Quartz lenses and reefs are seen in the sandstones at many places. These usually lie along the strike, *i.e.*, about N.E.—S.W. The sandstones in almost every case appear to be free from much admixture of felspathic or argillaceous material.

4. The Adele and Tutukpene Highlands.

This region, as pointed out above, falls naturally into two parts. Information regarding the Adele Plateau was got from a series of short traverses in different directions, from Bismarckburg as centre. The Tutukpene Hills were crossed from Pussepu to Tutukpene, and traverses were made North along the foot of the scarp from Tutukpene to Odumasi, thence East to Dadiasi, then South to Chai (Tschai) and Pussepu.

In the plateau country round Bismarckburg the quartzites, sandstones and schists of which it is built are invariably found dipping Eastwards. The quartzites form ridges of hills running North and South, the schists lying in the intervening valleys.

Ascending the valley of the Dijebu from Dadiasi we cross a series of white quartzites and purple or red phyllites all dipping East at 40 to 60 degrees. Between Dadiasi and Peleu (Dikpeleu) the road rises about 1,500 feet. The ridge forming the Western boundary of the plateau is principally composed of quartzite, apparently an altered sandstone. All along the valley of the Yege River, from North of Bismarckburg to Diginge, the chief rock is a green schist[89] (with numerous quartz lenses) weathering to a soft brown friable earth. In the flatter areas there is a large development of laterite.

[89] Further details about the rocks numbered thus are given in Appendix I.

The road from Bismarckburg to Diginge passes over such schists for most of the way, but quartzite appears on approaching the hills lying to the West. The Yege River yielded only a slight trace of gold on panning. The Gedentu River gave fair pannings. The Asinginibo River yielded neither gold nor black sands and almost no zircons. The schists South of this are nearly vertical, and a flaggy quartzite is interbedded with them. Other two streams nearer Diginge gave no concentrates on panning. At Diginge are schists with bluish flaggy quartzite below them. The return road, via Janja, shows vertical quartzites on the hills to the West and a talc-schist North-west of Djobo, also vertical, striking North and South. The Digbominibo River gave no gold and scanty black sand and zircons.

South of Bismarckburg, to the East of the Yege River, nothing of different character was seen. The Ataja, Brokote, Leosuto and Adshishabi Rivers yielded no gold, and moderate black sand and zircons.

To the East a succession of much weathered schists and phyllites is seen on the road to Tolo. The Kungu River gave no gold or black sand. The Kalabo and Tolo Rivers had very abundant black sand but only traces of gold. Talc-schist appears in one place between Tolo and Nkongkoa, dipping East at a high angle. The Apopotu River gave moderate black sand, very few zircons, and no gold. All the flat land between the streams is covered with laterite.

The road to Chirina (Kjirina), North of Bismarckburg passes via Kejenke, Gedemi and Kue. From Bismarckburg to Gedemi chiefly laterite(*) is to be seen. A few schist outcrops appear. The hills between Gedemi and Kue are of quartzite, dipping East, and they extend along the road between Kue and Chirina. A mile or so before Chirina the schists appear again, underlying the quartzites, and they are well exposed in the Gajale River*. This stream yielded a fair amount of gold on panning, with much black sand and zircons.

Between Chirina and Shiare, which lies further West, is a series of quartzitic sandstone ridges running North and South. The dip is about 60 degrees to the East. In the valley in which Shiare lies the soft phyllites and schists appear again, and just East of the town 8 to 10 feet of graphite-schist appear in the Sabu River. The hills North of Shiare are of quartzitic sandstone sometimes quite coarse-grained and frequently micaceous. The Sabu River yielded nothing but zircons on panning.

The road from Shiare to Bismarckburg passes along the top of a ridge and then descends into the Yege Valley. For the first two miles or more the ridge is of soft phyllites and green schist, with many quartz lenticles. Then the road descends into the valley of the Okuru, a tributary of the Sabu River. Here quartzitic schists are exposed, dipping Eastwards at 65 degrees. Panning yielded nothing of high specific gravity. The hills to the South-east of this, along which the road passes, are of round-grained altered sandstone, much veined, no dip being observed. After about three miles on such rocks the road turns Eastwards to the town of Osingi, crossing the strike of Eastward dipping quartzites. Beyond Osingi green schists appear, similar to those South of Yege, vertical and striking North and South. Thence to Yege they outcrop at frequent intervals. One stream on this portion of the route, a tributary of the Yege, gave scanty black sand and moderate zircons, but no gold.

We next turn to the Tutukpene Hills. Between Tutukpene and Odumasi the ground is obscured by detritus from the scarp and by the thick forest, which covers the larger part of the slopes. The Wulubong River, half a mile North of Tutukpene, shows no exposure, but there are many boulders of Buem sandstone, a bleached felspathic sandstone much veined with quartz, in general appearance similar to that seen in the Akpafu district. There is also some of the jaspery quartzite, such as that seen along the Dayi Valley so frequently. No gold or black sand was found on panning. The Kpangsolo River, a little further North, was dry. In its bed is an exposure of calcareous sandy clay, dipping East at 60 to 70 degrees. It was impossible to say whether this belongs to the Buem or to the Oti Series. In dip at least it corresponds with the Buem sandstones of the scarp

(40) Further details about the rocks numbered thus are given in Appendix I.
* For Assay of this schist see Appendix II (a)

to the East. The Kente River gave no gold or black sand, but abundant zircons. The Kejebi River yielded nothing but abundant black sand. A mile and a half North of Kejebi town white Buem quartzite appears in a hummocky exposure. No dip is visible. The Chai River near here gave nothing but very scanty zircons. At a mile and a half South of Odumasi there is an exposure of fine-grained grey sandstone, dip unknown. From Odumasi Eastwards to Korintai there is no rock exposure. The Sabu River, about a mile from Odumasi, gave nothing but a moderate amount of zircons. Thick forest covers most of the ground. The Tutukpene Hills seen from the North show a series of scarps and dip slopes, all the scarps on the Western side. The structure is not very pronounced, but quite definite.

Between Korintai and Dadiasi the road crosses several hills. On the slopes of these Buem sandstones of the usual type are seen, and above them mudstones and argillaceous sandstones, all dipping to the East, the angle varying from 40 to 80 degrees. The Kuanta River gave nothing on panning. The Dijebu gave no gold but abundant zircons.

The country South of Dadiasi was traversed as far as Pussepu. Two streams, a short distance South of Dadiasi, show purple shales, dipping at 40 degrees or more to the East. One bed of this contains many clay-galls of different colours. Panning here yielded nothing. A mile and a half further on a quartzite scarp is crossed striking North and South, probably the Southward continuation of the hills East of Korintai. Below the scarp soft altered shales are exposed. They become quite phyllitic further South. The dip is Eastwards at about 30 degrees. The Eting River, a little beyond this, gave a trace of gold, with scanty black sands and zircons. Vertical phyllites striking North and South are exposed for about half a mile beyond the river.

At a mile and a half to the South-east of Chai town, on the Ahunyo road, an altered basic rock outcrops in a stream bed. It appears to form an intrusive mass in the phyllites, but is of no great size, perhaps about 200 to 300 yards by 100 yards. It seems to be a very much altered gabbro(41), but very little original material remains. Practically all the felspar is gone, and three-quarters of the augite. The stream yielded nothing on panning but scanty black sand. Three other streams between this and Bantibo yielded nothing on panning. Sandstones appear here and there, all dipping to the East, and about two and a half miles East of Bantibo a phyllite is exposed with clay-galls like those in the shales South of Dadiasi.

Between Bantibo and Pussepu vertical micaceous sandstones appear, striking North and South, and just West of Pussepu similar rocks are seen, apparently dipping at a high angle to the West. No evidence of folding was seen.

The strata on the road Westwards from Pussepu to Achim are micaceous sandstones, in most cases nearly vertical, striking North and South. The streams panned on this road gave nothing of high specific gravity. At the highest point on the road, about two miles East of Achim (Atschim), a much altered basic igneous rock is exposed. It seems to be a dolerite(42), but is very much decomposed. The outlines of the mass are irregular. In the centre it is coarsely crystalline. Near where it comes in contact with the quartzitic sandstones which surround it, the texture changes and it becomes compact and flinty in appearance. This is probably a chilled edge. There is at least half a square mile of this dolerite, possibly more, and it seems to be elliptical in shape. In one stream flowing towards Achim the rock is quite decomposed, forming a serpentinous mass. A search failed to show the contact between the igneous rock and the quartzitic sandstones. It seems to be an intrusion however, but nothing very definite can be said on this point. The stream mentioned above gave nothing of high specific gravity on panning.

At Achim sandstones dipping steeply to the East are exposed, and thence to Tutukpene we are on sandstones all the way, except in one place about half-way between the two villages, where light grey mudstones are seen dipping East at 30 degrees. Sandstone appears both above and below them on the hill slope. Three streams were crossed, one of which, the Wulubong, gave a few specks of gold, scanty black sand and zircons. The others gave nothing.

(41), (42) Further details about the rocks numbered thus are given in Appendix I.

The Tutukpene Range appears from the above to consist of a series of quartzitic sandstones with a few softer argillaceous beds, all dipping steeply to the East and becoming vertical on the Eastern side. To the East of the range the strata in the low country contain a larger proportion of argillaceous beds.

5. The Dayi Valley.

This area will be discussed in two sections, First, that portion North of the Misahöhe-Kpandu Road, and, secondly, that portion South of the same road.

The whole of the Northern area, except the extreme North, lies in the Dayi River basin. It is bounded on the Eastern side by the Togo Mountain scarp, running in an almost straight line N.N.E.—S.S.W. On the Northern part of the Western side the Nkunya Hills form a natural boundary. Further South a low irregular range of hills separates the Dayi basin from the main portion of the Kpandu district.

The first traverse was from Liati to Borada, via Fodome, Pekipong, Akpafu, and Teteman. The return journey was made via Amamforo, Akpafu, Lolobi, Pekipong and Kolenu. Thence the road South to Logba was taken. At a later period the route from Liati to Wurupong, via Kolenu, Deme and Kpeme, was followed.

Leaving Liati by the Akpafu road we find that the country is very flat, until within about two miles of Santrokofi, and exposures are few in number. Nothing is seen *in situ* until about a quarter of a mile from the village of Dafong. The intervening ground is covered with laterite, and a few fragments of jaspery quartzite and of veined sandstone, usually bleached, are found lying about. The exposure at Dafong is of such bleached sandstone, much veined with quartz. No dip is to be seen. It is similar to most of the sandstone found in the Akpafu district. The Kole River, half a mile further on, gave no gold on panning, but only moderate black sand and zircons. Between this and the Avode River there is no exposure, but much veined sandstone is found on the road. The Avode gave very scanty black sand, but no gold. The Nubui River also, one mile past this, gave no gold on panning. The river sand at this place is a very fine white quartzose one. A soft brown mudstone, much puckered, is exposed in the stream bed. The axes of the larger folds, which are very irregular, seem to run N.E. and S.W. The folding does not appear to be more than local. Between Fodome and Pekipong there is no rock exposure. Much jaspery and white quartzite and veined sandstone are seen on the road. The rivers in this area gave no gold on panning. The E/e River had abundant black sand; the Tole yielded practically no black sand and only scanty zircons; whilst the Enfiwowo had both black sand and zircons in moderate amount.

One mile North of Pekipong the road crosses the Dayi River. Here yellowish brown to flesh-coloured friable mudstones are exposed, both in the stream and in the road-cutting further South. They dip at 35 degrees to the North-east. A search in them gave no fossils. The river yielded moderate black sand and zircons, but no gold. The Jetole River, a mile further North in low swampy ground, showed no gold, and neither did a smaller stream about half-way between the Jetole and Santrokofi. The road rises about 300 feet in the last mile or so before Santrokofi. Here we enter the Akpafu hill country, and most of the road beyond is in thick forest, with patches of elephant grass here and there. Much laterite, containing yellow shale fragments, appears immediately to the South of Santrokofi. Opposite the Rest House argillaceous sandstone outcrops, dipping East at 40 degrees. The stream North of the town gave no gold, but much siliceous ironstone in small chips and rounded grains (not pisolitic). The Vuvuli River, about a mile further on, showed nothing on panning. Light coloured sandstones, slightly felspathic and much veined with quartz, appear all the way from Santrokofi to Akpafu, showing no dip. A quarter of a mile below Akpafu town a bluish compact sandstone appears to be dipping East at 20 to 30 degrees. Round Akpafu itself sandstones veined with quartz are exposed. Frequently they are much indurated.

The Ironstone occurrences to the North and East of the town are described later (p. 41).

The road from Akpafu to Borada is a bush path through thick forest practically all the way. Travelling North from Akpafu we descend into the Odomi Valley and, crossing it, reach Teteman on the top of the hills to the East. Thence the road descends into the Odomi Valley again and follows it for a distance of about four and a half miles to Borada. Between Akpafu and the Odomi Valley chocolate-coloured quartzites are exposed at intervals, no dip visible. Three streams panned on the way gave scanty black sand, but no gold. On the hill slope up to Teteman, which is about 450 feet above the Odomi, sandstones of a brownish colour are seen dipping East at fairly high angles. In the town of Teteman sandstones, fairly well bedded, and alternating with soft weathered shales (almost phyllitic in character) show undulating outcrops and dip steeply to the East. At the North end of the town fine-bedded sandstones are seen dipping due East at 50 degrees. Half a mile further North, on the descent into the Odomi Valley, a serpentine[13] is exposed on the hill side. Nothing is shown which could guide in deciding how it is related to the sedimentaries. It is much sheared, the foliation-planes dipping East, and in general disposition it appears to lie parallel to the bedding-planes of the sandstones near at hand. The rock itself is so much decomposed as to give no clue to its original character. One is reminded by it of the Achim and Chai occurrences.

Between this and Borada the road lies along the Odomi Valley, and nothing is exposed, except some veined sandstone in one of the tributaries of the Odomi. Of five streams panned between Teteman and Borada none showed gold, and most of them only very scanty black sand and zircons.

A hill called Daklu, about two and a half miles South-east of Borada, is composed of quartzitic sandstone showing no dip, and similar rocks are found for two miles along the Borada-Jasekang Road. The town of Borada was formerly situated on the summit of Daklu.

On the return journey to Akpafu the route over the hills Westwards to Amamforo was taken. On the road up from Borada sandstones, similar to most of those seen in the district, are exposed on the hill-side. The Western slope, descending to Amamforo, is very thickly wooded, with dense undergrowth, and nothing is to be seen, except a few fragments of ferruginous quartzite. The valley of the Ravie between the Akpafu and Nkunya Hills, is mainly forest country, and almost nothing is to be seen in it on the road between Amamforo and Akpafu—a distance of about seven and a half miles. Along the whole road blocks of sandstone from the scarp on the East are sparsely scattered. At about a mile and a half to the North of Odomi brown and flesh-coloured fissile sandy shales, dipping East, are visible. A quarter of a mile on the same side of Odomi a veined quartzitic sandstone can be seen, probably *in situ*. A mile South of Odomi the road turns East and ascends the hill to Akpafu, a rise of about 1,000 feet. On the road up there are sandstones and quartzites similar to those at Akpafu. No dip was observed.

The road from Akpafu to Lolobi descends the valley of the Otupaso Eastwards, and then turns South-eastwards to Baika. In the Otupaso valley many exposures of sandstones and softer argillaceous beds occur, all dipping East at fairly high angles. One stream crossed shows vertical argillaceous sandstones striking N.N.W.—S.S.E. This stream gave no gold on panning and very scanty black sand. The Firau River, flowing South, was crossed two miles from Akpafu. It also gave no gold. Nothing was seen *in situ* between here and Baika. The Dayi River, about a mile South of Baika, showed no gold, but abundant black sand. A little further South vertical sandy shales are visible, striking North and South. The next stream panned, half a mile North of Lolobi, yielded nothing but moderate black sand and zircons.

At Lolobi somewhat contorted reddish sandy shales are to be seen. The strike is North and South. A mile and a half further on along the Pekipong road coarse Buem grits appear as blocks, probably nearly *in situ*. A hill just West of the road seems to be composed of such grits. They are felspathic and also contain fragments of argillaceous rock. A mile further on vertical sandstones striking N.N.W.—S.S.E. are exposed. The Tole River is crossed about two miles North-east of Pekipong. It gave nothing on panning. One hundred yards South of

[13] Further details about the rocks numbered thus are given in Appendix I.

it well bedded sandstones veined in several directions with quartz are exposed, and interbedded with these are grits such as are seen South of Lolobi. They dip North-east at 60 degrees.

From Pekipong the road to Kolenu was taken. The only rock exposures are at the Tolega and Kole Rivers. The Tolega shows green and brown beds, possibly tuffaceous.[40] They appear to be dipping North-east and 4 to 5 feet of rock are exposed. At the bridge over the Kole yellow weathered mudstones are seen dipping W.N.W. at 20 degrees. They seem to be overlain by a grey felspathic sandstone exposed on the opposite bank of the river. Four streams were panned between Pekipong and Kolenu, each of them giving moderate black sand and zircons, but no gold. The Enfiwowo River, two miles South of Pekipong, gave some pyrites.

The country between Kolenu and Liati is low-lying and marshy and gave no exposure of rock. A few fragments picked up just North of Liati are of veined sandstone and jaspery quartzite.

The road from Kolenu to Deme is similar. The Dayi River, about three miles North-west of Kolenu, gave very scanty black sand, but no gold, on panning. Both it, and a tributary crossed some 200 yards further West, have stiff clay bottoms. Fragments of brown and grey mudstones appear on the road.

The Akotsi River, a mile further on, showed traces of gold, but very scanty black sand. Another stream further West gave neither gold nor black sand. A mile beyond this sandstones are exposed dipping East at about 30 degrees. They contain many argillaceous and quartzitic fragments. Half a mile South of Deme a large hummocky exposure of Buem rock is to be seen. It is a quartzitic grit, much bleached, and contains a large number of argillaceous and felspathic fragments. In different patches it ranges from almost pure quartzite to a grit composed, for the most part, of argillaceous and felspathic fragments. Bedding is not clearly shown, but the dip seems to be East at about 30 degrees. The whole exposure is liberally veined with quartz.

From the foregoing it can be seen that only about half a dozen exposures were seen in the low country of this part of the Dayi basin, most of them soft mudstones or shales dipping East. These mudstones are in general not much altered, though in one or two of those seen in the Akpafu district the use of the name phyllite might be justified in describing them. No evidence of such folding as characterises the rocks of the Togo Range was found, either in the argillaceous beds or in the grits and sandstones of the Akpafu district.

Of rocks of igneous origin we have little trace, that mentioned at Teteman and the possibly tuffaceous beds in the Tolega being all that were seen. This is in striking contrast with the extensive igneous development in Kpandu and Nkunya.

In the Akpafu Hills the predominant rock is quartzitic sandstone somewhat felspathic, much veined with quartz and frequently bleached. It dips at a varying angle Eastwards.

The Southern portion of the Dayi Basin is similar in general appearance to the Northern portion and, geologically, it is the Southward extension of that region. The rock exposures are almost invariably of bleached and hardened sandstones or of mudstones more or less altered to phyllite. Wherever observed in the area, the strata always dip in a direction between East and South, the softer beds being sometimes rather contorted. The dip is usually above 20 degrees, and in the Northernmost parts of the area seems to be generally between 40 and 60 degrees.

The country was traversed in a North and South direction along the Kpandu Hill Range, the Dayi was crossed at three different places, and several short traverses were made in the North-western corner between the Kpandu Hills and the Volta River. The extreme West of the district was not visited.

Taking first of all the Dayi Valley proper we find that exposures are extremely scanty, and no idea can be got of what becomes of the Buem Series as it approaches the base of the Togo Mountains. The first crossing of this area was from Anfoi to Logba. West of the Dayi exposures of veined brownish yellow sandstone are

[40] Further details about the rocks numbered thus are given in Appendix I.

to be seen at Wademacha and a little to the East thereof. On the West (right) bank of the Dayi itself 5 or 6 feet of reddish decomposed sandy shales are to be seen dipping at high angles to the East. East of the Dayi there are no rocks to be seen at all until we get to the Liati-Kpeve road. No lateritic deposits are to be seen on this route.

The Liati-Kpeve road was followed from Liati to Adshakoe and from Fume to Agame. On the former portion, travelling Southwards from Liati, we find a large number of sandstone and jaspery quartzite fragments similar to those got North of Liati. No exposure is seen, however, until Fiape is reached. At Duga we find masses of quartzitic sandstone on the road, much veined with quartz. At Fiape similar rocks are seen *in situ*, but no dip is shown. Just South of Abessia the Flabo River was panned, giving no gold and no black sand.

On the road between Fume and Agame no exposure was seen, and two streams which were panned, the Gulugu and the Botoe, gave no gold or black sand.

The second traverse from West to East across the Dayi Valley was from Vakpo to Etoi. Between Vakpo and the Dayi there are the usual exposures of veined sandstone, and in the river itself 20 to 30 feet of strata are seen, thin beds of sandstone and sandy mudstone, all much hardened and dipping steeply to the East and South-east. Between the Dayi and Etoi the country is fairly open, and there is much laterite. At the Tolele River there are exposures of reddish friable sandstone apparently dipping South-east at a moderate angle. The streams in this area yielded only scanty black sand and zircons, the Dayi showing a few specks of gold.

The third traverse was from Kpeve to Soho (Socho). The country is quite hilly on this route, and for the most part thickly forested. The Tadsa River, a short distance West of Kpeve, shows highly contorted phyllite on the right bank. The general direction of dip appears to be Eastwards. If the distinction between the Togo and Buem Series is upheld, this exposure seems almost certainly to belong to the former rather than to the latter.

More than two miles further West, and a quarter of a mile beyond the Begbeve River, vertical phyllites and laminated quartzites are exposed, striking N.E.—S.W. Between this locality and the Dayi River there is a great thickness of brown decomposed strata, dipping steeply South-east. They may be either brown mudstones or weathered phyllites, and seem to be of the Buem Series. They are very similar to those mudstones seen East of Vakpo. Unless much folded, which does not seem probable, the strata exposed cannot be less than 1,500 feet in thickness, possibly more. Similar rocks are seen in the Dayi channel. West of this, and right to Soho, nothing is to be seen but veined and bleached sandstone. The Kpandp Hill range here is composed of two ridges, both of which seem entirely built up of such hardened sandstones. Like those seen North of Kpandu they contain decomposed felspar grains and also fragments of dark argillaceous material. The dip appears to be Eastwards. In the low country West of the range the sandstones in several places are found to be unbleached, being dark greyish green in colour. On the hill ridges such unbleached rock was not seen. The streams around Soho yielded only scanty black sand and zircons on panning.

The route followed Northwards from Soho to Kpandu is over Buem rocks the whole way. The first portion of the road to Botoku shows bleached sandstones for most of the way, no dip seen. About a mile South of Botoku, however, a very coarse pebbly sandstone is exposed, only about 2 feet thickness being seen. The pebbles, rounded to sub-angular, include grey limestone, granite, quartz-porphyry (?), phyllite, and jaspery and white quartzite. Beyond this the ordinary bleached sandstones appear again. Between Botoku and Ajingbe nothing is to be seen but large hummocky exposures of the same bleached and veined sandstone. One stream, just South of Ajingbe, gave a few specks of gold on panning, with scanty black sand and moderate zircons. Other two streams at Botoku gave traces of gold. The road from Botoku to Vakpo passes over the same rocks the whole way, except at Tota where, just North of the town, soft red, blue, and purple sandy shales are exposed for about a quarter of a mile. They are much contorted and show no definite structural arrangement, not even an approximate direction of strike. The sandstones seem in every case to be dipping Eastwards.

Between Vakpo and Anfoi there are no exposures, but the hills to the West are of the usual sandstones. Three streams in this area yielded scanty traces of gold with very little black sand and scanty zircons. North of this, to Sovie/e, nothing of note is to be seen. Toplale Hill, on the Western side of the road, is about 400 feet above the road level, and the sandstones on it are dipping at fairly high angles to the East. North of Sovie/e irregularly folded sandy mudstones are exposed. From this point to Kpandu the only other exposure is at Asia/e, where light purple sandstone seems to dip to the East at about 40 degrees.

The country to the North-west of Anfoi, between that town and Dukluja, was traversed in two directions, Northwards to Abessia and North-westwards to Atikbeta and Dukluja. On the Abessia road there is a steep scarp between Anfoi and Tateingbe, composed of bleached Buem sandstone. North of this, in the valley between the two ridges of which the hill range is made up at this point, there are several exposures of weathered mudstones, dipping East at 30 to 40 degrees. One stream near Abessia gave several specks of gold, with scanty black sand and moderate zircons.

The road from Anfoi to Atikbeta and Dukluja is fairly hilly for the first part of the way, and the country well forested. The Ataulo River, just West of Tateingbe, gave nothing on panning but the scantiest of black sand and zircons. On the hills to the West of this is bleached sandstone of the usual type, but accompanied by somewhat coarser material, with numerous slate and phyllite fragments. Thence Westwards to about a mile East of Kumfa are to be seen coarse-grained bleached sandstones liberally veined with quartz. Then appear flaggy brownish sandstones dipping at moderate angles to the South and South-east. Between Kumfa and the Volta at Adaho there are no exposures. In the middle of the Volta channel at this point, however, appear several exposures of a fine-grained dark bluish green basalt[45], very scoriaceous in parts. The three exposures visited are of the same type, with much accompanying calcite as small amygdales. Sand from here yielded a little gold, with moderate amounts of black sand, zircon and garnet. Between this and Dukluja there is no exposure of any kind. The hills to the East of the road are of Buem quartzite.

6. The Nkunya and Kpandu Volcanic Area.

Before commencing to describe this area some remark is necessary on the use of the termination "su" in the case of names of rivers. In the case of some streams the native seems always to use the termination when speaking of the stream, *e.g.*, Konsu, Ajamansu. In others the name is usually used without the termination in ordinary conversation, *e.g.*, Wawia, Ekple. Also villages beside certain of the streams are called by the name of the river without dropping the termination "su," *e.g.*, Ajamansu, Adenkensu. In consequence of these facts it has seemed advisable, from the point of view of utility, to use in this Report the names by which the various streams and villages seem to be commonly known in the district. Thus the village at the mouth of the Ajamansu is referred to as "Ajamansu," whilst the stream itself is called the "Ajamansu River" although strictly speaking this procedure is not sound.

The area in question is chiefly covered with forest, but a good deal of open park land occurs in some parts. The distribution of forest and park land is mainly controlled by the streams which nearly always have a dense forest belt on either side along their course. In two instances, however, a sudden change from forest to grassland can be observed at the boundary between quartzite and volcanic agglomerate, the former having the forest land upon it. This is in keeping with what is seen East of the Togo Range, in connection with basic intrusions. These in several instances have a grass covering, whilst forest occupies the neighbouring sedimentary or metamorphic areas.

Dr. Koert mapped the whole district as Buem, and noted the occurrence of volcanic rocks to the East of Akroso and to the South-west of Kpandu. The results of the recent traverses make it probable that the igneous belt is continuous between the two localities noted by Koert.

[45] Further details about the rocks numbered thus are given in Appendix I.

Commencing at Akroso, in the North of the area, Buem sandstones and conglomerates are found in the Asuokoko River just South of the town. Here dark fine-grained argillaceous sandstones are to be seen standing vertically in the stream bed and striking North and South. About 200 yards further East coarse conglomerate appears with large pebbles up to 6 inches or 8 inches in diameter, dip not seen. The pebbles seen were all sedimentary, chiefly quartzite. A few yards East of this place fine-grained dark greenish sandstone or arkose appears, and seems from the general disposition of the rocks to be lying on the conglomerate, though no actual contact was got. The sandstone appears to be dipping at a high angle to the East.

Half a mile further up the river gritty sandstones are found dipping at 20 degrees to the South-east. A few yards higher up a finer grained rock[46]—possibly tuffaceous—is seen dipping in the same direction, and upon it lie fine greenish-brown shales, upwards of 6 feet being exposed. Half a mile above this grits are seen again, 12 feet in thickness.

Higher up we come to a great thickness of green mudstones. At one place over 40 feet are exposed, but the total thickness must be several hundred feet, as they are seen at intervals beyond this. The dip is high to the East—sometimes nearly vertical. In places the mudstones are soft and friable, but now and again hard and fissile. After a gap of about half a mile similar mudstones outcrop again, dipping East at 60 to 70 degrees, but containing lenticular patches of grit and sandstone.

Between this and the point where the river nearly touches the Kpandu-Krachi road, a distance of about one and a half to two miles, sandstones outcrop at intervals, but could not be closely examined. Then indurated mudstones, brown in colour, are exposed, dipping East at high angles.

On the main road between Akroso and this point very little is exposed. Two small stream beds show Buem sandstones, brownish green in colour and possibly tuffaceous. No dip was noticed. Travelling Eastwards the Aboabo River is reached, crossing the road from South to North about a quarter of a mile beyond the point where the Asuokoko touches the road. A sandy mudstone, dipping East at 60 degrees, is exposed in the bed of the Aboabo. On following this stream up channel for about a mile and a half similar rocks are seen at intervals, together with dark sandstones and light yellow decomposed mudstones. There is some minor folding, but nothing of importance was noted. This stream gave fair gold prospects on panning and a little black sand. Between it and Komfo-kokrum there is no exposure.

About a mile East of this we enter the volcanic zone at the Ajanafi River. In the stream bed lie grey shales (weathering red) dipping at 30 degrees to the South-east. About 50 to 60 feet are exposed. East of this fragmental volcanic rocks occur. They are much weathered and vary from fine to very coarse in texture. No indication of bedding was seen. The blocks composing the coarse agglomerate are all of basic types, as far as was seen[47]. They include an amygdaloidal basalt with large porphyritic felspars and augites, and a fine-grained rock which appears to be of similar type. Blocks of apparently less basic character also occur. There is much scoriaceous rock in some parts.

No contact was found on the road between the mudstones and agglomerate. Near the western side of the agglomerate area, what is probably a dyke of fine-grained dolerite, is visible, traversing it in a N.E.—S.W. direction. South of this the porphyritic basalt occurs in a large mass, which may be a plug or another dyke. The agglomerate occurrence is about $\frac{3}{4}$ths of a mile broad. On the eastern side, just South of the road, brown mudstones are seen, veined with chalcedony and dipping East at moderate angles. Along with them appears in several places a crystalline siliceous limestone, light grey in colour and much veined with calcite and quartz. A stream, flowing roughly parallel to the road about a quarter of a mile away to the South, shows grey sandstones, dipping East at a moderate angle. Several yards further West appears a decomposed basic igneous rock overlain by grey shales. The igneous rock here appears to be interbedded. Crystalline limestone[48] is found in the vicinity and seems to be in lenticular patches striking

[46], [47], &c. Further details about the rocks numbered thus are given in Appendix I.

North and South. All West of the limestone seems to be agglomerate or lava. Similar limestone is exposed on the road in contact with serpentinised igneous rock. The streams here yielded nothing but the very scantiest of black sand on panning.

East of this the road passes on to Buem sandstones and grits, with pebbly bands here and there. This continues to beyond Abupaso, where we cross the Aboabo River again, here flowing South-west. In it a greenish quartzitic sandstone, of which several feet are visible, dipping South-east at about 20 degrees, overlies 20 to 30 feet of very coarse conglomerate. The pebbles vary from 6 inches in length downwards, and include granite, shale, slate, phyllite, mica-schist, vein-quartz, graphite-schist and pyritic phyllite, all well rounded. The matrix contains many clear, rounded grains of sand. About 100 yards down the stream from the road agglomerate, similar to that above-mentioned, appears in the stream bed, together with fine-grained basalt[49] or similar basic rock. It was impossible to say whether this is intrusive or interbedded. Some of it is very scoriaceous, with calcite amygdales. It occupies the bed of the river for at least a quarter of a mile—which is as far as it was followed. Panning yielded fair gold values, a few staurolites, but nothing else. North of this on the Tapa road nothing is to be seen but bleached Buem sandstones and grits with no definite dip showing.

The Kpandu road turns South beyond Abupaso, and nothing is to be seen between here and Kwamikrum but occasional veined sandstones and grits or soft mudstones. They all dip East at moderate angles. One stream in this area was panned, yielding nothing but moderate zircons.

From Kwamikrum a road leads Eastwards to Jasekang. No igneous rocks are to be seen on it, but a succession of brown mudstones and sandstones. They are exposed in the Konsu River and other streams, dipping steeply to the East. They are overlain further East by bleached Buem sandstones, much veined. No stream on this road yielded anything on panning.

West of Kwamikrum the igneous zone is encountered again. The road from Kwamikrum to Odumase shows brown sandy mudstones, dipping East at moderate angles, until within a mile of the latter place. Then igneous things begin to appear. At two springs just South of the town a much decomposed doleritic rock[50] outcrops. Near at hand is much jaspery quartzite, but none was seen *in situ*. A little further East a decomposed rock similar to that at the springs is found *in situ* on the road. The stream draining this area gave nothing on panning but moderate black sand and zircons. In its bed a compact basic rock is exposed, similar to that at the springs mentioned above. Blocks of a porphyritic basalt[51], similar to that between Komfokokrum and Abupaso, are also to be found lying about.

Following the road to Korumfenda, which turns off to the South-west half a mile south of Odumase, we come to another stream about 200 yards beyond the one mentioned. It shows exposures of the same dark blue rock as the first, veined with serpentinous material.

Past this the road crosses a range of hills, and on the eastern slopes much decomposed amygdaloidal material is to be seen *in situ*. The hills themselves, where crossed, are of chalcedonic quartzite[52] on top, similar to that seen near Odumase. The quartzite belt is several hundred yards wide and runs roughly North and South. It is succeeded on the West by coarse volcanic agglomerate like that seen near Abupaso. The quartzite is covered with forest. The basic rock on the East, and the agglomerate on the West, are covered with grass. No contact, however, was seen. Only basic fragments were noticed in the agglomerate. The nature of the jaspery quartzite is doubtful. It is probably due to hydro-thermal action.

Descending the western slopes of the hills the agglomerate becomes finer in character, and in one or two places is practically a fine-grained tuff. Then the forest country is entered and the next exposure is in a stream bed half a mile to the South-west. Here mudstones dip to the East at a high angle, and a very compact crystalline limestone appears interbedded with them. The bed of the stream is covered in many places with porous calcareous tufa. Panning gave nothing but plentiful black sand and epidotes. A little beyond this agglomerate

[49], [50], &c. Further details about the rocks numbered thus are given in Appendix I.

appears again, with many chalcedonic quartzite[53] fragments lying about. A mile further on a fine-grained basalt or dolerite is exposed in two streams.

Thence to the Konsu River there is no exposure, but igneous fragments are found lying about along the whole way. Between the Konsu River and Korum-fenda the road is in the Volta forest belt and there is nothing *in situ*. The fragments seen on the road, however, were of sandstone. No igneous fragments were seen. The Konsu yielded only a trace of gold on panning, very little black sand and few zircons.

At Korumfenda itself only sedimentary fragments are found lying about, and it is fully a mile from the village along the Wurupong road before igneous fragments appear. Those which are then seen may be derived from rocks in the neighbourhood, or may have come some distance—probably the former, but there are no exposures. Sedimentary rocks outcrop about half a mile further East. They are even-grained sandstones, indurated and bleached, showing no dip, and with them occurs a veined siliceous rock which seems very like a more siliceous variety of such limestone as was seen in the stream between Odumase and the Konsu River.

Half a mile further on sandy mudstones are exposed in a stream flowing South. They dip East at 60 degrees. The next stream, two miles further on, shows similar mudstones. Beyond this there is no exposure for another mile. Then jaspery quartzite is seen in a stream bed. Another mile further on a basalt[54], fine-grained and dark blue, with pyrite scattered through it, appears in the bed of a small stream flowing North. It is much veined with calcite. It is very similar in character to that seen just South-west of Odumase. The same rock appears in the next stream, half a mile further East. From this point to Wurupong the road is in thick forest, and there is no exposure of any kind.

The main road from Kwamikrum to Wurupong shows few exposures of rock. In the banks of the Konsu River, just South of Kwamikrum, green fissile shales are seen standing vertical, and striking N.W.—S.E., 20 to 30 feet being exposed. Near Adenkensu bleached Buem sandstones of the usual felspathic type are exposed. The Wiawia River further South yields weathered mudstones, dip not obvious, whilst about half a mile North of Wurupong Buem conglomerate is exposed with shale, quartzite and granite fragments and pebbles.

On the slopes of the Nkunya Range volcanic rocks are again exposed. Just East of Wurupong a section is to be seen in the Ajanku stream, which flows from the scarp (Fig. 7). The cliffs at this point are unscaleable, so the height of the scarp was not obtained. The cliffs themselves are of bleached Buem sand-stone, felspathic, and much veined with quartz. There are several hundred feet of this sandstone. In its lower portions it becomes somewhat flaggy, and argillaceous in character, and beds of very soft grey mudstone, with soapy feel, appear and alternate with more sandy beds. Below this comes sandstone like that of the scarp, about 30 feet in thickness and dipping almost due East at 30 degrees. Next appear mudstones similar to those higher up, and about 40 feet of these are to be seen all dipping East under the sandstone. Here and there they become quite sandy or gritty, and finally pass into a bluish gritty quartzite. This, after 6 or 7 feet, merges downwards into mudstones again. Twelve feet lower down a light blue pyritic quartzite band with angular fragments appears. Twenty feet below this the mudstones, which lie beneath the quartzite, have merged into an argillaceous limestone, of which there is 10 to 14 feet, bluish grey in colour and weathering to a yellow ochre. Below this there is an obscure 15 feet of much altered basaltic tuff[55]. Twenty feet below the limestone undoubted agglomerate is exposed. Everything appears to be dipping East at a moderate angle. The contact, though obscure, looks very much more like interbedding than intrusion, and this is supported by what is seen below the agglomerate, where finer tuff beds are almost certainly interbedded with mudstones dipping East at 40 to 50 degrees. The agglomerate is not coarse, no blocks over 2 to 3 inches diameter being exposed. Similar and finer grained rocks appear in the bed of the stream for about 200 feet below this point. The dip continues to be to the East at a moderate angle. Next appears a basic rock, non-fragmental in character, and much veined

[53], [54], &c. Further details about the rocks numbered thus are given in Appendix I.

with calcite, a decomposed dolerite[59]. No dip was seen. It is at least 20 feet thick. Forty feet lower down tuff (?) is exposed, dipping East at 30 to 40 degrees. This outcrops for a vertical distance of about 100 feet, and seems to be very argillaceous in character. Possibly it is a mudstone with more or less of fine volcanic material. Further down, however, it becomes more definitely a basic tuff in character. Beyond this there is a gap of about 200 feet, and then Buem conglomerate of the usual type is exposed, with red shales above it. About 100 feet lower still are bleached felspathic sandstones, seemingly *in situ*, and these are probably the same as the sandstones seen on the main road between Wurupong and Ntameda.

No other good section was found below the scarp, and igneous material was not seen *in situ* North of Wurupong on the eastern side of the Krachi road. The first two streams North of the town show one or two tuffaceous pebbles, but beyond this nothing was noticed. The Akum and Wiawia Rivers showed nothing but Buem grits where examined between the main road and the Nkunya Range. These grits are frequently dark green in colour, somewhat sheared and often contain fragments of phyllite, granitic gneiss and quartz. They are very like the rocks seen in the Aboabo River at Abupaso. The volcanic zone may have died out in this direction, or possibly is concealed by the quartzitic debris from the scarp. Its continuation Southwards is seen in the Asusunchu River, due East of Ntameda. Here some of the beds seen at Wurupong seem to appear, notably the limestone. Altered igneous rock, possibly a basalt or basaltic tuff, is seen at intervals for a distance of 50 or 60 feet (vertically) dipping steeply to the North-east. Above it lies a grey argillaceous limestone, much veined and dipping North-east at a moderate angle. There seems to be at least 15 feet of this, but the exposures are poor. Then coarser material, very like agglomerate in appearance, seems to occur *in situ*. Above this, probably 20 feet higher up, are light brown shales dipping North-east about 50 degrees, and similar, but grey, shales are seen 10 to 20 feet higher up (vertically). The intervening beds are chiefly shaly, sometimes micaceous or sandy. A little above this, decomposed igneous rock is to be seen, very like much of the Wurupong material. It dips at a high angle to the North-east, and the thickness seen might be 30 to 40 feet. Nothing was seen above this. The stream gave only the scantiest black sand on panning.

Further South no igneous rocks were seen under the Nkunya scarp. They may quite possibly extend in this direction, but the country is thickly forested. The road from Ntameda to Kpeme shows only bleached Buem sandstones, and in one place sandy mudstones, dipping East at moderate angles. South of Kpeme, on the road to Kpandu, only felspathic Buem sandstones are to be seen, dipping at moderate angles to the South-east. Several streams panned on this route yielded nothing but a few zircons.

Returning to Ntameda, we find a large development of volcanic rocks to the West of the town on the road to Ajamansu. For the first mile and a half only sandstone fragments are to be seen, but immediately after this we enter the volcanic zone, and blocks of agglomerate containing fragments of the porphyritic basalt, well known further North, make their appearance. About a mile further on a pyritic fine-grained basalt[57] is exposed in the bed of a stream draining North. It shows banding in several places, possibly flow-lines. It is almost certainly the same as the pyritic basalt seen on the Korumfenda-Wurupong road, some four miles further North. Beyond this the road is covered with decomposed igneous material, and 40 or 50 yards further on a similar basalt is exposed. A mile or so further on the fragments found on the road appear to indicate that we are back on sandstones again. At this point the Togloto Hills are seen to the South, about two or three miles away. They are composed of felspathic sandstone of the usual Buem type.

Further along the road igneous fragments appear again, and two miles away from the westernmost exposure of the pyritic basalt coarse volcanic agglomerate, like that at Abupaso and at Odumase, appears. Much of the material composing it is very scoriaceous. Porphyritic basalt blocks also occur, and here and there fragments of more acid type, porphyry and rhyolite[58], occur. These acid

[59], [57], &c. Further details about the rocks numbered thus are given in Appendix I.

fragments in the agglomerate were not seen at any of the exposures further North. They become more frequent along this road travelling Westwards.

Shortly after the reappearance of the agglomerate a large mass of basic rock appears to the North of the road, and seems to form an intrusion. It is a dark blue, fairly even-grained pyritic dolerite[59]. Its boundaries were not traced. Less than half a mile West of this a stream draining Southwards crosses the road, and in it is an amygdaloidal basalt. A quarter of a mile further North this stream turns right round and is found draining North over the basic rock mentioned above as probably an intrusion. In the amygdaloidal rock are patches of more acid character, irregularly distributed. Following the stream down (Southwards) for about 50 or 60 yards we come upon light brownish red amygdaloidal lavas[60], accompanied by a light gray rhyolite[61] veined with quartz or chalcedony. Shortly beyond this is a compact altered igneous rock (probably a tuff[62]) with a curious "tubular" or "peg" structure in some portions. It is blue in colour, very tough, and shows patches of dark ferro-magnesian minerals. It appears to be dipping steeply to the East. Fifty yards further on a very tough decomposed rock, perhaps agglomerate, is exposed. Below this, for about a quarter of a mile, tuffs seem to predominate, but are much altered. They appear to dip steeply to the East. In several places lava bands[63] seem to lie in the tuffs, whilst coarser fragments and blocks appear towards the bottom of the series. Then, after a gap of about 300 yards, soft grey mudstones, dipping East at 75 degrees, show in the bed of the stream. They seem to be somewhat folded. The tuffs may possibly lie conformably on these. The total thickness of the volcanic rocks seen in this stream section could hardly be less than 500 to 600 feet, and is probably more.

Beyond this stream to Ajamansu there is no further exposure, but for most of the road igneous fragments are seen lying about. Just North of Ajamansu, in the Ajamansu River, green Buem arkose is exposed. Twenty or thirty yards West of this, in the bed of the Volta River, there is an exposure of jaspery and chalcedonic quartzite, probably connected with volcanic activity. Beyond this, to the North-west, several basalt[64] outcrops appear in the Volta, whilst to the West are sandstones like that in the Ajamansu River. On the left bank of the Volta, one mile to the North-west, just opposite the igneous exposures at Obosumanu Station, there are outcrops of a pebbly sandstone with greenish tuff(?) fragments. This is banded with a non-pebbly sandstone, dipping 40 to 50 degrees towards the East.

About two miles East of Ajamansu is a conical-shaped hill rising 500 to 600 feet above the level of the surrounding plains. It is surrounded by coarse agglomerate with basic fragments and many scoriaceous ones. The hill itself appears to be a plug of dolerite[65] rising through the agglomerate. The rock composing it is fairly fine-grained, grey to reddish in colour. Pannings in the streams between Ntameda and Ajamansu gave nothing of interest, only very scanty black sand and zircons. The debris from the hill East of Ajamansu yielded nothing.

On the Ntameda-Kpandu road there is no exposure of igneous material. Felspathic sandstones are the only rocks seen, except at Dafo village, where reddish sandy mudstones are exposed. The dip usually appears to be to the East, but is in no case definitely shown, except on Agbonuhoi Hill, which is wholly composed of veined and bleached felspathic sandstone of the usual type. Here the dip is to the East at about 50 degrees.

West of Kpandu, however, the volcanic rocks again outcrop. The line of hills upon which Kpandu Station is situated are of quartzitic sandstone, but the ground between them and the Volta is for the most part composed of igneous material. On the road from Kpandu to Dukluja the igneous rocks appear about two miles West of the town. They seem to be lavas[66], very vesicular and much decomposed, with calcite amygdules. These occupy the surface for a distance of one and a half to two miles, and then volcanic agglomerate appears. The dip of the lavas appears to be gently to the West, but this is very doubtful. In the agglomerate only basic blocks were seen. On the slopes of a hill West of the road

[59], [60], &c. Further details about the rocks numbered thus are given in Appendix I.

lavas seem to be overlying the agglomerate. The agglomerate continues to be exposed until about a quarter of a mile from Dukluja, when yellowish altered shales appear, dipping to the East at 60 degrees or more. The unaltered shales, purplish in colour, are exposed in the Ataulo River, 100 yards North of Dukluja. The shales near the agglomerate look baked and porcellanitised. North of Dukluja the streams flowing from the volcanic area into the Volta yielded practically nothing but a little black sand and a few zircons.

The ground between the Kpandu-Dukluja road and the Kpandu hills shows igneous rocks similar to those on the road. Agglomerate begins to appear on the lower slopes of the hills West of Kpandu Station, and shows blocks of the basalt with porphyritic felspars so common further North.

Along with the agglomerate are finer-grained much altered basic rocks[67], possibly altered lavas, interbedded with nearly vertical sandstones. Three beds like this were seen with about 20 feet of sandstone intervening in each case. About a quarter of a mile from this a lava[68] with large yellowish green blebs of pyroxene is to be seen. An argillaceous limestone* is to be seen in the tributary of the Ataulo, which drains this area. Following this tributary Southwards a succession of altered lavas and tuffs is seen with coarse agglomerate in one place. Then shales appear, similar to those seen in the Ataulo at Dukluja, and beyond this no more igneous rocks are seen, but shales, slates, and dark sandstones, apparently much folded, for the dip is very irregular, but principally to the East. A short distance South of this are the Abessia Hills, of quartzite, felspathic sandstone and conglomerate†, and it seems almost certain that the outcrops of the igneous and argillaceous rocks have been displaced Westwards by faulting, for, as mentioned above, volcanic rocks are found at Adaho to the South west, in the Volta River. The quartzites and conglomerates of the Abessia Hills dip Eastwards at a moderate angle.

The road Northwards from Dukluja along the left bank of the Volta was followed as far as Sagada. For about a quarter of a mile North of Dukluja red baked shales, much veined, are exposed. Then igneous fragments begin to appear. Half a mile on there is much chalcedonic material containing calcite lying about on the road. Then, immediately after this, we cross the Western shoulder of a hill composed of coarse basic agglomerate with many scoriaceous blocks. No porphyritic basalt was seen here.

Further on, at Dolumuko/e, on the banks of the Volta, agglomerate is again seen. Half a mile beyond this a vesicular basalt[60] is exposed showing lines of flow by well marked lines of small vesicles. Near by, large vesicular spheroids appear in a compact rock similar to the above. Near here a fragment of a basalt with porphyritic felspars was seen. A mile further on a quartzite is seen in yellow mudstones, vertical, striking North and South. Two hundred yards beyond this grey mudstones are shown in a small stream. They contain quartzite bands, strike North and South, and are very sharply folded. The same grey mudstones, very much contorted, are seen in the Boflu River half a mile further on.

Just after this igneous fragments appear on the road for a short distance. Then sedimentaries again are seen. About two miles North of Agrama there is an outcrop of white crystalline limestone, with dark siliceous bands (reddish brown in colour) traversing it from North to South. Immediately beyond this conglomeratic quartzite appears, with sub-angular fragments of granite, quartz and schist, up to 3 inches in diameter. Large pebbles are scarce. The pebbles lie in bands. After 20 yards of this appears a vesicular quartzite, possibly an arkose. Thence to Kotobebi quartzite is seen. Between Kotobebi and Sagada there is only one exposure, about a quarter of a mile North of Kotobebi. It is of quartzite. The streams along this route yielded nothing on panning. The Ossosoplini and several other streams at Sagada gave nothing but abundant black sand. In the bed of the Ossosoplini River were found several agates, probably from the lavas[70] and agglomerates which are to be seen in the same stream and in the streams to the North.

[67], [68], &c. Further details about the rocks numbered thus are given in Appendix I.
* For Analysis, see Appendix II. (*b*).
† For Assay, see Appendix II. (*c*).

The road from Sagada to Ahenkro also shows igneous rocks. For two miles from Sagada all the road has fragments of basalt, most of them very scoriaceous or amygdaloidal, with porphyritic felspars. Then, on top of a hill more acid types are seen, namely, trachyte.[71], [72]

Beyond this nothing is seen until the Tsimakumaku River is reached, where a very much decomposed basic rock is found. Two other streams, at about a mile and a half further on, showed a rock like a decomposed dolerite or basalt in appearance. Beyond this agglomerate of the usual type is seen in fragments on the road for about half a mile, and then a reddish, fairly fine-grained igneous rock is seen in a stream bed. It looks like a lava. There is nothing of note between this and the Wurupong-Kpandu road.

From the above it is seen that igneous rock was encountered on every traverse across the country between the Nkunya Hills and the Volta River. The fine-grained pyritic rock seen at Odumase, on the Korumfenda-Wurupong Road, and on the Ntameda-Ajamansu Road seems most probably a dyke. The agglomerate is probably filling vents in some cases, and in others is ejected material interbedded with lavas. No clear relationship between the igneous and sedimentary rocks has been made out, but it seems almost certain that much of the igneous material is contemporaneous with the Buem rocks in which it occurs.

The tuffs, etc., seen below the scarp at Wurupong can hardly be other than contemporaneous. What their relationship is to the igneous rocks of the plains below is not clear. Koert speaks of the Nkunya Range as a block mountain system, which would imply faulting along the West scarp. Such an assumption does not seem necessary to account for the facts, though it may be correct. If so, the igneous rocks below the scarp may be the same as those in the Volta plains. Otherwise the scarp group is of later date. Rocks exactly corresponding to those under the scarp have not been seen in the plains however.

7. The Oti Basin.

If a straight line be drawn from Akroso to Tutukpene and continued into the Bo district to the North, it will show the Eastern limit of the Oti Series in the British zone of Togoland. West of this none but Oti rocks are to be seen in the Krachi and Yendi districts.

Low undulating park land characterises the whole area. There are practically no outstanding hills, and the only touch of variety in the scenery is that occurring along the valley of the Oti River. Here there is frequently a succession of terraces leading up from the river flats to the level of the surrounding country, due to differential weathering of the harder and softer members of a horizontal series of rocks (Fig. 4). There is little dense forest except in thin strips along the river courses.

Crossing the Asuokoko at Akroso, where Buem beds are to be seen dipping West to South-west at 20 to 40 degrees, there is no exposure until at about a mile and a half to the North of Akroso, where coarse horizontal conglomerates are seen. They contain pebbles of quartzite, of Buem sandstone like that seen in the Asuokoko and further South, and of granite or granitic gneiss. The Sumansu and Bombata Rivers, several miles further North, gave no gold and no black sand. Half a mile South of the Aboabo River much weathered sandstone and a little conglomerate like that North of Akroso are exposed. The Aboabo gave neither gold nor black sand. Just beyond this the road turns Westwards, and here brown arkose is seen lying practically horizontal. Both here and half a mile to the West these arkoses contain sparsely scattered large pebbles of quartzite, granite, etc. The rock is bluish grey in colour when fresh.

The Danganu River, two and a half miles North of Apaso, gave nothing but a few zircons on panning, and no rock *in situ* is seen until North of the Santrufi River. Thence to Otisu flat arkoses like those South of Apaso are seen at intervals. At one place they contain a few pebbles of quartzite, phyllite and granite. A much more argillaceous type appears about a mile South of Otisu. Most of the streams between Apaso and Otisu were dry. Two of them on panning yielded

[71], [72] Further details about the rocks numbered thus are given in Appendix I.

nothing. The Oti River at Otisu gave no gold but abundant black sand. On the banks of the river, half a mile below Otisu, green and blue fissile shales are exposed, dipping very gently to the West. Upwards of 30 feet are seen. They are most probably below the strata seen on the Apaso-Otisu road. Two miles down the river from Otisu hard compact fine-grained sandstones lie exposed on the left bank, horizontal.

On the Krachi road North of the Oti nothing is seen for about four miles. Then Oti sandstones of the usual type outcrop, with no large pebbles showing. The Ajamassa River gave nothing on panning. Somewhat argillaceous sandstone appears a little further on, horizontal. The Aboabo-Kuma and Aboabo Rivers showed nothing. Between them Oti sandstones again appear. Much of the road has laterite several feet in thickness on it. Half a mile North of Dentemanso at least 100 feet of Oti sandstone are exposed on a hill slope. It is slightly current-bedded in parts. One thin zone of large pebbles is situated about half-way down the hill. Otherwise the exposure is quite fine grained. Beyond this nothing is seen until the Bonda River is reached. Here fine-grained horizontal sandstones again outcrop. Above, on the hill-slope, coarse conglomerate is visible. It forms the ridge running North-east and South-west from Krachi to Kpetsu. In the Volta at Krachi the same conglomerate is exposed, and below it appears the fine-grained sandstone seen in the Bonda River.

On the road from Krachi to Tutukpene large exposures of coarse conglomerate are seen about a mile out from Krachi. No granite pebbles were noticed here but only quartzite, sandstone, slate and phyllite ones. Finer beds alternate with the coarser ones. Between Abojero and Kpetsu the finer sandstones lower down in the series are seen at several points, and these form the lower portions of the ridge of small hills West of the road. The top 100 feet or so is of the coarse conglomerate. Here discoidal granite[73] pebbles are frequent together with quartzite, gneiss and sandstone ones. One block of veined Buem sandstone measured 2½ feet by 2 feet by 1½ feet, but this is much larger than the average.

The terraced slope from Kpetsu down to the Oti shows a succession of harder and softer sandstone beds, some of them limy (Fig. 4). Near the bottom flaggy sandstones, green on the fresh surface, appear. The dip is East at less than 5 degrees. The Oti River is about 300 feet broad here. The river gravel, chiefly composed of pebbles of Oti sandstone, gave a fair amount of gold on panning and abundant black sand. The same result was obtained at Danbai, further North. The road between Kpetsu and Danbai shows very few exposures. At the Njamaneabra River, about half-way between the two places, hard fine-grained sandstone is visible, dipping West at less than 5 degrees. Panning gave scanty black sand, plentiful zircons, but no gold. Nearer Danbai weathered sandstones and shales are seen. Between Danbai and Tutukpene only two exposures occur, both in streams near Danbai. The Jaraga River shows fine-grained well bedded shales, green in colour, and associated with argillaceous sandstone. The dip is to the West at a low angle. The other exposure, between this and Danbai, is of fairly hard fine-grained sandstone, dipping in the same drection. The Jaraga gave neither gold nor black sand on panning. Near Tutukpene fragments of Buem sandstones from the hills to the East are common. A contact between the Oti and Buem rocks was not obtained. An obscure exposure one mile South of Tutukpene shows weathered mudstones, dipping East at about 30 degrees. They may belong to either series.

The road from Krachi to Yendi was followed at a later date. Between Krachi and Tariasso there are no exposures. The Kunto River gave nothing on panning. A good deal of laterite is found all along the route, and quartzite pebbles from the coarse conglomerate are frequently seen. The Chare (Tschare) River, north of Tariasso, gave nothing on panning but zircons. A brown, fine-grained sandstone, with chocolate-coloured mudstone fragments, lies horizontally in the stream bed. It is slightly limy. Further North, the Momata River shows soft marly shales with hard sandstone above them, both flat. (Fig. 6). The outcrops are concealed by laterite in many cases. A little to the North of this the Volta comes to within half a mile of the road. It gave fair gold pannings, with moderate black sand and zircons. Hard sandstone is exposed here and is probably below the shales in the Momata

[73] Further details about the rocks numbered thus are given in Appendix I.

River. What is apparently the same horizon is seen on the road between Bafore and Chindere (Tschundere). Beyond Chindere long lateritic slopes extend to the Bonwe River. The Nkpabre River, four miles North of Chindere, gave nothing but zircons on panning. The Bonwe, like the majority of the streams along the route, was dry. In its channel horizontal well bedded sandstones occur, probably lower than anything seen between here and Krachi. The same rocks are exposed in the Daka, two miles to the West. Just South of Banda similar sandstones showing current-bedding are visible. From Banda to Kpandai only laterite[74] is to be seen, except for one sandstone exposure North of the Gowa River. The same holds good along the whole road from Kpandai to Nakpajile. Between Nakpajile and Bimbila sandstone similar in character to that seen further South is exposed. East of Bimbila sandstone outcrops near Kukuo and on the slopes down to the Oti River there. Panning gave abundant black sand, scanty zircons, much garnet, but scarcely a trace of gold.

Between Bimbila and Pussuga there is much laterite, but weathered sandstones appear in one place. From Pussuga to Langanja laterite is the only rock exposed, except near the Nabulugu River where there is a small exposure of sandstone of the usual type. Between Langanja and the Yendi boundary another exposure of sandstone[75] is seen, and at Adibo still more appears dipping, if anything, to the North, but practically horizontal. The same sandstones appear several times between Adibo and Yendi.

The Daka, where seen West of Yendi on the Sambu road, shows massive brown sandstone. A little higher up some calcite veins and bands appear in the sandstone, whilst a quarter of a mile up the stream from the road, and a little higher up in the succession, well bedded ripple-marked sandstones are exposed dipping West at less than 5 degrees. Panning gave a trace of gold but no black sand.

One mile East of Yendi more sandstones are seen. Here soft shaly beds overlie about 15 feet of flat well jointed limy sandstone, greenish in colour. Below this are more argillaceous sandstones, possibly 20 feet in thickness and passing downwards into more limy compact sandstone. Excellent water is obtained from shallow wells dug in these sandstones, but not in any great quantity.

On the Wapuli road, running North from Yendi only laterite is seen until Batia is reached. Here a good brick clay* covers the ridge on which the town is built. It is covered by laterite, but appears to extend over an area of at least a square mile. It is 4 feet or more in thickness. Thick massive sandstones, with some softer argillaceous bands, appear just South of Sunsong, and also compose the hills to the West of the town. Strata some 200 feet in thickness are exposed. The road from Sunsong to Wapuli shows similar rocks at intervals. The Jamboa River gave nothing but zircons on panning. In the Tanja River, North of Wapuli on the Sansane Mangu road, flat, well bedded, regularly-jointed brown sandstones (green when unweathered) are to be seen. Two miles lower down the river are horizontal green and grey shales with limy bands†[76] about 8 feet of strata being exposed. Panning gave only a few zircons. The tough green sandstones appear on the slopes of the high ground to the North. Between this and Nafekele nothing more is exposed.

The Tupe River, North of Nafekele, gave only a few zircons on panning, and no rocks are exposed in the vicinity. South of Nafekele, however, on the Gujoni (Gudjoni) road a limestone band‡[77] about 1½ feet thick occurs on the left bank of the Tupe river amongst soft argillaceous beds. It dips gently to the South. It appears to be composed almost entirely of calcareous sponge spicules. Just North of Gujoni a thickness of about 80 feet of strata is exposed on the hill slopes, mainly soft grey shaly beds alternating with harder sandstones. Between Gujoni and Shangpong (Tschangpon) there is thick laterite.

From Shangpong to Sambul the road passes along the terraced slopes bordering the Oti flats. They show alternating grey shales and limy sandstones. The Oti at Sambul gave no gold on panning, but abundant black sand and garnet. The

[74], [75], &c. Further details about the rocks numbered thus are given in Appendix I.
* For Analysis see Appendix II. (*d*).
† " " " " II. (*e*).
‡ " " " " II. (*f*).

green shales and flaggy sandstones here form cliffs up to 50 feet in height, the dip being very gently towards the North.

Between Sambul and Demong the road is mainly over laterite. Flat sandstones are exposed in the bed of the Monjoch River. From Demong to Jankpima (Djankpima) nothing but laterite is seen. Just past Jankpima, however, the ground falls away steeply to the Oti flats, and about 200 feet of strata are partially exposed. They are practically horizontal and are mainly sandstones, but near the top two beds of a white to yellowish compact earth* (78) are seen about 25 feet apart. Each of them is about 2 to 3 feet in thickness with sandstone (79) above and below. They were traced along the outcrop to Kuaju, about one and a half miles to the South. The material is very absorbent, weathering grey or brown. The Demong-Yendi road shows few exposures, all of sandstone.

GENERAL GEOLOGICAL RESULTS.

The observations detailed above lead to certain general conclusions regarding the geological structure of the country.

It seems very probable that the crystalline metamorphic series is quite distinct from the Togo Series and forms a basement upon which the Togo, Buem and Oti Series are built.

The observations supporting this are: (1) The Crystalline Metamorphic Series is nearly always at a lower level than neighbouring rocks of the Togo Series, and seems to underlie these, not only along the East Togo Scarp but in the Dsawöe Valley and in the Ho district. Where Crystalline Metamorphics are found at a higher level than neighbouring Togo ones the field evidence independently suggests either faulting or folding together of the strata as the explanation, *e.g.*, at Matse and Toji. (2) The rocks of the Crystalline Series are much more highly altered, and this is not a gradual change with distance from West to East. (3) Often a distance of only 200 or 300 feet intervenes between exposures of typical basement gneiss and typical Togo quartzite and phyllite. (4) The apparently large number of intrusive igneous rocks in the Crystalline Metamorphic Series compared with the small number seen in the Togo Series.

Rocks of the Crystalline Metamorphics, for which an igneous origin is presumed, are seen in numerous localities, *e.g.*, at Matse, between Matse and Tshome, between Safie/e and /ane, at Tokwe, between Palime and Poji, on Agu, Djeti and /eto. Rocks which are most probably sedimentary in origin also occur in many localities, *e.g.*, acid gneisses on the Ho-Palime road, schists at Kpatave, acid gneisses below the Togo Scarp, marble and basic schists in the Chra River, and acid gneisses in the Amu River.

The planes of foliation nearly always strike N.E.—S.W., sometimes rather more to the North, and the Togo rocks strike in the same direction. As pointed out by Koert the folding of the Togo rocks and the final folding of the Crystalline Metamorphics were apparently simultaneous, as shown by the foliation planes being in concordance and by the varying heights at which the junction appears to be in cases in which faulting is absent.

The appearance of the country East of the Togo Range, as described above, is such as has been by most observers described as that shown by a land surface far advanced in denudation towards its base-level. This is the view taken by Koert, and the scenery which characterises this peneplain can be matched in many other parts of Africa. The writer is inclined to favour this view. The Togo Range is a sedimentary series which probably once extended Eastwards over the top of the Crystalline Metamorphics. It has not been subjected to any very great deforming forces, for the folding is in most cases gentle, though in one or two cases, *e.g.*, at Gemi Mountain, near Amedzo/e, the folds are tilted over to the West (Fig. 1). The faulting also, though possibly reversed in some cases, does not amount to anything like severe overthrusting.

(78), (79) Further details about the rocks numbered thus are given in Appendix I.
* For Analysis see Appendix II. (*g*).

The metamorphism of the Togo rocks appears to be more intense in the Adele region than in the Misahöhe district, what are phyllites in the latter being practically schists in the former. Faults seem to be in two sets, striking N.—S. and E.—W. respectively.

The chief problem connected with the Togo Series, however, is its relationship to the Buem rocks further West. As Koert suggests, the presumption is in favour of a fault line along the foot of the Western Togo Scarp, bringing Buem rocks down against the Togo ones. Lithologically there is a distinction between the Togo and Buem rocks in the Dayi region, but this distinction is not quite so easy to trace in the Tutukpene-Adele region. It is significant, however, that Hubert distinguishes between the two series in Northern Dahomey. Nothing quite like the felspathic sandstones or the jaspery quartzites of the Buem region is found on the Togo Range; nor is there anything in the Togo Series to match the conglomerates with igneous and metamorphic pebbles which are found all along the line of hills from Soho to Tapa, or the phyllites with claygalls seen in the Tutukpene region. On the other hand, the degree of metamorphism of the Buem Series at some places is practically as great as that of the Togo rocks—but this is not of so much importance. At present, in default of further evidence it is best to look upon the two series as distinct.

The most interesting feature of the Buem Series is the volcanic development in the Nkunya and Kpandu region. This has already been described in detail and is shown to lie along a definite zone, which suggests that the period of volcanic activity was during the first third or half of the time during which those Buem rocks which are exposed in Togoland, were being deposited. The succession of the Buem Series, travelling from West to East, is probably interrupted by one or two repetitions due to faulting, making the total thickness of strata appear much greater than it really is. Koert shows the Buem Series as cut out by faulting in the Bo region North of Adele, in French territory, bringing Oti rocks up against the Togo Scarp.

The country occupied by the Oti is practically reduced to base-level, as is shown by the winding of the river, but the absence of hard rocks has prevented the formation of isolated mountains. It is not necessary, however, to assume from the facts at present known that this area has ever stood high since the deposition of the Oti rocks.

There seems little doubt that the Oti Series is quite distinct from the Buem, and much younger. They are seen within a mile or two of one another at some places, but never in contact. The lack of alteration in the Oti rocks, however, their inclusion of pebbles which seem almost certainly derived from the Buem, their undisturbed nature quite near the junction, the original nature of the rocks themselves, the absence of volcanic activity in the vicinity of those Buem regions affected by such activity—all these, though of little weight singly, suggest that the Oti Series is younger than the Buem, and probably rests unconformably on it. The approximate position of the junction is shown by a scarp of Buem rocks in Togoland, but there is no such scarp on the Ashanti side of the Volta, South of Akroso—no physical feature to mark the junction. The scarp may be due to faulting. It is equally possible that the scarp existed prior to the deposition of the Oti beds.

Much of the low country to the East of Yendi, especially in the valleys of the streams, has a good deal of very fine grey or reddish brown dust scattered over its surface during the dry season, sometimes 2 to 3 feet in thickness. This appears to be an aeolian deposit, perhaps carried some distance by the dry Harmattan currents of air. A specimen examined under the microscope consisted mainly of angular to rounded grains of quartz. In the Oti rocks themselves no sandstones of aeolian derivation were seen, and the series was probably laid down under estuarine or fairly shallow marine conditions. A ripple-marked sandstone was seen in the Daka River channel at Yendi.

The sands and gravels which occur in the Southern portion of the Lome district, for a distance of 15 to 20 miles inwards from the coast, and which are of Recent date, were not examined, as time did not permit. In the Asuokoko and other rivers, banks of gravel and clay are to be seen some 20 or more feet above

the usual height of the river during the wet season. Such occurrences are not really frequent however, and did not lead to any generalisation. Usually, decayed vegetation and the mud derived from it cover the area which is subject to the seasonal floods, and conceal anything of the nature of a terrace which may happen to exist.

WATER-SUPPLY.

The following notes may be found useful, but, as in most cases each locality mentioned was visited only once, certain reservations must be made depending upon the season during which the place was examined. Also it should be noted that the year during which the observations were made was an unusually dry one.

The districts will be considered under the same headings as for the geological descriptions.

1. The Country East of the Togo Range.

The towns and villages along the foot of the Togo Scarp have rarely any difficulty in getting water, as even at the end of the Harmattan season there is still water in the larger streams coming from the hills, the Aha at Palime, the Todshi at Nyive, the Kalagba South of Ho, and the tributaries of the Shio between Palime and Sodo. Damp fogs hang round the higher peaks of the Togo Range even in the earlier months of the year. It is when we go South-eastwards over the open plains that shortage of water during the dry season is felt severely. Along the railway line from Palime to Lome for example, the supply of water is very poor, and at many places, *e.g.*, Assahun, large earthenware pots are used to store water in, forming excellent breeding-places for mosquitoes.

A German observer attributed the dryness of the Nuatja region to deforestation by the natives, but it is doubtful if there was really thick forest there at any comparatively recent date.

The streams flowing from the Togo Range are fairly clean when they first reach the low ground, but are quickly polluted by decaying vegetation and by the natives.

It is rather curious that along the foot of the Togo Scarp, in the region just North of Sodo, goitre is extremely common. It was not observed elsewhere.

2. The Togo Range South of Misahöhe.

The general remarks made above about the country just below the Togo Scarp apply also to the Dsawöe Valley. The low country immediately to the West of the Togo Range is also similar as regards water-supply.

In the hills the principal towns are near streams which can be relied upon to flow during the whole year, *e.g.*, Fane, Biakpa, Kpoeta, and Tomegbe. Amedzofe obtains water from a stream just outside the town, near the Mission Settlement. It is not in a very good position to avoid pollution, as there are huts on the ground above it. Several small streams cross the Amedzofe-Biakpa road.

3. The Dayi Plateau.

This area was visited during the latter part of the wet season, and nothing can be said about the water-supply during the dry months. The Dayi and its tributary, the Tonyo, would certainly not cease to flow however. The water on the plateau seems clear and good, and in most cases the water-drawing places happen to be where there is less risk of pollution than is usual in the case of the watering-places of villages.

4. The Adele and Tutukpene Highlands.

The water-supply is fairly good over the whole area and does not seem to fail during the dry months. No falls with a volume of water sufficient for use in the production of power were seen in the course of the traverses in this region. There

are falls on the Asuokoko, about fifteen miles South of Bismarckburg, but time did not avail for a visit to them, and the natives professed themselves unable to give any information regarding them.

5. The Dayi Valley.

Here, as elsewhere, the chief towns are near the larger streams, Pekipong and Lolobi on the Dayi, Kolenu and Fodome on the Kole. The tendency of the villages on the Akpafu Hills to be abandoned on account of the difficulty of getting water has been already noted above (p. 9).

Kpandu obtains much of its water from wells in the valley below the Station, but during the early part of 1919 the water-supply was so poor that they had to carry much from the Volta and the Dayi. The water in the springs referred to is not very good, and there is great risk of pollution.

Generally speaking, the water-supply is bad in the smaller towns and villages during the earlier part of the year.

6. The Nkunya and Kpandu Volcanic Area.

The water-supply is not good along the Kpandu-Akroso road during the dry season, and at that time the springs along the Nkunya Hill scarp only flow for a few hundred yards from their sources and then disappear into the ground. Wurupong, for example, the head town of Nkunya, obtains its water from a stream flowing from the scarp to the East of the town, but except towards the end of the rains the water is all absorbed by the ground before it has reached the low country. Kwamikrum on the Konsu, and Akroso on the Asuokoko, have a reliable and much better supply of water. Tapa to the North-east is high up on the hills and is not well supplied, but Worawora, further East on the lower ground, is near the head of one of the main tributaries of the Konsu, and is well provided for.

7. The Oti Basin.

The traverses in this area were made during the months of January and February, after an exceptionally light rainy season, and the water-supply in many parts was very poor. The Krachi-Yendi road, on which or near which practically all the chief towns are situated, passes along a water-shed for a large part of the way, and the only sources of water-supply during the dry season are stagnant pools in some of the stream beds, the quantity being small and the quality very poor. In the eyes of the native, however, its viscosity appears to be a redeeming feature, making up in some degree for its scarcity.

Apaso, Otisu and Krachi are, of course, well supplied. Thence to Yendi the water is bad. Yendi itself is fairly good, for the Daka is near at hand—though this river was only a disconnected line of pools when visited. There are also wells in the limy sandstones about a mile East of the town which yield a small but excellent supply of water, free from taste and smell.

Between Gujoni and Shangpong, in the flats South of a stream draining East, are many circular water-holes dug through the thick laterite which covers large areas of the district. They are usually about 2 feet in diameter at the top, but widen out below to a diameter of 10 feet or even more. In several of them the water-level was about 12 feet from the surface. The Gujoni water-supply is got from these wells, and there are many others all over the district. It was not found possible to ascertain whether or not the wells are in laterite all the way down. The invariable widening out at the bottom suggests that they are in softer material there. They do not seem, from inquiries that were made, to have been dug by the present generation of natives or even by those of one or two generations back.

Along the Oti Valley, *e.g.*, at Sambul, Palba, Demong and Gnani the water-supply is assured during the dry season, but may be a source of annoyance during rains when the river is flooded.

LATERITE IN TOGOLAND.

A few details regarding the distribution of laterite in the British zone of Togoland may prove useful.

The bauxite[80] on Agu, which has been examined by Mr. Kitson, is the only deposit of its kind known in the area in question. All the other laterite deposits which were seen are of the ordinary impure type which is found along the courses of the great majority of streams in such climates as that of West Africa. An occurrence at Bismarckburg suggests a means by which such bauxites as that on Agu might be produced. It will be dealt with in more detail later (p. 41).

From Pode to Sodo, along the foot of the Togo Scarp, patches of laterite appear in many of the stream banks, but in no place does it cover any large area. In the country East of the Togo Range few traverses were made, and consequently the information is scanty. It is not seen in the forest-belt along the course of the Amu between Lauuru and Amukpa. This is probably due to the level of the ground-water in such belts never being lower than the surface of the ground. It is noteworthy that on the road from Glei to the Chra River marble deposit there is much laterite on the low ground near the Chra River (ground probably swampy during the wet season), but the laterite ceases abruptly as soon as the forest-belt along the river-course is entered. The underlying rock is gneiss or hornblende schist.

No development of laterite was observed in the higher portions of the Togo Range South of Misahöhe, but this is not surprising, as there are no comparatively flat stretches of ground, all the slopes being fairly steep. On the Dayi Plateau there is very little indeed, in fact only one occurrence was noted, just outside Basagbe, and in this case lateritisation was merely incipient.

In the Dsawöe Valley less laterite was encountered than had been expected. Very little indeed is to be seen on the Matse-Tshome road until near Tshome. South of Todome, below the scarp on the Kpeve road there is quite a large number of laterite blocks to be seen, probably brought down from higher up the slopes. None was found on the hill-tops however.

There is not a large amount to be found in the Dayi Valley; the ground is probably too continuously damp. A fair stretch exists on flat ground between the Dayi River and Ahave on the Vakpo-Ahave road. There is also a good deal between Liati and Atafong on the Akpafu road.

It is not very common near the Kpandu Range nor, generally speaking, in the Kpandu and Nkunya districts, though many of the streams show a little.

North of the Asuokoko, however, we enter a well lateritised area. All along the main road from Akroso to Wapuli in the North of the Yendi district laterite is to be seen, sometimes in small patches, sometimes completely covering long stretches of the road. Some very pisolitic material is found at Wulenchi (Wulehe-Sochani). In the Eastern part of the Yendi district there is also much laterite. Reference has already been made in the water-supply section to the water-holes at Gujoni. The laterite here is possibly 6 to 8 feet thick. Along many of the streams in the district similar stretches of laterite are to be seen. The Palba-Demong road is covered with laterite in many places, whilst at Sambul the cliffs bordering the Oti have laterite on top of them, 50 feet above the river-level. This, however, is probably not in process of formation at the present day. With that found on the river flats and on the tops of the long ridges on the Krachi Yendi road the case is different, for these are at present in process of formation, favourable conditions for the production of laterite existing—whatever these conditions may be.

East of Krachi we find much laterite on the Danbai-Tutukpene road, on the flat ground beyond the Jaraga River forest belt. There is not much elsewhere on the Krachi-Dadiasi road.

The Adele Highlands show extensive lateritised* areas, and Bismarckburg affords a good example of what appears to be laterite in process of formation. Nothing was seen in Togoland to indicate that laterite has any special connection with any type of rock. The distribution of laterite is quite independent of the petrological nature of the underlying rocks.

[80] Further details about the rocks numbered thus are given in Appendix I.

* For Analysis see Appendix II. (*h*)

The Bismarckburg occurrence is illustrated in the section given through the hill on which the Station is situated. (Fig. 5.) Travelling Northwards from Yege the ground is covered with light coloured altered schists until we get to about half a mile from Bismarckburg Station. At this point the road begins to rise at a moderate inclination, and continues to do so until about 200 yards from the Station, when the slope becomes very steep. It is on this moderately inclined slope that the lateritic deposits are seen. The top of the hill shows exposures of weathered schist or phyllite with numerous lenses of quartz.

At the top of the lateritised slope, at an elevation of about 40 feet below the station, there is hard siliceous laterite, brown in colour, and this covers the ground for about 600 feet along the road towards Yege. The thickness was not seen. Next comes about 450 feet covered with softer, semi-consolidated laterite, less siliceous than that above, and dark brown in colour. Then follows about 900 feet of dark red earth, over 8 feet in thickness in some places, merging downwards into weathered schist. Beyond this on the road is the light-coloured weathered schist seen in so many parts of the district.

A similar succession is seen on the Northern side of Bismarckburg, on the Kejenke road. It is on the gentle slope of the hill between that on which the Station is built and the Lalango River.* In both cases the long stretch of red earth below the laterite proper is noteworthy. The different zones shade into one another, making it probable that they are only different phases in the process of lateritisation.

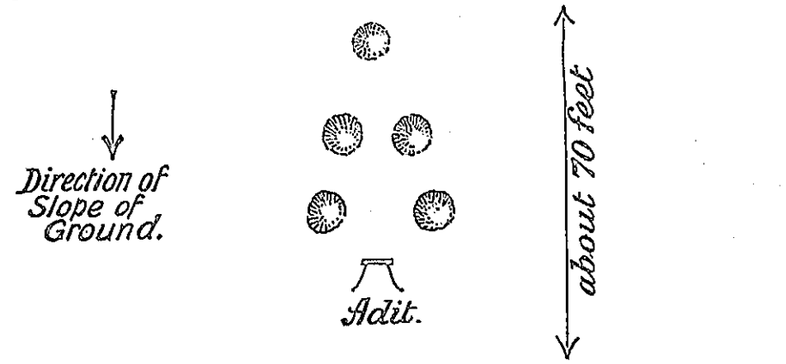
By picturing the result of denudation-processes applied to such country as the Bismarckburg area, the distribution of such bauxite deposits as are found on the tops of mountains in different parts of West Africa seems explicable. Large blocks of bauxite are sometimes found strewn over spurs of the hills which are capped with bauxite. Also hills near the bauxite-capped ones, and of the same height or higher, are frequently devoid of bauxite. The bauxite-capped hills seem to be developed from the areas of gentle slope on the original plateau, *e.g.*, the hill between Bismarckburg and Kejenke, and other flat laterite-covered areas to the North and East of Kejenke; whilst those peaks devoid of bauxitic or lateritic material are presumably what is left of the hills similar to Bismarckburg itself.

The above remarks, however, do not claim to do more than show a possible connection between the bauxite of the mountain-tops and the ordinary laterite of the country.

AKPAFU IRON ORE DEPOSITS.

Akpafu is situated in Lat. 7° 15′ N., Long. 0° 30′ E., on a line of hills which has been described above. The iron ore is associated chiefly with the quartzites and appears to occur in brecciated areas, possibly along a line of dislocation. The three localities described below lie approximately in line and suggest the occurrence of a fault line running North and South.

The localities mentioned are as follows: (1) About two miles North of Akpafu, in a valley looking East. Six or more holes had been dug to a depth of over 15 feet, and were arranged thus:



* For Analysis see Appendix II. (*i*).

Below them on the steep slope is an adit, as shown, and the holes appear to be connected underground.

It is many years since the mine was worked, and the workings have fallen in. An attempt to clear the mouth of the adit showed much fallen ground. The material exhibited by an old native as having been got from this place was poor, certainly not over 20 per cent. iron. No trace of good ore was seen in the vicinity. Some of what was got may have been lateritic, as is almost certainly the case in a recent hole dug about a quarter of a mile further South.* This remark does not apply to what was got at the bottom of the deep holes however.

(2) About half a mile North of Akpafu along the Teteman road, 100 feet or so below the road, on the side of the hill. The workings here are the most extensive which were seen, and are reached by means of several adits running into the steep side of the hill and dipping at from 0 degrees to 16 degrees. These adits reach one continuous working-face, irregular in outline, 20 to 30 feet in from the mouths of the adits. The working-face is 1 to 4 feet in width and appears to be 150 feet, or perhaps more, in length, but the roof has caved in at several places. By the appearance of the workings the ore seems to be in irregular brecciated areas in the quartzite and hardened sandstone which form the surrounding country. These rocks dip Eastwards at from 40 to 50 degrees. Several samples were taken from the face, but everything seen was of poor quality and worth nothing from the European point of view.†

(3) About half a mile East of Akpafu, on the Baika Road, in the valley of the Otupasso River. A vertical shaft goes down for 12 to 15 feet, and from the bottom of this a drift leads into the side of the hill for a distance of about 50 feet, varying in width from 6 to 9 feet. Samples were taken, but as in the other two instances, the material seen was not of economic value.

Very near the second occurrence is an old bank of furnaces which have been used at some time for smelting the ore. They were built of earth from ant-hills, according to the guide, who was an old man, and said he remembered their being used when he was young. There is very little left of them now. Six furnaces are to be seen in a row, and a good deal of slag is lying about, but no ore.

The iron ore seen occurs in cracks and fissures in quartzite and hardened sandstone, and is very siliceous. Here and there a little manganese oxide is seen. Most probably the deposits are due to concentration of the iron from the bleached rocks in the vicinity along a line of brecciation and movement, by means of percolating waters.

CHRA RIVER MARBLE DEPOSIT.

The position of this deposit is about four and a half miles East of the Kpele-Atakpame boundary, in Lat. 7° 14′ N., Long. 1° 03′ E. It is situated in the bed of the Chra River about 12 miles South-west of Glei on the Lome-Atakpame railway line, and about the same distance (12 miles) up the river from Chra village. It is reached by bush-track from Glei through open park-land. The surrounding country is flat or gently undulating.

Geologically, the deposit occurs in the crystalline metamorphic series. The district is for the most part composed of a muscovite and biotite gneiss, well seen near Glei and along the course of the Amu River. Planes of foliation are usually nearly vertical with strike N.E.—S.W.

Three exposures of marble were observed, all in the bed of the Chra River. The bank of the river is about 20 feet high on either side, and the ground rises beyond—gradually on the eastern side, more steeply on the western.

The main bed[81] is about 55 feet thick with a dip of 79 degrees at 312 degrees (magnetic) and runs obliquely across the river-course. It is greyish white in colour, tough and of even texture.‡ It is nearly pure, but has subordinate tremolite in some places. It shows definite planes of jointing. An endeavour appears to have been made by the Germans to trace this bed Westwards, as is shown by a number of prospecting pits, now fallen in. Some of them could not have been less than 20 feet

[81] Further details about the rocks numbered thus are given in Appendix I.
* For Analysis see Appendix II. (*j*).
† „ „ „ „ II. (*k*).
‡ „ „ „ „ II. (*l*).

in depth. A native who had been working on these pits said that they did not find any white stones in them, but little reliance is to be placed on this statement. No fragments of marble were found around the pits however, the debris being green schist chiefly.

The second bed is about 100 yards further up the river, and the exposure in this case measures 20 feet across the outcrop, dip greater than 80 degrees at 124 degrees (magnetic). The marble is similar to that in the main bed. Several blocks found near here had much tremolite in them, as crystals scattered throughout the marble[82].

The intervening strata are hornblende-schists[83] showing the same strike as the marble, but too much contorted to give a definite dip for the foliation-planes.

The third exposure is some 50 yards higher up the stream than the second, and is only poorly shown—possibly about 10 yards are exposed in the stream-bed. It is the same as the other beds in quality and appearance. The strata between the second and third beds are not exposed. In all possibility there are other beds of marble exposed in the stream, but time did not permit of further investigation.

Just West of the main bed an endeavour had been made by the Germans to calcine the marble in a kiln made out of an ant-hill. Some of the burnt lime was still lying about.

As regards the origin of the deposit, the evidence as shown in the above description makes it almost certain that the strata in question were originally sedimentary, and this may apply to a very large part of the strata of the whole district. The intense metamorphism which the rocks of this series have undergone makes it difficult, or impossible in many cases, to come to a conclusion regarding their original nature.

The chief question from the economic point of view is the lateral extent of the marble, and there are no surface indications to guide one in estimating this. It should be noted that there is no difficulty in the way of transport, as Glei is within easy reach over flat country, in which a road could easily be made and maintained. Glei is in direct connection with Lome and Atakpame by rail.

DJETI CHROMITE DEPOSIT.

Djeti is a hill situated in Lat. 7° 23′ N., Long. 1° 05′ E., and is the Northern-most of a line of peaks running North and South. It is most easily reached from Dadja (on the Lome-Atakpame railway line), from which place it is about nine miles to the South-west. The nearest village of importance is Amukpa, about three miles to the North-east, on the opposite side of the Amu River.

Northwards the ground falls away from Djeti to the Amu, about two miles distant, and beyond are the Amukpa Hills. To the West a fairly flat area—the Amu Valley—stretches right across to the Togo Mountain Scarp, a distance of 12 to 15 miles. Eastwards several hills intervene between Djeti and the flat or undulating country which forms the basin of the Monu River. The German map is not reliable as far as the positions of the hills in this region are concerned. The country is fairly open park land, except near the rivers, where there is thick forest. Djeti itself is chiefly covered with grass, except the top, which is wooded. It stands about 550 feet above the average level of the country below.

The district in which the deposit occurs has already been described, the chief rock being a hornblende or biotite gneiss[84], which is well exposed in the Amu River at Amukpa.

The position of the deposit is shown at A on the accompanying sketch (Fig. 8), which is partly copied from Koert's sketch map of the locality. A portion of the eastern side of the hill is composed of massive quartzite. The rest appears to be serpentine[85], greenish to yellowish in colour and accompanied by much talc, and here and there common opal in veins. Two pits at B, on the South of the hill showed talc-schist as far as sunk (about 8 feet).

The chromite-bearing area is on the North-eastern slope and does not appear to occupy more than an area 50 to 100 feet square. Outside this area no chromite was seen *in situ* during the visit. Several of the old prospecting pits were reopened

[82], [83], &c. Further details about the rocks numbered thus are given in Appendix I.

and the ground on some other parts of the hill was cleared. The pits in the chromite area showed patchy ore, but no really good ore-body was disclosed. Much of it is an intimate mixture of chromite with chlorite and serpentine. The chlorite present is mainly a chrome-bearing one showing a fine violet colour in hand-specimen. The chromite[86] occurs in this chlorite in broken crystals, different parts of the same crystal being separated by chlorite, as if the chromite had been brecciated and then chlorite had formed round and between the fragments of chromite.

Two small streams drain through the chromite area, one towards the North, the other towards the North-east, and it is in these that the most satisfactory ore is to be seen. Their beds are strewn with a large number of blocks of good-quality chrome-ore for some distance below the deposit. Following these streams down we come upon an actinolite-schist[87] striking North and South and dipping to the West at a variable but steep angle. The contact of the serpentine and the amphibolite is not a sharp one. The former seems to be intrusive in the latter, and to have penetrated it in cracks and fissures. Much of this may have been done, however, during the alteration of the original intrusive rock to serpentine.

Sections of the schist show that it consists almost entirely of actinolite crystals in sheaves, accompanied by a little clear interstitial quartz. The serpentine near the chromite area contains a large amount of talc and chlorite, and there is sometimes much fine powdery chromite scattered through the talc and other constituents.

The serpentine is probably derived from a peridotite which has been intruded into the schists and quartzites of the Crystalline Metamorphic series. It does not appear to have the schistosity of the district imposed upon it. This may be due either to its having been intruded at a later date than that during which the regional metamorphism took place, or to serpentinisation having taken place after that period, as the expansion in volume on alteration of the olivine into serpentine might easily cause the masking of any characters imposed upon the mass at an earlier time. If the view of an intrusive peridotite be adopted, we are immediately led, as in the case of the vast majority of chromite occurrences, to the conclusion that the ore deposit is the result of segregation of the chromite from the intruded peridotite, and the examination in the field upholds this, *e.g.*, the apparently elliptical shape of the peridotite mass and the irregular and patchy character of the ore occurrence, near the margin of the intrusion.

The first reference to this chromite deposit appears to be in a report by Koert, dated October, 1907. Several prospecting pits were sunk about that time and samples of the ore sent to Germany for analysis. Much correspondence was carried on regarding the economic possibilities of the ore, but almost nothing else was done as the deposit was not considered worth working.

As regards the economic value of the deposit, the ore is undoubtedly of marketable quality. The German analyses of samples taken from five different prospecting pits in the chromite-bearing area are as follows :

	1	2	3	4	5
$Cr_2 O_3$	37·1	39·3	40·0	41·7	36·4
$Si O_2$	8·7	5·6	3·7	1·8	6·9
$Mg O$	19·7	19·6	19·1	21·0	20·8
$Al_2 O_3$	18·9	19·6	22·9	22·6	23·7
$Fe O$	14·9	14·9	13·5	12·2	11·8
$Ni O$	0·7	0·8	0·5	0·6	0·4
$S O_3$	trace.	0·04	0·04	0·07	0·07
$P_2 O_5$	trace.	trace.	trace.	trace.	trace.

These analyses show the ore to be suitable for use in the iron and steel trade, though probably not of sufficiently good quality for manufacture of chemicals.

[86], [87] Further details about the rocks numbered thus are given in Appendix I.

Nothing can be said about the quantity of ore procurable. Small prospecting pits are not likely to give very much information in proportion to the time and labour spent on them. Boring is more efficient, though even this method is not wholly satisfactory for such types of deposits.

In connection with the prospects of this ore, the possible development of the Banyeli iron ore, North of Bassari, in the future is noteworthy. A source of chromium near at hand, even if not of the first quality, would be an appreciable asset in such circumstances. A little gold was found on panning the stream draining North Eastwards from the deposit, but not enough to be of any value. No trace of platinum was found.

Transport would not be easy between Dadja and Djeti without some little attention to roads. The road to Dadja is only a bush-path, and much of it through rough country. Two considerable rivers, the Amu and the Amukpa, each over 50 feet in width, have to be crossed. The Amukpa has no bridge, the Amu merely a native foot-bridge.

It is not worth while examining the Djeti deposit in more detail at present. The small total size of the intrusion makes a large chromite segregation improbable. If the Banyeli iron ore is exploited, it might be advisable to test the Djeti area further.

ACKNOWLEDGMENTS.

This report would not be complete without an acknowledgment of the debt which the writer owes to Mr. A. E. Kitson, C.B.E., under whose direction the work was done. His kind and willingly given help on all needful occasions, not only in connection with the business of the tour, but in many other and more personal matters as well, and his wise criticism and counsel, make this debt greater than can well be put into words.

For facilities granted and assistance given in connection with the work in Togoland the writer wishes to express indebtedness to Major Rew, Officer in Command of the British Forces, and also to Mr. H. S. Newlands at Lome, to Captain Mansfield at Misahöhe, to Mr. R. S. Rattray, M.B.E., at Kete-Krachi and later at Misahöhe, to Mr. R. Brace Hall at Kete-Krachi, and to Mr. Castellain at Yendi.

APPENDIX I.

The following notes upon the rocks mentioned in the Report do not claim to be detailed descriptions, but they will give some idea of the types which were met with :—

(1) P. 11. *Muscovite and Biotite Gneiss.*—Large rounded crystals, up to half-an-inch in diameter, of fairly fresh acid plagioclase, surrounded by sheared granular quartz, acid plagioclase, and muscovite and biotite, with subordinate epidote. The whole rock is much sheared.

(2) P. 11. *Pyroxenite.*—A holocrystalline aggregate of diallage and hypersthene in roughly equal proportions. Both constituents are nearly fresh. The diallage individuals are up to half-an-inch in length. The hypersthene crystals are rather smaller, and hypidiomorphic in many cases.

(3) P. 12. *Quartz Mica Norite.*—A medium-grained rock of granitic structure, consisting of plagioclase (labradorite), with hypersthene, augite, biotite and quartz. About half the rock is plagioclase, with pyroxene, biotite and quartz making up the other half in approximately equal quantities, the pyroxene predominating.

(4) P. 12. *Muscovite and Biotite Gneiss.*—A holocrystalline aggregate of orthoclase, muscovite and biotite. The orthoclase has numerous small inclusions, and is in individuals up to about 10 mm. in diameter. The muscovite and biotite are intimately intergrown. They are accompanied by much calcite. No quartz is to be seen.

(5) P. 12. *Epidote Biotite Gneiss.*—A rock very like (4), but with epidote in small laths, taking the place of the muscovite. There is much more biotite than in (4).

(6) P. 12. *Hornblende-Schist.*—A dark green schist consisting of hornblende in crystals up to 12 mm. or more in length, accompanied by some chlorite.

(7) P. 12. *Eclogite, or Garnet-Amphibolite.*—Large crystals of pale green hornblende and of epidote, up to 15 mm. in length, in a ground-mass of small hornblende and garnet crystals, the whole somewhat sheared. The epidote crystals enclose small rutiles and garnets.

(8) P. 12. *Eclogite.* A coarse-grained holocrystalline aggregate of green hornblende, zoisite, diopside and garnet. The zoisite is in large lath-shaped crystals. The hornblende and diopside show no definite form and are somewhat decomposed. No quartz is to be seen in this specimen.

(9) P. 12. *Eclogite.*—Similar to (7) and (8), composed of green hornblende, in individuals of all sizes, and garnet. There is also a little diopside and calcite. No quartz is to be seen.

(10) P. 12. *Muscovite and Biotite Schist.*—A finely granular crystalline aggregate of quartz and orthoclase, with much muscovite and brown biotite, and subordinate epidote. The micas show distinct directional arrangement in thin section.

(11) P. 13. *Hornblende-Schist.*—The chief constituent is a green hornblende in elongated crystals up to 10 mm. in length, and showing distinct directional arrangement. Orthoclase is subordinate, in crystals which are sheared round the edges. Quartz occurs interstitially.

(12) P. 13. *Epidote-Schist.*—A well-foliated rock, medium to fine-grained, containing hornblende, quartz, epidote, muscovite, biotite and orthoclase, intimately mixed. All the constituents are elongated along the foliation-planes.

(13) P. 13. *Biotite-Gneiss.*—A medium-grained holocrystalline aggregate of quartz, an acid plagioclase, and green biotite, with some titanite. In places it contains a good deal of epidote. Not much trace of shearing is seen in thin section.

(14) P. 13. *Biotite-Gneiss.*—This rock contains large individuals of plagioclase (albite or albite-oligoclase) up to half-an-inch in diameter, without crystal outlines, along with which is subordinate quartz showing mortar-structure. Biotite and epidote are subordinate. Some orthite is also present.

(15) P. 13. *Biotite-Gneiss.*—A holocrystalline aggregate of quartz, felspar and green biotite, with varying amounts of epidote. The felspar is chiefly altered plagioclase. A little orthite also occurs.

(16) P. 13. *Garnetiferous Hypersthene-Gneiss.* A sheared aggregate of quartz, felspar and hypersthene. This last has in most cases a kelyphitic border. The felspar is an intermediate plagioclase. At other places the quartz and garnet are absent, or only one of them appears, whilst green hornblende is present in some cases.

(17) P. 13. *Biotite-Gneiss.*—A moderately fine-grained rock consisting of highly altered plagioclase (probably oligoclase) with much green biotite, a little muscovite, and a good deal of titanite and epidote. Quartz is subordinate. No distinct banding is shown in thin section.

(18) P. 13. *Biotite-Gneiss.*—A sheared crystalline aggregate of acid plagioclase and greenish-brown biotite, with subordinate quartz, epidote and titanite. Very like (17), but coarser grained.

(19) P. 13. *Pyroxenite.*—Very like (2). The proportion of orthorhombic to monoclinic pyroxene varies greatly.

(20) P. 14. *Ilmenite.*—Irregular brecciated masses of ilmenite in much sheared quartz. There is much sericite along with the quartz. The ilmenite encloses numerous tiny crystals of pyroxene.

(21) P. 14. *Biotite-Gneiss.*—Very like (18), but coarser in grain.

(22) P. 14. *Tremolite-Gneiss.*—An irregular sheared aggregate of plagioclase (albite to oligoclase) in individuals up to 8 mm. in diameter, with quartz and subordinate tremolite and sericite.

(23) P. 14. *Amphibolite.*—An irregular aggregate of green hornblende and epidote, together with a little augite and titanite. There is a good deal of iron ore. Hornblende forms over 80 per cent. of the rock.

(24) P. 14. *Biotite- and Hornblende-Gneiss.* Very like (18) and (21). In some places the chief ferromagnesian mineral is hornblende.

(25) P. 14. *Zoisite-Schist.*—Elongated crystals of zoisite and green hornblende surrounding eyes of felspar (probably an intermediate plagioclase). The hornblende and zoisite crystals all lie in one direction.

(26) P. 14. *Muscovite and Biotite Gneiss.* A medium-grained granitic aggregate of quartz, felspar (chiefly albite-oligoclase) and mica. The rock is somewhat sheared. Both muscovite and biotite are present in fair quantity.

(27) P. 14. *Muscovite and Biotite Gneiss.* A medium-grained rock, consisting of individuals of plagioclase (albite to oligoclase) up to 10 mm. in diameter, in a mass of smaller grains of felspar, quartz, biotite and muscovite. There are numerous small garnets scattered through the rock.

(28) P. 15. *Limonitic Breccia.* White quartz and quartzite fragments cemented by ferruginous material.

(29) P. 15. *Biotite-Gneiss.*—A coarse-grained granitic aggregate of altered plagioclase, orthoclase, quartz, and green biotite. This last is intergrown with a good deal of epidote.

(30) P. 16. *Biotite-Gneiss.* A granitic aggregate of quartz, highly-altered plagioclase, fresh microcline, and green biotite. In some places there is a fair amount of titanite.

(31) P. 16. *Limonitic Breccia.*—Similar to (28).

(32) P. 16. *Hornblende-Gneiss.*—A coarse-grained granitic aggregate of felspar, quartz, hornblende and muscovite. The felspar is almost completely altered and the hornblende is bleached except in the centres of the crystals. Some parts show a good deal of fresh microcline. There is a good deal of epidote.

(33) P. 16. *Gabbro.*—A medium-grained aggregate of plagioclase and augite, with much iron ore. The felspar is mainly in lath-shaped crystals. The rock is much altered.

(34) P. 17. *Muscovite and Biotite Gneiss.*—Similar to (4). Some of the calcite is full of tiny rutile crystals.

(35) P. 17. *Biotite-Gneiss.*—A granitic aggregate of felspar (probably plagioclase) with green biotite and some augite. There is much secondary hornblende and some quartz. The felspar and augite are much altered. Possibly the rock was a biotite gabbro originally.

(36) P. 17. *Hornblende-Lamprophyre.*—A fine-grained dyke-rock consisting chiefly of green hornblende and brown biotite, with much iron ore. Felspar is subordinate and most of it seems to be plagioclase.

(37) P. 17. *Biotite-Gneiss.*—A coarse-grained granitic aggregate of quartz, and an intermediate plagioclase, with subordinate brown biotite. The rock does not appear much sheared and the constituents are fresh.

(38) P. 17. *Gabbro.*—Similar to (33). The plagioclase is much altered, and the augite (a titaniferous variety) is to a great extent altered to dark brown hornblende.

(39) P. 19. *Mica-Schist.*—A mosaic of highly-sheared and crushed grains of quartz, with aggregates and veins of fine sericite and chlorite scattered through it.

(40) P. 20. *Siliceous Laterite.*—A porous rock consisting of quartz grains in a matrix of yellow to brown ferruginous cement. Incipient formation of pisolites is seen here and there. Most of the quartz grains appear angular, but some look rounded, as if they had partially gone into solution.

(41) P. 21. *Gabbro.*—A highly-altered coarsely crystalline granitic aggregate of diallage and felspar, the individuals being up to about 8 mm. in diameter. The felspar is nearly all quite altered to saussurite, veined with chlorite. The pyroxene is mostly altered to chlorite, the decomposition taking place initially along the cleavage planes and resulting in fragments of unaltered mineral in a matrix of chlorite. A very little iron ore is also present.

(42) P. 21. *Dolerite.*—A medium-grained rock with ophitic structure, consisting originally of augite and felspar, with possibly olivine. The augite is still fresh, the felspar completely decomposed. The augite is frequently sub-idiomorphic, and large composite augite crystals contain up to half their volume of small felspar laths arranged longitudinally. The chilled edge shows irregular sheaves of augite microlites, in a crypto-crystalline groundmass containing a few felspar microlites.

(43) P. 23. *Serpentine.*—Patches of fibrous serpentine, with veins of similar material through and around them. The long fibres are much bent and twisted, and the direction of length of the fibres in the veinlets is perpendicular to the length of the veinlets themselves.

(44) P. 24. *Sandstone.*—Angular to rounded grains of quartz, with a good deal of felspar in similar and smaller grains. The rock is slightly sheared, and has much micaceous material throughout it. It may be a sandy tuff.

(45) P. 26. *Basalt.*—A highly-altered basic volcanic rock full of calcite amygdules. Some of the calcite seems to replace felspar phenocrysts. There are also a few fairly fresh augite crystals. The ground-mass is very fine-grained, and composed of the same minerals, with abundant iron ore.

(46) P. 27. *Felspathic Sandstone.*—A dark fine-grained aggregate of angular grains, more than half of them felspar in various stages of decomposition. Clear quartz grains make up most of the remainder, with a good deal of chloritic material and some mica.

(47) P. 27. *Basalt.*—All the specimens examined are porphyritic basalts, many of them highly altered. In some the augite phenocrysts are fresh and those of felspar quite altered. In others the felspar is fresh and is labradorite. Zonal banding is seen in the felspar. The ground-mass is a fine-grained aggregate of felspar laths with iron ore, and much calcite and chlorite.

(48) P. 27. *Crystalline Limestone.*—Calcite in a fine-grained mosaic with veins of coarser-grained calcite traversing it.

(49) P. 28. *Basalt.*—Completely altered augite and perhaps olivine phenocrysts in a dark base containing felspar microlites. There are calcite and chalcedony amygdules.

(50) P. 28. *Dolerite.*—Augite prisms and dusty felspar laths in a dark crystalline ground-mass of similar material, with much iron ore.

(51) P. 28. *Basalt.*—Similar to (49), but somewhat more altered.

(52) P. 28. *Chalcedony.*—An irregular aggregate of chalcedony and quartz, with numerous specks of hematite throughout it.

(53) P. 29. *Chalcedony.*—Similar to (52), but darker and very patchy in appearance.

(54) P. 29. *Basalt.*—A fine-grained aggregate of augite, felspar and iron ore. The felspar is chiefly in laths, the augite in fairly well-developed crystals.

(55) P. 29. *Basaltic Tuff.*—Small angular fragments of basalt, together with broken crystals of augite in a decomposed ground-mass. There is much chlorite and calcite, often in spherules.

(56) P. 30. *Dolerite.*—A medium-grained basic rock, the chief constituent being fresh brown augite accompanied by altered felspar. There are small patches of serpentine throughout the rock, possibly after olivine.

(57) P. 30. *Basalt.*—A much decomposed rock, the only fresh constituent being felspar in small laths in a decomposed ground-mass with much chlorite and calcite.

(58) P. 30. *Rhyolite.*—Sheaves of felspar microlites, with intergrown quartz, and in some places a yellow crypto-crystalline ground-mass, possibly devitrified glass. There are numerous orthoclase and plagioclase phenocrysts, and much quartz.

(59) P. 31. *Dolerite.*—A fairly coarse-grained much altered rock consisting of large decomposed felspar laths in a ground-mass of small fresh augite crystals, felspar and magnetite. Patches of serpentine may represent original olivine.

(60) P. 31. *Basalt.*—The chief constituents are plagioclase and magnetite. The plagioclase is in laths, with variolitic structure, in a decomposed chloritic base. The magnetite is in grains throughout the rock.

(61) P. 31. *Rhyolite.*—Probably a devitrified glass, light coloured and crypto-crystalline in structure, with very numerous perlitic cracks. It is microspherulitic in structure in some parts.

(62) P. 31. *Basaltic Tuff.*—Similar to (55).

(63) P. 31. *Basalt.*—Small well-developed crystals of augite and plagioclase felspar in a fine-grained brown base—possibly devitrified glass. The augite is fairly fresh, but the plagioclase is a good deal altered. There is much iron ore.

(64) P. 31. *Basalt.*—Much decomposed and very like (57), with numerous calcite amygdules.

(65) P. 31. *Dolerite.*—A much-altered, fairly coarse-grained rock. The only fresh mineral is plagioclase. This is in large and small laths, with much interstitial chlorite and calcite, and a good deal of magnetite. There may have been olivine in the fresh rock.

(66) P. 31. *Basalt.*—A fine-grained apparently holocrystalline basic igneous rock, with variolitic structure. The main constituents are plagioclase laths in sheaves and bunches, and much magnetite in small crystals and specks. No fresh ferromagnesian mineral is to be seen. There is much calcite, interstitial and also in blebs. In some places the rock is much coarser in grain.

(67) P. 32. *Basalt.* Decomposed, quite like (66). One section shows variolitic structure on quite a large scale.

(68) P. 32. *Basalt.* An altered rock showing large, well-formed phenocrysts of augite, felspar and olivine, in a holocrystalline base of augite and felspar, with much magnetite. The ground-mass is fairly fresh, but the olivine and felspar of the phenocrysts are completely altered.

(69) P. 32. *Basalt.*—A medium to fine-grained rock, consisting of felspar laths in a completely altered dark ground-mass, which was probably holocrystalline. There is much calcite in the ground-mass and a fair amount of magnetite.

(70) P. 32. *Basalt.*—A fine-grained lava, consisting of small felspar laths in a matrix full of felspar microlites, with directional arrangement showing flow structure. The rock has numerous small amygdules of chlorite and of secondary quartz.

(71) P. 33. *Trachyte.*—Well-formed phenocrysts of felspar, chiefly orthoclase, in a finely crystalline felspathic ground-mass. There is some serpentinous material associated with the phenocrysts.

(72) P. 33. *Trachyte.*—The rock is in most cases somewhat decomposed, with secondary quartz, chalcedony, and chlorite. There are also phenocrysts of a pale augite. Plagioclase is the dominant felspar in some cases.

(73) P. 34. *Granite.*—A crushed rock, coarse in grain, consisting of quartz, felspar (chiefly microcline), and a little biotite—all much broken.

(74) P. 35. *Laterite.*—A very ferruginous rock, composed of angular quartz grains of various sizes enclosed in a red opaque matrix. The rock is very porous and the sand grains are collected into spheroidal nodules of a quarter to half-an-inch in diameter.

(75) P. 35. *Arkose.*—A rock consisting of angular fragments of quartz, felspar, biotite and chlorite, with a little augite, in a very fine base of similar material. The felspar seems the most abundant constituent and is in many cases fresh.

(76) P. 35. *Limestone.*—An impure crystalline limestone with many small quartz, chlorite, and sericite fragments. The calcite forms shadow crystals, throughout which are scattered the other constituents.

(77) P. 35. *Limestone.*—Similar to (76), but much purer, with only a few quartz and muscovite particles. The slide is full of calcareous sponge spicules.

(78) P. 36. *White Earth.*—A very fine-grained compact, absorbent earth. In powder it shows minute grains of crystalline material with low double refraction. The refractive index of most of the particles is about 1·53. It may possibly be composed of very fine felspar particles for the most part.

(79) P. 36. *Arkose.*—A rock similar to (75), with a fair amount of calcite in it.

(80) P. 40. *Pisolitic Bauxite.*—In the pisolitic varieties, pisolites up to a quarter of an inch in diameter compose most of the rock. They are nearly opaque, dark red in colour, and have septarian structure. Frequently in the centre of a pisolite there are light-coloured patches of isotropic material, which in some cases seems by its form to have replaced angular grains, possibly of quartz. Round the pisolite centre are concentric layers of dark brown bauxite. In the spaces between the large pisolites are numerous small ones composed of light-coloured cryptocrystalline gibbsite. The interstitial matter is partly colourless gibbsite and partly limonitic material.

(81) P. 42. *Marble.*—A granular aggregate of clear non-interlocking crystals of calcite, averaging 6mm. to 8 mm. in diameter. No other mineral is to be seen in thin section.

(82) P. 43. *Marble.*—Similar to (81), but with a large amount of tremolite scattered throughout it in fairly well-developed crystals.

(83) P. 43. *Hornblende-Schist.*—A medium-grained schistose rock. The chief constituent is green hornblende in sub-idiomorphic crystals up to 10 mm. in length, all arranged in one direction. The other principal constituent is fresh labradorite, which fills up the spaces between the hornblende crystals. There is a fair amount of epidote present.

(84) P. 43. *Biotite-Gneiss.*—A medium-grained aggregate of plagioclase (about oligoclase) quartz and brown biotite, with a little muscovite. The micas are arranged chiefly in one direction. The rock is much sheared.

(85) P. 43. *Serpentine.*—An intimate mixture of serpentine and talc, with a little chlorite. A fair amount of very fine powdery chromite is scattered throughout the rock, some of it in elongated particles along the talc cleavage planes.

(86) P. 44. *Chromite in Chlorite.*—A fibrous matting of clinochlore with individuals up to 2 mm. in length. With this is mixed a large amount of chromite in crystals and crystal fragments. The crystals are much broken, the cracks being filled with chlorite. Much of the chlorite is a chrome bearing variety.

(87) P. 44. *Actinolite Schist.*—This rock consists almost entirely of sheaves of actinolite crystals, with a very little clear interstitial quartz.

APPENDIX II.

ROCK ANALYSES.

(*a*) P. 20.—Schist exposed in the bed of the Gajale River, west of Chirina:

Gold	5·2 dwts. per ton of 2,240 lbs.
Silver	10·8 „ „ „ „ „ „

(*b*) P. 32.—Argillaceous limestone in the bed of a tributary of the Ataulo River, between Kpandu and Dukluja:

SiO_2	41·73 per cent.
TiO_2	·87 „ „
Al_2O_3	9·09 „ „
Fe_2O_3	6·24 „ „
CaO	19·34 „ „
MgO	1·59 „ „
P_2O_5	·26 „ „
CO_2	14·15 „ „
H_2O	3·97 „ „
	97·24 „ „

Alkalies, &c., not determined.

(*c*) P. 32. Conglomerate bed outcropping on the road between Dukluja and Abessia:

Gold	*nil.*
Silver	3·2 dwts. per ton of 2,240 lbs.

(*d*) P. 35. Bedded clay at Batia, north of Yendi:

SiO_2	64·77 per cent.
TiO_2	·72 „ „
Al_2O_3	14·92 „ „
Fe_2O_3	5·22 „ „
FeO	·27 „ „
CaO	·56 „ „
MgO	1·65 „ „
Na_2O	1·30 „ „
K_2O	2·73 „ „
H_2O-	3·61 „ „
H_2O+	4·64 „ „
	100·39 „ „

P_2O_5, MnO, &c., not determined.

(*e*) P. 35.—Argillaceous limestone, Tanja River, north-east of Wapuli:

SiO_2	44·01 per cent.
TiO_2	·40 „ „
Al_2O_3	12·30 „ „
Fe_2O_3	3·55 „ „
CaO	17·31 „ „
MgO	1·39 „ „
P_2O_5	·15 „ „
CO_2	12·96 „ „
H_2O	3·50 „ „
	95·57 „ „

Alkalies, &c., not determined.

(*f*) P. 35.—Limestone from the Tupe River on the road from Nafekele to Gujoni:

SiO_2	34·73 per cent.
TiO_2	·26 „ „
Al_2O_3	7·52 „ „
Fe_2O_3	1·87 „ „
CaO	27·32 „ „
MgO	1·05 „ „
P_2O_5	·35 „ „
CO_2	21·23 „ „
H_2O	2·60 „ „
	96·93 „ „

Alkalies, &c., not determined.

(*g*) P. 36.—White to yellow earth, Jankpima, near Demong:

SiO_2	69·13	per cent.
TiO_2	·20	„ „
Al_2O_3	17·34	„ „
Fe_2O_3	1·02	„ „
FeO	·12	„ „
CaO	·17	„ „
MgO	·49	„ „
Na_2O	4·00	„ „
K_2O	3·02	„ „
P_2O_5	·02	„ „
MnO	·03	„ „
$H_2O - 110°$	·98	„ „
$H_2O + 110°$	2·95	„ „
CO_2	*nil.*	
BaO	·24	„ „
S	·03	„ „
Cl	trace	
	99·74	„ „

(*h*) P. 40.—Laterite between Tolo and Bismarckburg, Adele Highlands:

SiO_2	31·15	per cent.
TiO_2	·68	„ „
Al_2O_3	19·61	„ „
Fe_2O_3	35·18	„ „
CaO	·21	„ „
H_2O	13·20	„ „
	100·03	„ „

(*i*) P. 41.—Laterite, between Bismarckburg and Kejenke:

SiO_2	27·35	per cent.
TiO_2	·67	„ „
Al_2O_3	20·25	„ „
Fe_2O_3	38·00	„ „
CaO	·20	„ „
H_2O	13·52	„ „
	99·99	„ „

(*j*) P. 42.—Ironstone. A heavy piece from lateritic earth north of Akpafu

SiO_2	19·12	per cent.
Al_2O_3	1·96	„ „
Fe	47·83	„ „
Mn	·05	„ „
CaO	trace	
P	·04	„ „
S	·05	„ „

A small but appreciable amount of Chromium is also present.

(*k*) P. 42.—A specimen of iron ore found on the opposite side of the valley, a short distance to the east of the workings gave the following on analysis:

SiO_2	45·81	per cent.
Al_2O_3	2·00	„ „
Fe	35·68	„ „
Mn	*nil.*	
CaO	trace	
P	trace	
S	trace	

A small but appreciable amount of Chromium is also present.

(*l*) P. 42.—Marble from the bed of the Chra River, 12 miles south-west of Glei:

SiO_2	1·03	per cent.
TiO_2	·01	„ „
Al_2O_3	·55	„ „
Fe_2O_3	·09	„ „
CaO	30·94	„ „
MgO	20·95	„ „
P_2O_5	·04	„ „
CO_2	46·24	„ „
H_2O	·65	„ „
	100·50	„ „

The above analyses, excluding the gold and silver assays, are by Dr. H. F. Harwood, of the Royal College of Science, South Kensington.

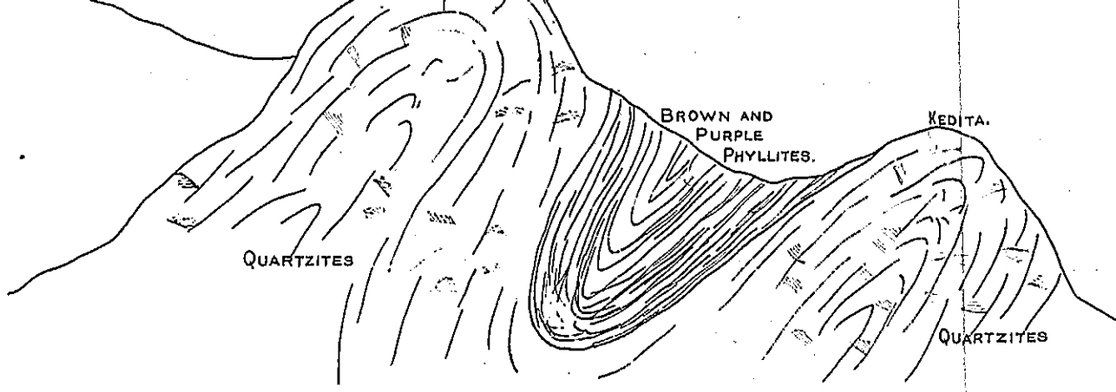


FIG. 1. GEMI LOOKING SOUTH

ABOUT ¼ MILE.

S

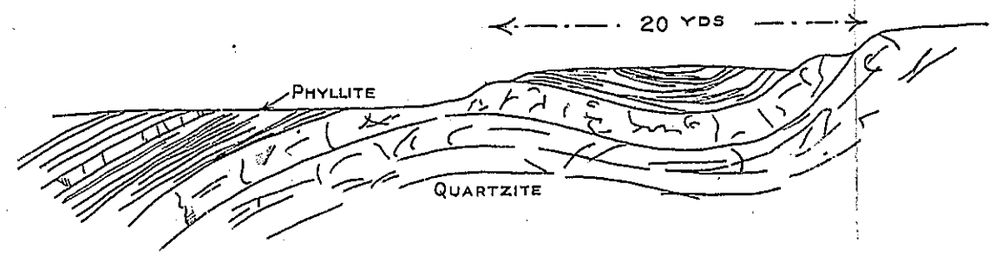


FIG. 2. SECTION ALONG BED OF DAYI RIVER, W OF BASAGBE. LOOKING WEST.

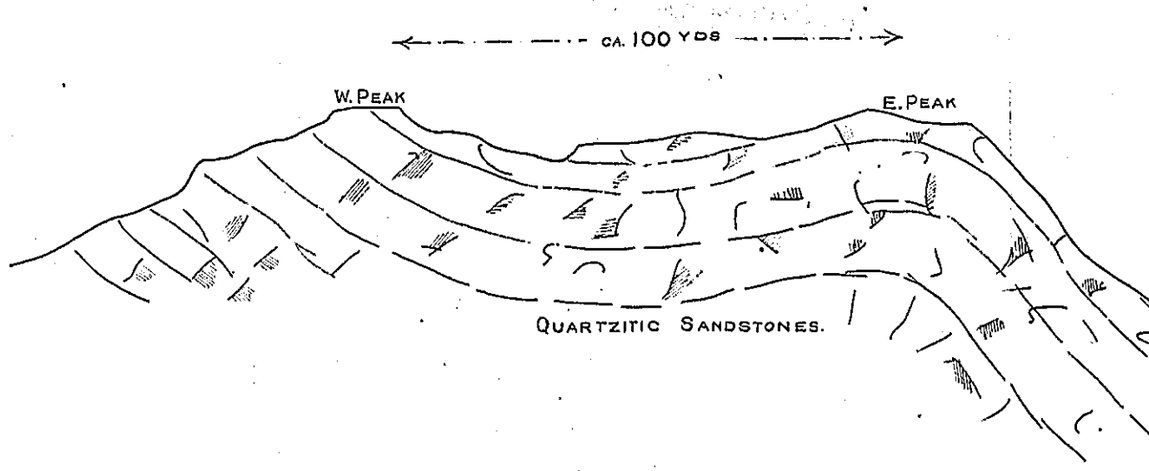


FIG. 3. ATILAKUSE HILL LOOKING N.

DIAGRAMMATIC SECTIONS ILLUSTRATING THE STRUCTURE

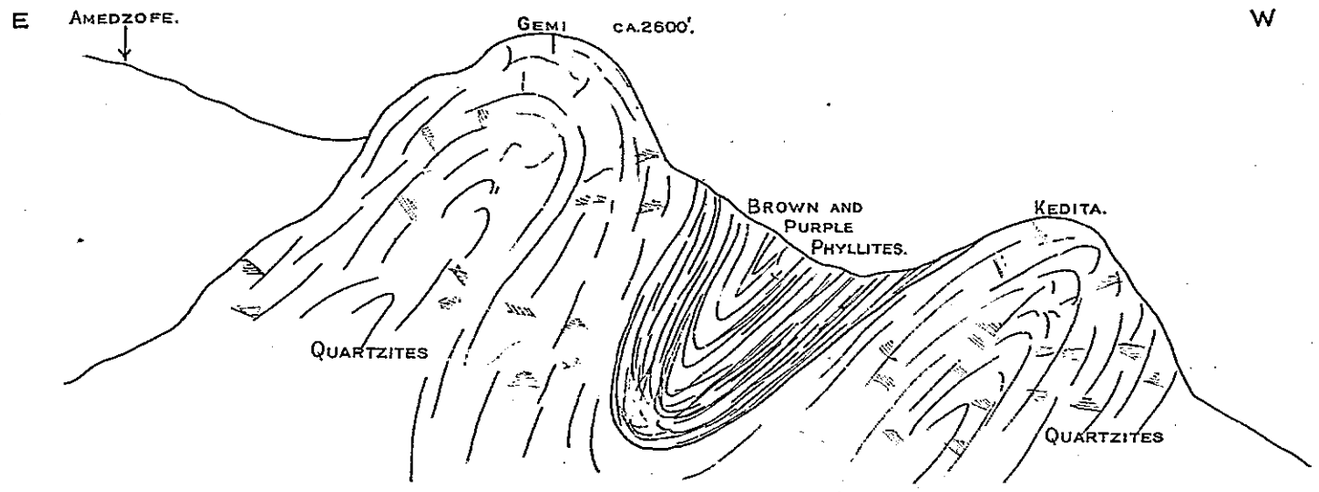


FIG. 1. GEMI LOOKING SOUTH

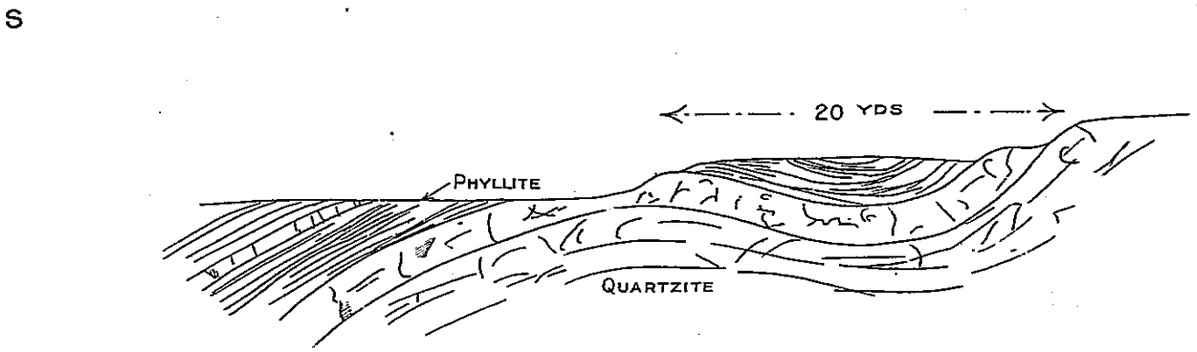


FIG. 2. SECTION ALONG BED OF DAYI RIVER, W OF BASAGBE. LOOKING WEST.

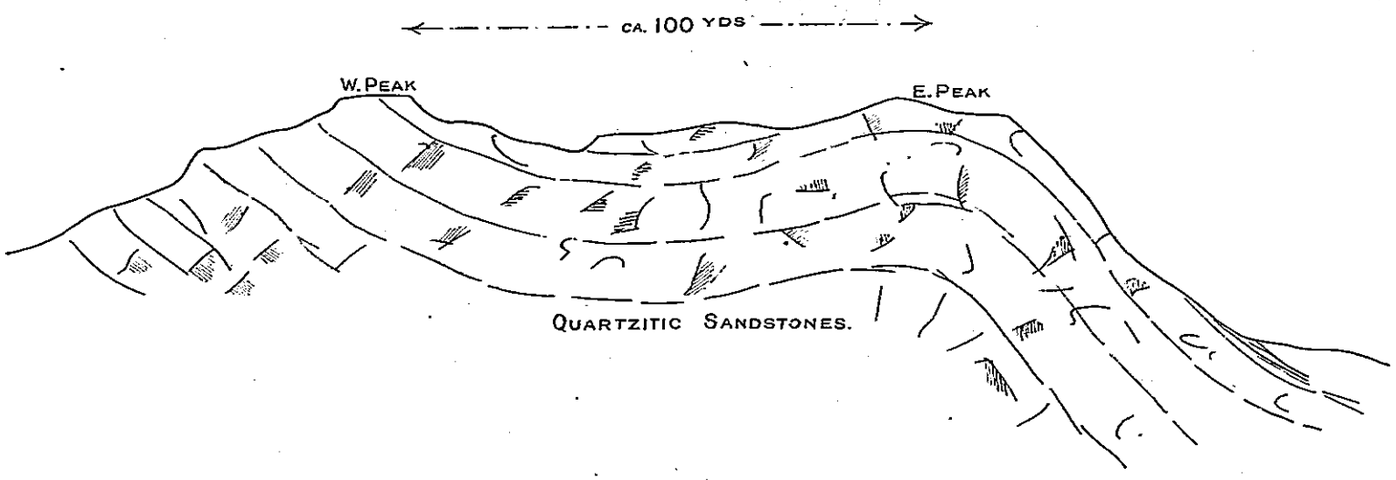


FIG. 3. ATILAKUSE HILL LOOKING N.

DIAGRAMMATIC
SECTIONS ILLUSTRATING THE STRUCTURE
OF THE TOGO RANGE.

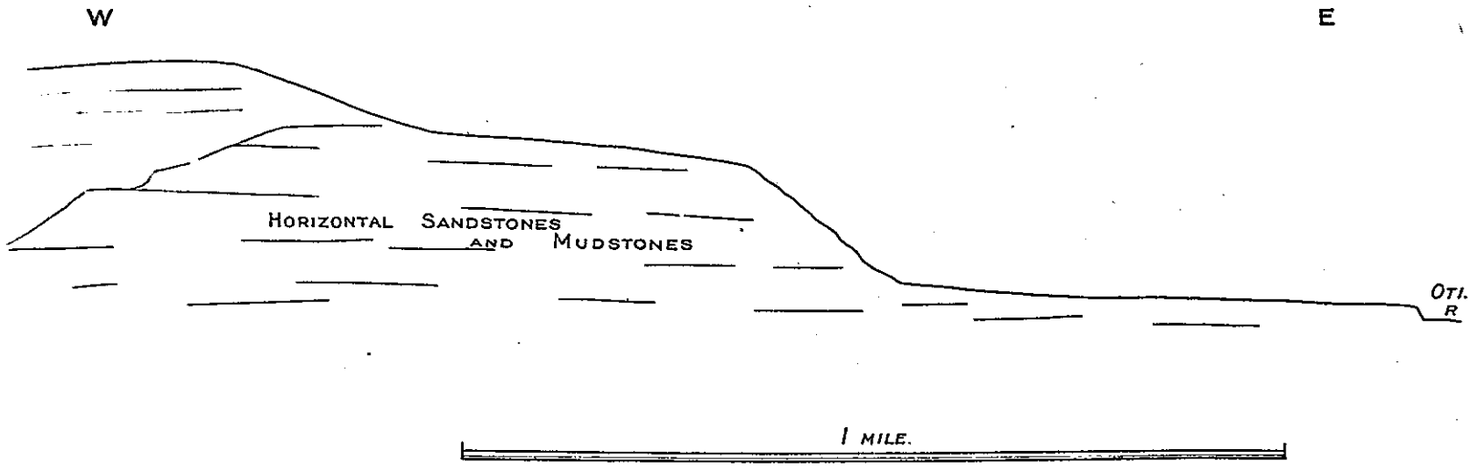


FIG. 4. DIAGRAMMATIC VIEW OF OTI TERRACES. N OF KPETSU, LOOKING NORTH.

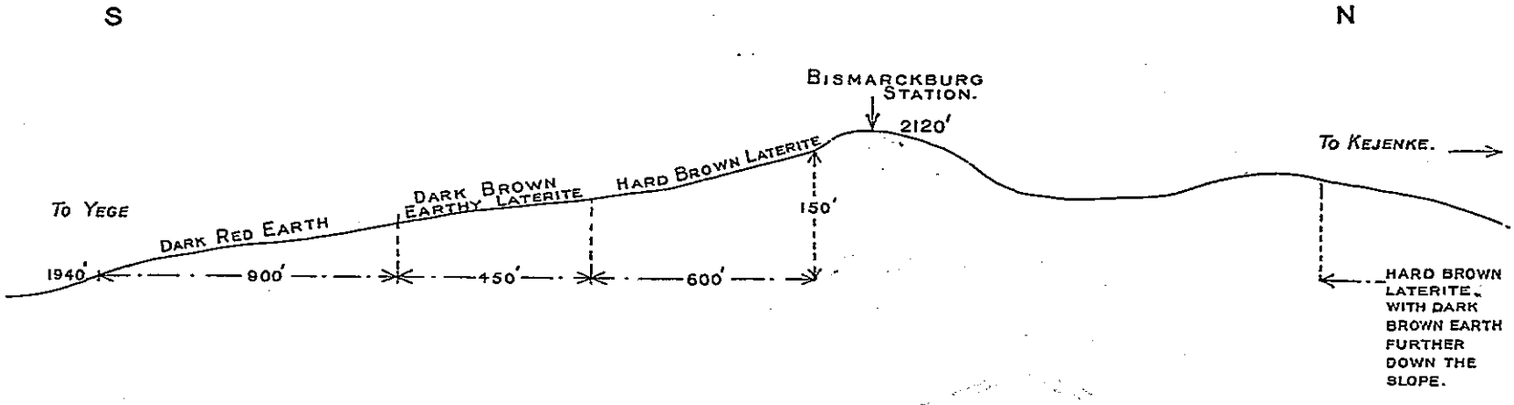


FIG. 5. SECTION THROUGH BISMARCKBURG TO SHOW LATERITIC DEPOSITS, LOOKING WEST.

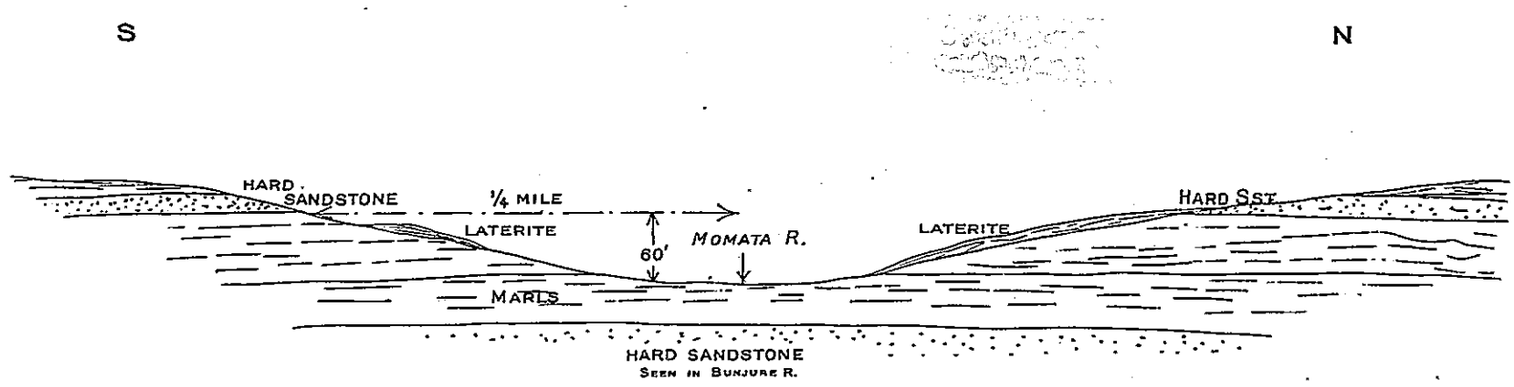


FIG. 6. SECTION ALONG THE KRACHI-YENDI ROAD AT MOMATA RIVER, LOOKING WEST.

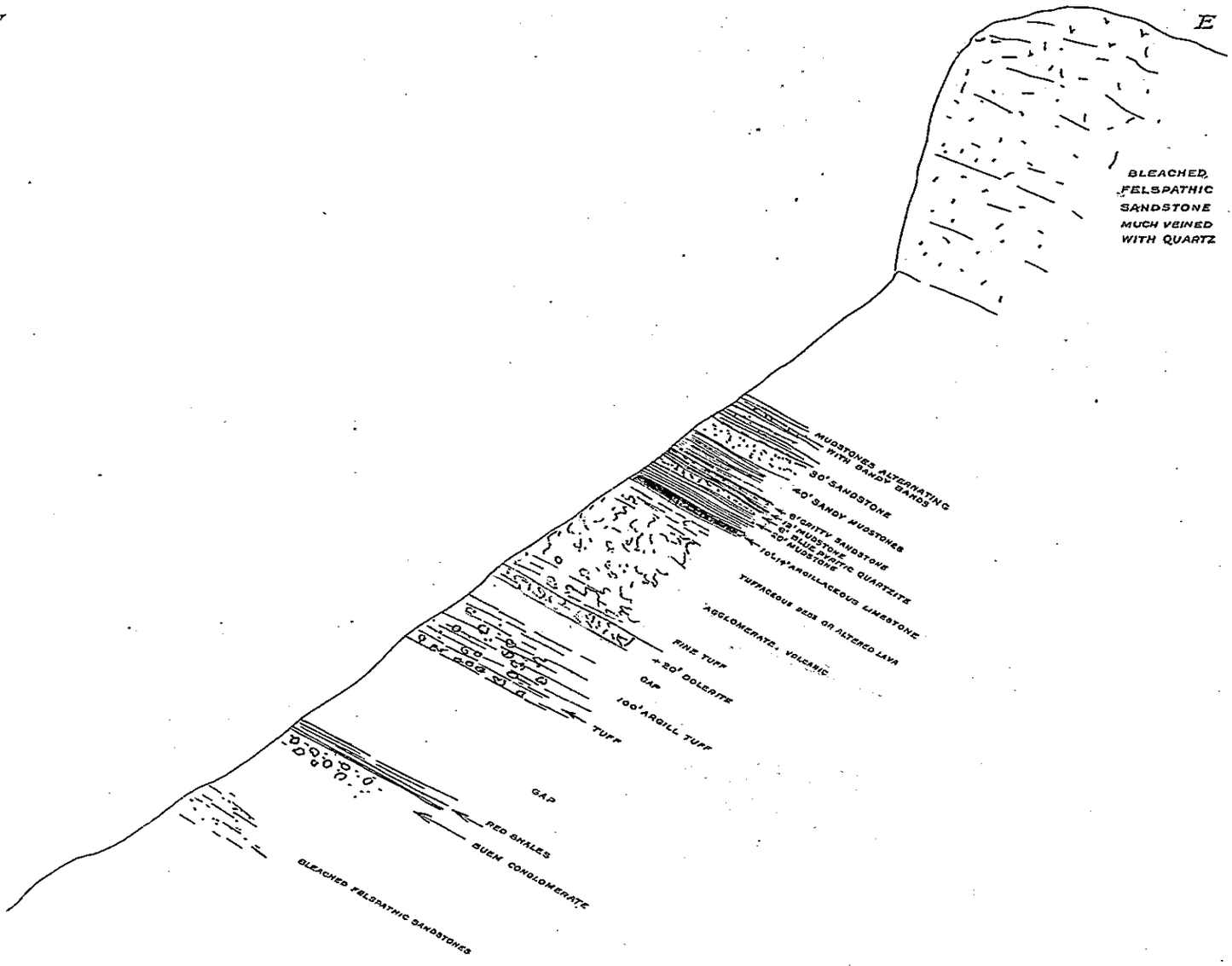


FIG. 7. SECTION BELOW NKUNYA SCARP, WURUPONG.

LOOKING NORTH.

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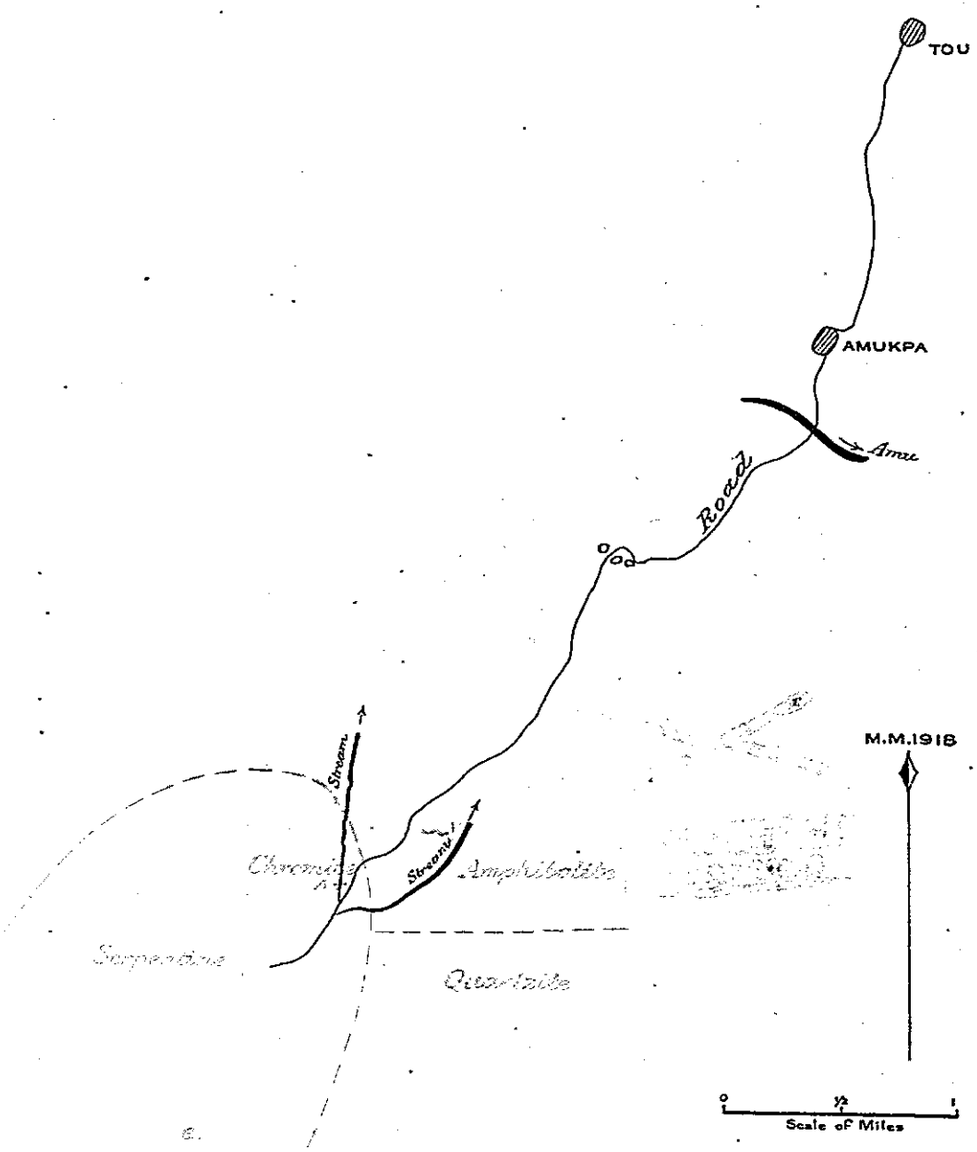


PLAN OF THE

FIG. 8. DJETI CHROMITE DEPOSIT.

WATERLOW & SONS LIMITED LONDON WALL, LONDON.

MAP I.

WESTERN TOGOLAND

SHOWING ROUTES TRAVERSED
BY
MR THOMAS ROBERTSON, B. Sc.

Scale 1: 1,000,000.

10 5 0 10 20
MILES

ROUTES:-
RAILWAYS:-

0° 1°E

N10° 10° N

9° 9°

8° 8°

7° 7°

TERRITORIES

NORTHERN

ASHANTI

COLONY

YENDI
BIMBILA
TUTUKPENE
BISMARCKBURG
KETE KRACHI
WORAWORA
ATAKPAME
GLEI
AKPAFU
WURUPONG
GUDAVE
KPANDU
MISAHOHE
PALIME
AMEDZOFE
AGU

Oti
Tupe
Daka
Volta
Bassa
Asuokoko
Menu
Amu
Monu
Obosum
Dayi
Haho
Chra
Shio

Scale 1: 1,000,000.

10 5 0 10 20
MILES

ROUTES:-

RAILWAYS:-

NORTHERN TERRITORIES

ASHANTI

GOLD COAST COLONY

GOLD COAST COLONY

YENDI

BIMBILA

Daka

Daka

Oti

Oti

Volta

Volta

TUTUKPENE

BISMARCKBURG

KETE KRACHI

Asuokoko

Menu

WORAWORA

ATAKPAME

Amu

Amu

Monu

GLEI

AKPAFU

Obosum

WURUPONG

GUDAVE

Chra

Dayi

Haho

KPANDU

MISAHOHE

PALIME

AMEDZOFE

AGU

Shio

KPEVE

HO

Afram

Volta

Dsawoe

Todshi

Kalagba

Shio

Haho

KPONG

LOME

GULF OF GUINEA

T.R. 1920.

9°

8°

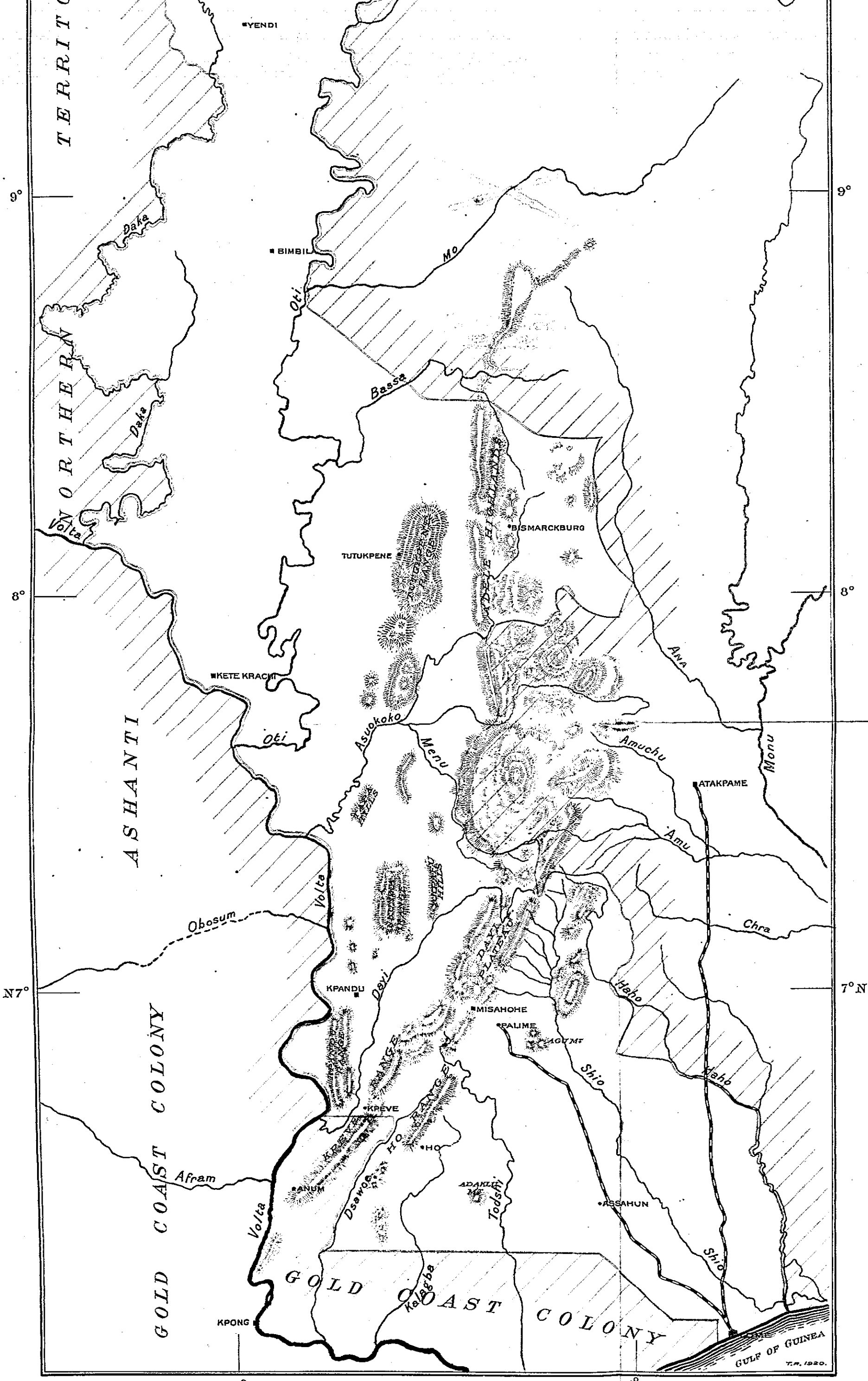
7°

6°N

0°

E

Waterlow & Sons Limited, London Wall, London.



Waterlow & Sons Limited, London Wall, London

0° 1°E

WESTERN TOGOLAND

TOPOGRAPHICAL

Scale = 1: 1,000,000

20 5 0 10 20 MILES.

RAILWAYS:-

N10° 10°N

9° 9°

8° 8°

N7° 7°N

NORTHERN TERRITORIES

ASHANTI

COLONY

Tuppe

Oti

Kara

Lake

YENDI

Daka

Daka

Daka

Volta

BIMBIL

Oti

Mo

Bassa

TUTUKPENE

DAYI RANGE

DAYI PLATEAU

BISMARCKBURG

KETE KRACHI

Oti

Asuokoko

Menu

Ana

Amuchu

Monu

ATAKPAME

Amu

Chra

Volta

Obosum

KPANDU

Dayi

MISAHOHE

PALIME

AGU MT

Haho

Shio

Haho