GEOLOGICAL SURVEY OF NIGERIA

BULLETIN NO. 23

THE GEOLOGY OF THE COUNTRY AROUND ILESHA

AN EXPLANATION OF SHEET NORTH $\frac{B31}{E2}$ (ILESHA)
WITH 2 MAPS, 21 FIGURES AND 2 PLATES

BY

A. M. J. DE SWARDT, D.Sc.

WITH AN APPENDIX ON
THE SOILS OF THE ILESHA-IKIRUN-EFFON ALAIYE AREA

BY

H. VINE, Ph.D.
DEPARTMENT OF AGRICULTURE

Price : 10s. 6d.

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PREFACE

In 1922, the Geological Survey published Bulletin No. 2 "The Geology of the Western Railway: Section 1 Iddo to Okuku" by Wilson, Bain and Russ. It was intended that this, the first detailed study of the Basement Complex in West Africa, should be followed by further bulletins describing the Basement Complex in the Western Provinces. Economic interest, however, dictated that this plan should not be carried out and it was only after nearly thirty years that the study was resumed. In the interval, the discovery of gold in Ilesha Division and the great development of cocoa as an export crop in that area, made a geological survey advisable to assess the extent and value of the goldfield and to provide a background for the important soil survey now in progress.

An important result of the survey has been the recognition of a close relationship between the amphibolites and the gold deposits. It is to be regretted that the goldfield has not proved as large and profitable as had been hoped, but the work done on it has resulted in the production of a detailed geological map on which may be logically superimposed the results of the soil survey. The work has been carried out under conditions of some difficulty owing to the densely forested character of much of the country.

I am especially indebted to the Inspector-General of Agriculture and Dr. H. Vine for the appendix on soils which gives some indication of the progress being made on important soil surveys being undertaken by the Department of Agriculture with funds allocated by the Nigerian Cocoa Marketing Board. Acknowledgments are also due to the Resident and District Officers of Oyo Province and to many mining operators for facilitating the work of the survey.

R. R. E. JACOBSON,
Director,
Geological Survey of Nigeria.

Kaduna Junction

THE GEOLOGY OF THE COUNTRY AROUND ILESHA

INTRODUCTION

The area described in this Bulletin is covered by the Ilesha Standard Sheet in Oyo and Ondo Provinces, western Nigeria, between latitudes 7° 30′ and 8° N. and longitudes 4° 30′ and 5° E. Alluvial gold was discovered in 1940 around Ilesha and Ife, and up to the present more than 50,000 ounces have been won.

Mapping is difficult owing to scarcity of outcrops and the dense vegetation. The geological map has been compiled by compass traverses along deeply entrenched bush paths. In these, the original structures of the lateritized and weathered rocks are exposed. Most of the outcrops of fresh rock occur along the main stream channels. To the east of Ikirun the porphyritic granite and granite gneisses are well-exposed, but most of the critical contacts are obscured by soil.

PREVIOUS WORK

A strip of country along the Western Railway was mapped in 1919-21 by Wilson, Bain and Russ (1922), who differentiated between the banded gneisses and composite banded gneisses, and considered that the injection of semi-conformable leucocratic veins into the former gave rise to the composite variety. The Ikirun-Ire granitic assemblage was mapped as porphyritic gneissose granite. They did not distinguish, however, between the granite gneiss and coarse porphyritic granite, but noted the presence of a non-porphyritic type between Ikirun and Ire. They also observed that oligoclase predominates along the western margin of the granites, while microcline is the most abundant felspar east of Ire. Leucocratic gneisses and tremolite schists east of Oshogbo were described, and the latter were regarded as metamorphic equivalents of calcareous horizons in the Basement Complex.

ACKNOWLEDGMENTS

The writer is greatly indebted to Professor D. L. Scholtz of Stellenbosch University for guidance during the investigation and to Professor T. W. Gevers for laboratory facilities at the University of the Witwatersrand. Thanks are also due to the Mineral Resources Division of the Directorate of Colonial Geological Surveys for six chemical analyses.

TOPOGRAPHY

The greater part of the Ilesha area forms a gently undulating plain at an average elevation of 1,200 feet above sea level. East of Ilesha the monotony of the plain is broken by conspicuous hills of vein quartz, which, towards the eastern boundary of the map, form persistent strike ridges. To the south-west of Ilesha, particularly in the Isaobi area, massive amphibolites form rounded hills with smooth forested slopes. In the Ikirun-Ire area the granitic rocks give rise to a hilly topography, with numerous smooth exfoliation domes. The Ilesha area is dissected by a fine-textured drainage system, but with the exception of the Oshun River, the streams flow only during the rainy season.

A subdued scarp marks the watershed between the tributaries of the Oshun and Eriperi Rivers and the southward flowing streams, of which the Owena is the most important. During recent periods of erosion, following on the formation of the older laterite, the latter streams have incised their courses considerably and they are gradually encroaching on the Oshun and Eriperi River catchments.

The northern edge of the map coincides roughly with the boundary between the savannah of northern Nigeria and the deciduous forest belt. Although the forest is broken by numerous small farms, the average visibility is seldom more than fifty yards.

THE EROSION SURFACES

Three recent erosion surfaces, referred to as the older, intermediate and younger surfaces respectively, have been recognized. Although the difference in elevation between the older and younger surfaces rarely exceeds 100 feet, they are of considerable interest as they control the distribution of the gold-bearing deposits.

Widely separated relics of the older surface, capped by a thick layer of laterite, are preserved on broad divides overlooking the intermediate surface. They are bounded by small scarps and the slopes below are covered with ironstone rubble. In some areas, however, there is only a minor break between the older and intermediate surfaces.

The intermediate surface, which is also capped with laterite, embraces most of the present landscape. It has been slightly modified by a later cycle of erosion. Near the stream channels the intermediate surface forms a terrace overlooking the narrow valley flats which range from fifty yards to half a mile in width. The valley flats owe their formation to renewed erosion after the second period of lateritization and to subsequent alluviation.

THE LATERITES

Two periods of lateritization are represented. The older laterite is a coarse porous rock which is found only on relics of the older erosion surface, while the younger laterite is restricted to the intermediate surface. Fragments of the older rock can often be distinguished in the younger laterite, and much of the ironstone on the steeper slopes has been formed by re-cementing of rubble from the older horizon.

The colour and composition of the laterite are dependent on the nature of the underlying rocks. Laterites formed on the amphibolites and biotite schists are dark brown in colour and contain a high percentage of iron. The laterites developed on the granitic rocks, on the other hand, are light yellowish-brown gritty rocks which contain a much smaller proportion of iron. The cement is composed largely of aluminium hydroxides.

Two zones can usually be recognized in the laterite profile. The upper horizon, which represents a lateritized soil, contains a high proportion of ironstone pellets and angular fragments of quartz. Near the Oshun River it also contains rounded river pebbles. Within the lower zone, which is soft and earthy in texture, relic structures of the underlying rocks can generally be recognized. Quartz veins and ferruginized pegmatites show no signs of disturbance, and it is clear that the lower horizon originated by lateritization of the bedrock *in situ*. In depth the lower zone grades into the weathered rocks.

THE ALLUVIAL DEPOSITS

The alluvial and eluvial deposits, which range up to 20 feet in thickness, are confined to the younger erosion surface. The basal grits consist of angular quartz and, in addition to gold, contain tourmaline, ilmenite, staurolite, garnet, rutile and zircon. The grits and coarse sands above the gold-bearing wash contain a high proportion of laterite pellets and small pebbles. These are succeeded in turn by sandy clays with angular fragments of weathered gneiss and schist. A layer of soil forms the top of the profile.

THE EROSION CYCLES

The three erosion surfaces can be related to three cycles of downcutting which were the direct result of changes in climate. In each case the climatic cycles culminated in a period of aridity.

The First Cycle of downcutting produced the older erosion surface, and the gentle slopes encountered indicate that the old landscape attained a very mature stage. Towards the close of the cycle the climate became progressively more

arid, leading to a lowering of the watertable and the gradual extension in depth of the laterite crust.

The Second Cycle. A change in climate following the final arid phase of the previous cycle ushered in a new period of erosion, and a new surface was formed. Erosion was much greater in the deeply weathered zone near the headwaters of the tributaries than along the main stream channels. The result was a general lowering of the main valley gradients, but an increase in the topographic relief. The second erosion cycle also ended in a period of aridity, and the formation of laterite.

The Third Cycle. A third cycle of erosion gave rise to valley flats about 20 feet below the terraces representing the intermediate surface. During its closing stages unsorted alluvial deposits were laid down along the streams. The top layer of the alluvials has been locally ferruginized. At present most of the streams are incising their courses into these deposits.

WEATHERING

With the exception of the hilly area east of Ikirun, the depth of weathering is considerable, probably extending to 100 feet below surface in many places. The main effects of weathering are the kaolinization of the felspars, and the leaching of biotite to a yellow flaky alteration product.

GENERAL GEOLOGY AND TIME SEQUENCE

With the exception of the recent deposits and a few dolerite dykes, all the rocks in the Ilesha area belong to the pre-Cambrian Basement Complex. The oldest rocks are a series of gneisses of great structural complexity. They have been invaded by sheeted basic bodies which have been transformed into amphibolite by regional metamorphism. Within the gneiss complex there occur bodies of granite gneiss (granodiorite) in which oligoclase is the predominant felspar. The field relationships suggest that these have been formed by granitization.

During a later cycle coarse porphyritic granites were emplaced. Although marginal migmatites, indicating granitization on an extensive scale, are present, the granites were mobile and were intruded into their present positions. The material of the porphyritic granites was derived largely from the granite gneiss. Aplites and pegmatites were formed at a later stage of this cycle, while quartz veins and certain quartz schists represent the final products. Around Oshogbo the gneiss was transformed into pegmatite during the granite gneiss cycle and this process was repeated during the later cycle. The rocks of the porphyritic granite cycle are characterized by the abundance of microcline felspar. The generalized time sequence is given in Table I.

TABLE I

GENERALIZED TIME SEQUENCE

CYCLE	*PRODUCTS*	*TECTONIC AGENCY*	*PETROGENETIC PROCESS*
YOUNGER DEFORMATION CYCLE	Quartz-tourmaline veins	Tensional rebound	Silicification and tourmalinization
	Mylonites and augen-gneisses	Renewed faulting in rigid rocks	Microbrecciation
	Quartz-sericite schists	Intense folding under E-W compression	Recrystallization and intense dynamical metamorphism
SEDIMENTATION (?)	Sandstones ?		
	Dyke pegmatites, microcline-muscovite pegmatites and quartz veins	Localized tension and regional relief of pressure	Pegmatization and silicification along tensional fractures Regional pegmatization
	Aplogranites	Localized shearing stress	Aplitization along shear fractures
PORPHYRITIC GRANITE CYCLE	Migmatites *Coarse porphyritic granite*	Moderate E-W compression	Growth of large microclines in granite and country rocks Mobilization and ultimate injection
	Semi-conformable pegmatites and quartz sheets	Tension above rising granite mass	Regional pegmatization
	Secondary banded gneisses and dykes of biotite schist ? Talc-tremolite and sericite-chlorite schists	Main deformation with shear faulting (E-W stress)	Renewed segregation of light and dark minerals in gneisses and replacement of amphibolite by talc, tremolite and chlorite
GRANITE GNEISS CYCLE	Oligoclase pegmatites Early pegmatite dykes	Uniform confining pressure	Regional pegmatization
	Granite gneisses Amphibolites Biotite gneisses and schists	Major period of deformation (close folding)	Granitization Development of secondary schistosity and amphibolization of gabbros
BASIC INTRUSIVE CYCLE	Olivine gabbros and norites		
ANCIENT GNEISS COMPLEX CYCLES	Banded gneisses	Several periods of deformation with intense shearing	Segregation of leucocratic and dark minerals into separate bands

THE GNEISS COMPLEX

The gneisses include a varied series of granulitic and gneissic rocks composed of quartz, felspar and mica. The proportions of the constituent minerals, particularly biotite, vary considerably and several distinctive types of gneiss can be recognized.

FIELD CHARACTERS OF THE GNEISSES

The Leucocratic Gneisses occupy the low hilly country on the eastern outskirts of Oshogbo. To the west, the junction with the gneisses and schists is comparatively sharp, but bands of biotite gneiss become abundant towards the east, and it is impossible to map the eastern contact. All the gneisses in this area have been subjected to intense pegmatization and they are grouped with the pegmatite complex on the geological map. The leucocratic gneiss is a massive, fine- to medium-grained rock with a faint foliation imparted by small flakes of biotite. Near the Residency Hill, thin bands of biotite schist appear, and the rock assumes a broadly banded character. The leucocratic gneisses are diversified by veins and irregular patches of pinkish microcline pegmatite.

The Banded Gneisses are found only to the west and north-west of Oshogbo. Their most characteristic feature is the extremely regular and persistent banding. Medium- to fine-grained quartz-felspar bands, containing an occasional flake of biotite, alternate with strongly foliated bands of biotite gneiss. The bands average about one inch in thickness, are perfectly conformable and are completely gradational into one another.

The Biotite Gneisses and Schists are predominant over most of the Ilesha area. They are medium-grained, contain abundant biotite and are strongly foliated. Small semi-conformable lenses of granular quartz are usually present, and also lenses and streaks of contorted biotite schist. The biotite gneisses grade into biotite schists, the transition being marked by the development of biotite-rich partings in the former. Bands of biotite schist also occur in most of the amphibolite masses.

The Variegated Gneisses to the east of Iwara are faulted against the amphibolites and biotite gneisses to the west. The fault dies out to the north and the gneiss continues as a narrow band beyond the northern edge of the map. Near Iwara the principal types present are a coarse, lineated, leucocratic gneiss and a fine-grained grey gneiss. These occur separately or in alternating bands, ranging from six inches to three feet in width. Coarse potash granite gneiss, in which pink microcline predominates, appears along the western margin, and also occurs sporadically within the body of the gneiss. Towards

the north the potash granite gneiss assumes greater importance and finally predominates. Another body of potash granite gneiss occurs to the west of Oshu.

The Sericite and Chlorite Schists. Sericite schists underlie a large tract of country around Irogbo. The outcrop terminates against the Iwara fault. These schists are composed of fine flaky sericite, subordinate biotite, abundant quartz and varying amounts of felspar. Highly contorted chlorite-sericite schists are found along the margin of a large amphibolite body near Ijebu-Ijesha.

STRUCTURAL FEATURES OF THE GNEISSES AND BIOTITE SCHISTS

The rocks of the Basement Complex have been subjected to deformation during several orogenic cycles. The structures belonging to separate periods of deformation have been superimposed on each other and it is difficult to differentiate between them. Very little is known of the deformation cycles preceding the formation of the banded gneisses.

The Structure and Mode of Origin of the Banded Gneisses. The structure of the banded gneisses suggests that the banding is the outcome of a cycle of intense deformation. Important in this connection are inclusions of fine-grained garnetiferous amphibolite, dark hornblende-biotite gneiss, and a garnet-diopside rock. These inclusions display gneissic foliation at an angle to the foliation in the surrounding rocks, and it is clear that they had already been highly metamorphosed before they were incorporated in the banded gneisses. The banding in the enclosing gneisses curves smoothly round the inclusions. It is probable that these inclusions were formed during an ancient cycle of deformation. The presence of anomalous strikes within the same outcrop is also significant ; the gneissic banding in one part terminates obliquely against that in the adjoining parts. This suggests that the contact between the two portions represents a shear plane, the banding on the concordant side being slightly later.

Effects of the Granite Gneiss Deformation Cycle. This cycle gave rise to intense shearing in the banded gneisses, and the formation of secondary biotite gneisses and schists. During the closing stages the granite gneisses were emplaced.

(*a*) *Deformation of the Banded Gneisses.* The banded gneisses are traversed by numerous shears which follow several directions. The displacement is small, but the drag is considerable. In the biotite-rich gneisses, biotite is concentrated along the shear planes thereby producing secondary bands of schist transverse to the main foliation. The shear planes served as the loci for concentration of

leucocratic material at a later stage. The banded gneisses have locally been crumpled into small close folds, the leucocratic bands being drawn out and disrupted during folding.

(*b*) *The Development of Secondary Banded Gneisses.* It is probable that the formation of the secondary banded gneisses is related to the coarse porphyritic granite cycle of deformation. The final product is a broadly banded rock in which traces of the old banding can nearly always be seen. The first stage in the process is the crumpling of the gneisses into small close folds, followed by shearing along the limbs of the folds. Biotite and other minerals tend to aggregate along the shear planes transverse to the older banding (Fig. 1).

Shearing was also responsible for the formation of inclusions in the secondary gneisses. In the Ilesha area amphibolite often occurs as a series of pods within the gneisses. This structure is probably due to displacement along a set of transverse shears. The fragments of an original band of amphibolite have been drawn apart and under intense shearing they assumed an oval form.

(*c*) *The Secondary Biotite Gneisses.* These were formed during deformation preceding the emplacement of the granite gneisses. The old banded gneisses contained semi-conformable veins of leucocratic material, and during deformation these were folded, drawn out and disrupted (Figs. 2A and 3). The biotite gneiss host rock has a uniform foliation which follows the axial planes of the folds and abuts against the transverse leucocratic fragments.

(*d*) *Development of Biotite Schists.* The biotite schists were formed in the same way as the biotite gneisses. In their case, however, relief took place along a number of sub-parallel shear planes which are now represented by partings of biotite schist. When these partings are closely spaced the gneiss grades into biotite schist.

(*e*) *Lineation.* Nearly all the gneisses show linear structure within the plane of foliation, but its plunge is variable. In general it was found to incline at low angles towards the north.

PETROGRAPHY OF THE GNEISS COMPLEX

The gneisses display considerable variation in texture and composition. Relationships have also been complicated by the introduction of late microcline and quartz, the former being particularly prominent in the gneisses associated with the pegmatitic and granitic rocks.

The Leucocratic Gneisses of the Oshogbo area are medium to coarse, even-grained rocks, composed of oligoclase, quartz and microcline. The average grain size is 2 mm. Oligoclase constitutes about one-third of the rock and forms irregular grains which have been marginally invaded by microcline with

the development of myrmekite (A133). The oligoclase is weakly zoned and the twin lamellae are widely spaced or absent. The microcline occurs in irregular crystals embaying the oligoclase along cleavages and intergranular boundaries.

Quartz is abundant. It occurs as inclusions in the felspars, and as large units showing strong columnar strain shadows. These larger grains of quartz have been embayed by the felspars (A195). Irregular aggregates of a later generation of weakly strained quartz, enclosing fragments of oligoclase and microcline, are also present (A189). The accessory constituents include a little biotite, sericite and sphene.

The Banded and Biotite Gneisses consist of a fine, even-grained, granular mosaic of oligoclase and varying proportions of biotite and quartz (A132, 143, 186 and 246). The oligoclase contains about 25 per cent. of the anorthite molecule and is as a rule untwinned. Universal stage determinations indicate that the oligoclase crystals are orientated in a preferred direction. It is interesting that microcline is absent in those gneisses which have not been affected by granitization or pegmatization.

The biotite occurs in strongly pleochroic, stubby flakes with a sub-parallel orientation. It is concentrated in definite zones in the biotite gneisses. Quartz is an important constitutent. It forms an integral part of the granular mosaic, but the bulk of it occurs in the form of irregular grains which pass into sutured aggregates containing inclusions of the oligoclase mosaic. This quartz is apparently of late origin. Crystals of garnet, up to 0.5 mm. in diameter, are common. They tend to be concentrated in the oligoclase mosaic along the margins of the quartz aggregates (A339). Tourmaline is often associated with the garnet. Other accessories include ilmenite, sphene, zircon, apatite and occasionally calcite.

The shear dykes of biotite schist contain an oligoclase mosaic similar to that of the normal gneisses, and even the quartz and biotite show similar associations (A340). This indicates that the oligoclase mosaic was formed under shearing stress, and suggests the structural origin of the gneisses. The dykes also contain poikiloblasts of staurolite enclosing numerous grains of quartz. The staurolite has the following optical properties : $2Vz = 80°$, $Z>Y>X$, with Z = golden yellow, Y = light golden green and X = light yellow.

The Variegated Gneisses. The leucocratic bands in the variegated gneisses are composed of marginally cracked plates of oligoclase and microcline, in a cataclastic matrix of felspar and quartz (A507, 511). Streaks of a very fine micaceous aggregate curve concentrically around ovoids of felspar and the cataclastic aggregates of microcline. Biotite is sparingly present, while late quartz forms decussate aggregates. The darker bands have a similar texture on

a finer scale. The dark colour is due to specks of iron ore and numerous shreds of biotite and green hornblende (A527). The cataclastic textures of the variegated gneisses appear to be related to a late period of mylonitization (see p. 35).

The Sericite and Sericite-Chlorite Schists are similar to the biotite gneisses except for the presence of muscovite. Silicification has been more intense, and some of the schists contain very little oligoclase (A435). The contorted sericite and sericite-chlorite schists in the Ijebu-Ijesha and Ijaregbe areas vary considerably in texture. Some contain coarse oligoclase with inclusions of the earlier mosaic. The oligoclase is marginally intergrown with quartz (A417), and in many cases it has been completely replaced by a felted aggregate of sericite. The oval aggregates of sericite, chlorite, quartz and iron ore are enveloped by a strongly foliated matrix of quartz, biotite, chlorite, sericite, and ilmenite, in typically augen texture (A419).

THE AMPHIBOLITE COMPLEX

The amphibolite complex consists of a suite of intimately associated basic rocks ranging from hornblende gneiss to talc-tremolite schist. Individual bodies of amphibolite are lenticular in form and, except where late faulting has occurred, the contacts and foliation are concordant with the regional foliation in the gneisses. During the intense granite gneiss deformation cycle the gneisses have flowed round the more competent amphibolites, with the result that many of the contacts are abnormal.

AMPHIBOLITES AND HORNBLENDE GNEISSES

The common amphibolite is a dark green, weakly foliated to massive rock, composed of hornblende and basic plagioclase. Felspathic varieties grading into plagioclase amphibolites are not uncommon. The amphibolites often contain impersistent felspathic veins following minor shear zones. Even in the apparently massive varieties a weak foliation can be seen on weathered surfaces. As the foliation becomes stronger, the amphibolites pass into hornblende gneisses which in turn grade into biotite-amphibole schists. These schistose varieties are commonly found on the margins of the amphibolite masses.

The massive to gneissic amphibolites constitute the greater part of the broad amphibolite belt which runs from near Ikirun to the southern edge of the map. The massive variety grades locally into a weakly schistose type composed almost entirely of a deep blue-grey amphibole. A massive, almost felspar-free facies, composed of radiating aggregates of amphibole, is also present. Garnet is a constant accessory constituent of the amphibolites. Small

lenses of fine-grained amphibolite are also found in the gneisses. The contacts range from concordant to strongly discordant (Fig. 4A).

A fine-grained platy amphibolite is the dominant type in the large belt to the east of Ilesha. Oval porphyroblasts of microcline are locally abundant, while transitions to a garnetiferous variety are common. The platy amphibolite passes into bands of schistose augen-gneiss and mylonite up to five feet in thickness. In the Olobu-Isaobi-Oshu area green amphibolite, containing an appreciable proportion of epidote, is found.

TALC-TREMOLITE AND TALC-CHLORITE SCHISTS

The talc-tremolite rocks are widespread in the Ilesha area. Bands and lenses composed of radiating aggregates of tremolite in a matrix of talc are found in the central parts of the amphibolite belts. To the east of the Ilesha-Iwara road the tremolite rocks form bands up to ten yards in width in the amphibolites.

The most common talc-tremolite rock, however, is a pale green schist. The talc occurs in parallel flakes which impart the schistosity to the rock, whereas the tremolite forms radiating groups of needles. Relatively pure talc schists are sometimes encountered. The most important outcrop of talc-tremolite schist occurs in the Iregun area where it follows a major fault zone. Fissile chlorite schist and talc-chlorite schist are found to the south-east of Ilesha.

PETROGRAPHY OF THE AMPHIBOLITE COMPLEX

Common hornblende constitutes from 45 to 75 per cent. of the dark massive amphibolites. It is strongly pleochroic with $Z>Y>X$; Z=blue-green, Y= yellow-green and X=pale yellow. The optic axial angle is negative and ranges from 75° to 79° while the extinction angle varies from 14° to 20°. The hornblende occurs in plates and sheaf-like aggregates (Pl. IA). Associated with the amphibole are grains of ilmenite, often rimmed by sphene, apatite and granules of epidote. The plagioclase forms plates up to 2 mm. across and ranges from labradorite to bytownite in composition. It may contain abundant inclusions of quartz, epidote and actinolite.

The talc-tremolite schists are composed almost exclusively of radiating aggregates of tremolite in a matrix of minute flakes of talc (Pl. IB). The proportions of these minerals vary considerably and pure talc and tremolite rocks are not uncommon (cf. A459). The talc-chlorite schists are composed of small flakes of chlorite in a fine-grained felted matrix of talc. Mosaics and small veins of quartz are also present.

Diopside is present in small bodies of amphibolite in the muscovite pegmatite complex. It forms large poikiloblastic plates enclosing grains of quartz and plagioclase (A132). In some of the amphibolites along the Ilesha-Iwara road secondary microcline is quite common (A455).

An analysis of the amphibolite from Iregun village is given in Table II. The norm shows that the rock is slightly undersaturated, and the composition approximates closely to that of a norite.

TABLE II

COMPOSITION OF AMPHIBOLITE *

		NORMATIVE COMPOSITION		
SiO_2	47.40			
Al_2O_3	15.52			
Fe_2O_3	2.26	Orthoclase		1.67
FeO	7.61	Albite		7.86
MgO	10.07	Anorthite		36.25
CaO	13.16	Diopside	$CaO.SiO_2$	11.37
Na_2O	0.91		$MgO.SiO_2$	7.80
K_2O	0.29		$FeO.SiO_2$	3.04
H_2O+	1.34	Hypersthene	$MgO.SiO_2$	14.80
H_2O-	0.09		$FeO.SiO_2$	6.47
CO_2	0.02	Olivine	$2MgO.SiO_2$	1.82
TiO_2	1.05		$2FeO.SiO_2$	1.02
ZrO_2	n.d.			
P_2O_5	0.09	Magnetite		3.25
F	0.02	Ilmenite		1.98
S	0.02	Apatite		0.34
Cr_2O_3	0.01			
V_2O_5	n.d.			
MnO	0.19			
NiO	0.02			
BaO	0.04			
SrO	0.02			
Li_2O	0.01			
	100.14	MODAL COMPOSITION		
Less O = F, O = S	0.01	Labradorite		28.50
		Actinolite		68.73
Total	100.13	Iron Ore		1.87
Sp.Gr.	3.03			

n.d. = not detected :

Analysts : W. H. Bennett, M.Sc., F.R.I.C. and L.C. Chadwick. M.A., A.R.I.C., Mineral Resources Division of the Directorate of Colonial Geological Surveys.

* Amphibolite (A807), Iregun Village.

Red garnet may form up to 10 per cent. of the amphibolite (A461), and brown streaks composed of garnet and sillimanite are common (A308). The distribution of the hornblende and plagioclase in thin section is suggestive of the texture of a coarse gabbro (Pl. IA), and clots of iron ore, possibly representing altered olivine, are also present (A468).

The green amphibolites are composed largely of radiating aggregates of actinolite (A398). Felspar is subordinate. The gneissic amphibolites, commonly found as a marginal facies of the larger bodies, contain thin bands of granular oligoclase and quartz (A361, 476). Green rocks, composed of quartz, epidote and occasional plates of hornblende, were noted in the Isaobi area (A421).

LEUCOCRATIC VEINS AND SHEETS IN THE AMPHIBOLITES

The leucocratic veins and sheets in the amphibolites can be divided into three groups. The oldest veins, which are composed of a fine-grained granular mosaic of quartz and oligoclase, have been subjected to disruption and strong deformation during the granite gneiss cycle (Fig. 2A). A later group of veins and conformable sheets are composed mainly of coarse oligoclase and subordinate quartz. The felspar has been granulated, and in some sections it has been almost completely replaced by epidote. These veins are prominent near the granite gneisses to which they are related. The youngest group of conformable sheets ranges from a few inches to several hundred yards in width and is probably related to the post-main granite pegmatites. One large band, 300 yards in width, outcrops about half a mile east of Itagunmodi. It is composed almost entirely of microcline perthite with a little albite and green hornblende. Scattered inclusions of amphibolite, with the same direction of foliation as in the neighbouring major amphibolites, indicate that the rock has been formed by replacement. Two sets of intersecting veins occur in the actinolite-biotite schists north of Idokka (Figs. 2B and 2C). They consist mainly of coarse oligoclase. Large crystals of potash felspar, which embay the oligoclase, and aggregates of epidote are also present. These veins belong to the granite gneiss cycle.

REGIONAL METAMORPHISM OF THE BASEMENT COMPLEX

The rocks of the Basement Complex have been subjected to intense regional metamorphism, but as shearing stress was the dominant control, minerals of high metamorphic grade are scarce. Several periods of metamorphism have been superimposed on each other and it is almost impossible to differentiate between them. There does not appear to be any increase in the intensity of metamorphism towards the granite masses or towards the migmatites.

THE GNEISSES

The residual structures in the biotite gneisses indicate that they were formed by intense deformation, and the banded gneisses were probably formed by the same process. Stress appears to have been more important than high temperatures. The gneisses are composed of biotite and oligoclase, both of which are capable of response to stress. Coarse oligoclase is almost entirely absent, and with the exception of garnet and staurolite, no high grade metamorphic minerals are present. The granular texture of the gneisses is the product of deformation under shearing stress, which was also responsible for the formation of the transverse "dykes" of biotite schist.

The sericite and sericite-chlorite schists represent a different type of transformation which can probably be related to shear faulting and local deformation along the amphibolite margins during the porphyritic granite cycle. The high-grade gneisses of the previous cycle were broken down completely and transformed into schists.

THE AMPHIBOLITE COMPLEX

One of the striking features of the amphibolites is the transition from the massive central portions to marginal gneissic and schistose facies. In the massive central facies residual plutonic textures can be seen and the main effects of metamorphism have been amphibolization of the original olivine and pyroxene, and saussuritization of the plagioclase. In this instance garnet and sillimanite have been observed as minor constituents. Towards the margins of the amphibolites, amphibole with a high proportion of the tremolite molecule becomes more abundant, and most of the original plagioclase appears to have been converted to amphibole. Near the contacts with the gneisses, banding has been induced by increased deformation. The bands are rich in oligoclase and frequently also in quartz and biotite indicating that silica and alkalis were introduced. The appearance of a granular oligoclase mosaic indicates intense shearing stress. The concordance of the foliation with that of the biotite gneisses shows that the regional metamorphism may probably be related to the granite gneiss cycle of deformation.

The talc-tremolite schists and the chlorite schists belong to a different period of metamorphism. The former are characteristic of the interior parts of the amphibolite masses. They are well-developed along the fault zone at Idokka and Iregun. The talc-tremolite schists are related to shear faults initiated during the coarse porphyritic granite cycle of deformation. The marginal chlorite-talc schists are also probably of the same age.

THE GRANITE GNEISS CYCLE

Four occurrences of granite gneiss are known in the Ilesha area. They are characterized by the preponderance of oligoclase, which appears to have been the only felspar present in the original rocks. In chemical composition they are related to the granodiorites. Faulting often obscures the contacts of the granite gneisses, but the well-preserved Ibokun body indicates that they were conformable and had an elongated shape. The contacts with the gneisses in the Ikirun and Iliye areas are concordant.

The foliation in the granite gneisses is essentially a relic feature of the parent gneisses, and not the outcome of deformation of an even-grained granite. The retention of the foliation on a regional scale, however, proves that directed stress was still operative during their formation.

DESCRIPTION OF INDIVIDUAL OCCURRENCES

The Eko Ajala Granite Gneiss is the only body of granite gneiss which has not been intensely modified during the porphyritic granite cycle. It is a medium-grained, light grey rock possessing a strong foliation. Over large areas, however, the granite gneiss becomes darker in colour owing to the presence of schistose biotite-rich streaks. Towards the Awin River this biotite-rich component constitutes up to half the rock. Inclusions of biotite-hornblende schist and amphibolite occur sporadically within the granite gneiss. The former contain scattered metacrysts of plagioclase, while the amphibolites are invaded by irregular veinlets of leucocratic material derived from the granite gneiss. In contrast with the banded gneisses, the foliation of the granite gneiss retains its regional direction, regardless of the alignment and form of inclusions.

The dark granite gneisses in the Eko Ajala area grade into "injection gneisses." They contain numerous wisps of coarse biotite schist with the same orientation as the biotite folia in the adjacent granite gneiss. In other cases a complete transition can be traced from biotite schist with scattered metacrysts of felspar, to normal granite gneiss. The field evidence indicates that the dark granite gneiss represents a biotite gneiss or schist which has been granitized without structural disturbance.

The Ikirun Granite Gneiss shows notable variations in texture from place to place, but the different types grade into one another. The most common variety, to the east and north-east of Ikirun, is a well-foliated granitic rock with thin partings of biotite. The quartz also occurs in lenses and streaks, and the rock has a porphyritic appearance imparted by oval aggregates of felspar. Around Iragbiji a fine, even-grained granite gneiss is present. It is composed of subhedral to oval-shaped felspars in an even-grained matrix, which resembles

the coarse biotite gneiss. To the south-east a coarse, weakly foliated variety makes its appearance, in which the quartz and felspar form a granular aggregate, while the biotite imparts a faint foliation to the rock. Inclusions of biotite gneiss occur sporadically within the granite gneiss. They are usually elongated in the direction of foliation. Small metacrysts of felspar are commonly present and most of the inclusions are bordered by a fringe of biotite.

The contacts between the Ikirun mass and the gneisses are either faulted or obscured by soil and debris. The contact relationships can be studied, however, in an outcrop a few hundred yards to the west of Iragbiji. Here the granite gneiss contains numerous inclusions of the older gneiss, ranging from sharply defined ovoids of felspathized gneiss, with thin biotite fringes, to completely granitized inclusions, the ghost-like outlines of which can still be recognized. The inclusions all possess the same foliation as the host rock which suggests that the granite gneiss was formed *in situ* by granitization.

The Ibokun Granite Gneiss forms an elongated, crescent-shaped outcrop in the Ibokun-Ipetu area. It is intimately associated with conformable sheets of gneissic amphibolite. The granite gneiss in this area is a fine-grained, sugary rock composed of quartz, felspar and biotite. The mica occurs in long streaks, sometimes giving the rock an impersistently banded appearance.

The Isaobi Granite Gneiss outcrops sporadically in the gneiss belt around Isaobi. The rocks are poorly exposed, but the granite gneiss appears to form small lenses in the country rock. The most common variety is a medium-grained, strongly foliated, granitic rock. This grades locally into a coarse leucocratic facies with an even granitic texture. Another variety is a fine- grained biotite-rich granite gneiss which occurs as narrow bands and lenses in the normal medium-grained type.

PETROGRAPHY OF THE GRANITE GNEISSES

The various types of granite gneiss are all similar in mineralogical composition and textural relations, but the proportions of the essential minerals, plagioclase, microcline, quartz and biotite, vary considerably.

Biotite normally constitutes from 5 to 12 per cent. of the granite gneisses, but it is almost entirely absent in some of the leucocratic types, while in the highly contaminated Eko Ajala granite gneisses it forms up to 25 per cent. of the rock. The biotite is strongly pleochroic, with the following optical properties: $X>Y = Z$; X = fawn, and Y, Z = dark brown. It alters to chlorite and iron ore. Most of the biotite is present in coarse flakes and sheaf-like aggregates which usually show a rude alignment. It is embayed by felspar and quartz,

and is frequently bent and fractured. The biotite in the fine gneissic groundmass, however, forms small flakes which show almost perfect parallelism.

Oligoclase occurs in a granular mosaic which averages about 1 mm. in grain size, and as large crystals 1 cm. and more in length. The granular oligoclase is clear, untwinned, and ranges from $Ab_{80}An_{20}$ to $Ab_{70}An_{30}$ in composition. The large tabular crystals of oligoclase form from 20 to 55 per cent. of the granite gneisses. They are weakly zoned, and range in composition from $Ab_{75}An_{25}$ to $Ab_{63}An_{37}$. Intense deformation is indicated by bent twin lamellae and cataclastic structures. In the deformed oligoclase, polysynthetic twinning has been induced, the twin lamellae wedging out towards the undisturbed cores of the larger crystals. Sutured aggregates of oligoclase, formed by fracturing of larger plates during deformation, can also be seen.

Myrmekite is prominent in the microcline-rich granite gneisses, and is closely related to the late microcline. Inclusions of oligoclase in the potash felspar and the margins of the oligoclase crystals have been transformed into myrmekite. The intergrown quartz takes the form of radially disposed U-shaped rods.

Microcline is present in at least two generations. The earlier microcline forms a granular mosaic averaging 1.5 mm. in diameter. Many of these crystals show no trace of microcline twinning, but determinations of extinction and axial angles show that all the potash felspar is microcline. Much of the microcline is microperthitic. The late microline forms large crystals up to 3 cm. in length with inclusions of oligoclase, quartz and earlier potash felspar. It is strongly twinned and coarsely veined with perthitic albite.

Quartz occurs in small rounded grains in the granular oligoclase mosaic, but the bulk of it occurs in the form of large aggregates and lenses up to 4 cm. in length. Nearly all the quartz displays columnar strain shadows, and large grains of optically continuous quartz are often found to pass into sutured mosaics.

Of the accessory minerals *sphene* is the most common. It is usually present in small grains associated with biotite, but occasional large crystals have been noted. Sphene is also found as rims to large aggregates of *ilmenite*. Small grains of *zircon* are found in association with the biotite, and euhedral prisms of *orthite* up to 3 mm. in length are not uncommon. They are zoned and strongly pleochroic. Small crystals of *garnet* and a little *fluorite* and *calcite* are present in some sections. *Apatite* is abundant, particularly in the biotitic types. A little blue-green *hornblende* may also be present.

The Eko Ajala Granite Gneiss varies in texture and appearance according to the amount of biotite present. The leucocratic varieties are granitic in

appearance, while the biotitic facies, which contains up to 25 per cent. of mica, is distinctly gneissose. The early oligoclase forms a granular mosaic with biotite and subsidiary quartz, while the later plagioclase occurs as large crystals moulded on, and enclosing, the earlier mosaic (A161). Table III shows that the percentage of late oligoclase varies considerably from place to place. The coarse biotite has been partially replaced by late oligoclase and quartz (A162). At the junctions of microscopic gneiss inclusions there is a concentration of coarse biotite similar to that found around larger xenoliths (Pl.IC). Two generations of quartz are present. Scattered grains of the older quartz, which form part of the relic gneiss mosaic, can be recognized. The bulk of the quartz, however, occurs in irregular masses and vein-like lenses aligned parallel with the foliation (A160). A little interstitial microcline, which replaces the oligoclase, is present.

In *the Ikirun Granite Gneiss* potash felspar is relatively abundant. The grain size averages 2 to 3 mm. with phenocrysts of microcline and plagioclase up to 3 cm. in length. Oligoclase occurs in association with early quartz in a gneissic mosaic, and a coarse secondary mosaic can also be distinguished (A141). The larger crystals enclose areas of the earlier oligoclase-quartz mosaic. The greater part of the microcline belongs to an early generation (A166), and forms a granular aggregate similar to the secondary oligoclase mosaic (Pl.ID). Several stages in the replacement of oligoclase by potash felspar can be recognized. The late microcline occurs in the form of large metacrysts enclosing fragments of biotite, oligoclase, early microcline and a little quartz (A175). The oligoclase inclusions are deeply embayed (Pl.IIA), and their ghost-like outlines are clearly visible. An albite selvedge is usually present between the microcline and oligoclase. It is thought that the late microcline developed by homogenization of the earlier microcline mosaic (A167). The progressive stages in the replacement of oligoclase by microcline are illustrated by the variation of the modes of specimens from different parts of the mass (Table III). Most of the quartz is late and forms irregular lenses and veins replacing both oligoclase and biotite. The late microcline, however, replaces the quartz along intergranular boundaries. The biotite is more or less confined to certain zones.

The Ibokun Granite Gneiss is similar to the Ikirun mass, but cataclastic effects are more prominent. Most of the large oligoclase crystals have been broken down into angular aggregates, which can be seen in various stages of replacement by microcline (A294, 388). Late crystals of microcline up to 2 cm. in length are also present. It is of interest to note that the quartz is only weakly strained, indicating that it was formed after the deformation which led to the

TABLE III

MODES OF THE GRANITIC ROCKS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Coarse oligoclase	18.8	36.0	45.0	22.4	36.3	38.0	25.8	56.4	56.2	40.7	38.7	32.0	33.3	33.3	25.5	30.0	23.9	31.4	14.7	21.2	28.0
Mosaic oligoclase	19.7	1.5	2.9	2.0	—	0.5	—	—	—	—	—	—	—	—	—	19.2	12.4	11.1	22.7	—	—
Microcline	17.5	11.0	23.6	22.6	19.7	35.5	29.8	16.6	30.3	37.6	26.6	31.0	29.7	22.7	23.2	0.8	3.0	1.7	0.7	43.7	33.8
Quartz	36.0	47.2	15.8	42.9	24.8	15.9	36.0	15.4	9.5	18.3	30.5	27.5	34.8	39.1	49.0	29.4	41.6	43.0	46.4	31.6	31.2
Biotite	8.0	4.3	12.7	10.1	19.2	10.1	8.4	11.6	4.0	3.4	4.2	9.5	2.2	4.9	2.3	20.6	19.1	12.8	15.5	3.5	7.0
Oligoclase/microcline ratio ...	2.20	3.40	2.03	1.08	1.84	1.08	0.87	3.40	1.85	1.08	1.45	1.03	1.12	1.47	1.10	61.50	12.10	25.00	53.43	.49	.83

1. Granite gneiss with gneissic matrix along contact south-east of Ikirun.

2-12. Series of spaced specimens from Ikirun towards the coarse porphyritic granite contact.

13-15. Weakly foliated granite gneisses south of Ada.

16-19. Granite gneisses from the Eko Ajala-Iliye area.

20. Granite gneiss from Ibokun.

21. Average composition of the coarse porphyritic granite.

shattering of the oligoclase and biotite (A295). The biotite is fractured and even granulated, thus confirming the cataclastic origin of the oligoclase mosaic.

The Isaobi Granite Gneisses are similar to those of the Ibokun mass.

Contact Rocks and Xenoliths in the Granite Gneisses. Where oligoclase is the predominant felspar in the contact rocks it occurs as oval grains in a fine-grained gneissic mosaic (A169). Biotite is usually abundant in association with late felspar and in the gneissic mosaic. Microcline occurs as interstitial pools in the gneiss mosaic, and in large crystals with small inclusions of oligoclase. Apatite, sphene and iron ore are noticeably more abundant than in the normal granite gneiss.

The gneiss xenoliths possess a typical gneiss mosaic, but the grain size is much coarser (A150). The basic fringe is composed of plagioclase, abundant apatite, coarse biotite, aggregates of ilmenite and abundant sphene and zircon. Quartz and microcline are usually interstitial (A163).

SEMI-CONFORMABLE LEUCOCRATIC VEINS

In the Oba area, the development of late semi-conformable quartz-felspar veins has given rise to composite biotite and hornblende gneisses. They represent the granite gneiss cycle beyond the main areas of intense granitization. Though individual veins are roughly conformable, they are transgressive in detail, and are subject to sudden changes in width. Where the veins broaden out, the contacts become strongly transgressive (Fig.5). The semi-conformable veins are invariably fringed by a narrow zone of a biotite enrichment.

Under the microscope the leucocratic veins are seen to be composed of a coarse aggregate of twinned oligoclase with inclusions of an earlier generation of plagioclase (A208). Much of the oligoclase had been sericitized. Quartz occurs in irregular veins bordered by grains of albite. A little biotite is also present.

OLDER APLITES AND PEGMATITES

Aplites and pegmatites, related to the granite gneiss cycle, are occasionally seen around Ikirun. The pegmatites generally form irregular dykes cutting across the foliation of the gneisses. They are coarse, even-grained rocks composed of felspar, subordinate quartz and occasional flakes of biotite. Many of the pegmatites contain angular xenoliths of gneiss which have been partially replaced by epidote. The granite gneiss pegmatites have been intensely altered during the subsequent porphyritic granite cycle.

Although aplite dykes are occasionally found, most of the aplite occurs in the form of irregular bodies and lenses in the Ikirun granite gneiss. They are fine-grained tough rocks with a flinty fracture, composed of a fine mosaic of oligoclase, subordinate quartz, and in some cases a little biotite.

THE COARSE PORPHYRITIC GRANITE CYCLE

Only two bodies of coarse porphyritic granite* occur in the Ilesha area, but related rocks are of widespread occurrence. Two phases, the main granites and the migmatites, can be distinguished. The former cover a large area, while the migmatites are extensively developed only in the Inisa gneisses and schists.

THE MAIN GRANITES

The Igbajo Granite is a tabular body, up to ten miles in width, which dips at a steep angle to the west. Two miles south-east of Otun the mass terminates rather abruptly. A well-marked foliation is present throughout the main granite, but it attains its best development in the marginal facies where the phenocrysts are less crowded. The foliation is due to the parallel arrangement of the biotite and some of the large felspars. Though the latter show all orientations, about half of them have their longer axes in the plane of foliation. The rough parallelism of the phenocrysts on dip slopes is due to a faint lineation plunging at low angles to the north. The fact that the foliation closely follows the contacts of the granite, indicates that the emplacement of the granite involved some degree of movement. There is, however, little doubt that the granite was derived by granitization and mobilization of the pre-existing rocks. The central part of the Igbajo granite is uniform in texture, but the marginal facies is characterized by great textural diversity. The Ara granite differs in having muscovite as an essential constituent.

The *typical coarse porphyritic granite* is an inequigranular rock, composed of subhedral phenocrysts of pink potash felspar, averaging 2.5 cm. in length, in a medium-grained groundmass of quartz, felspar and biotite. The foliation, although weak, is constant in direction over large areas. The granite is traversed by numerous shear planes showing small displacement, but considerable drag. They are now marked by streaks of coarse granite, grading into pegmatite. Scattered ghost-like inclusions, only slightly finer in grain than the surrounding granite, are common. They are fringed by coarse biotite and represent com-

*The coarse porphyritic granite and other granites of the Basement Complex are sometimes referred to collectively as the "Older Granites" to distinguish them from the "Younger Granites" of the Plateau Tinfields, which are probably considerably younger in age.

pletely granitized xenoliths of gneiss. Schlieren of coarse biotite are frequently encountered. Though most of the granite is uniform in texture, a medium-grained gneissic facies with small, scattered metacrysts of potash felspar is found north-east of Ira. It grades into the normal porphyritic granite.

The *marginal granite* is well-developed in the Iba area, where it forms a belt up to two miles in width. It displays considerable variations in texture and composition, and is nearly always of a composite nature. Around Iba village, the granite is composed of alternating lenses of granite gneiss and porphyritic granite. The contacts across the strike are comparatively sharp, but along the strike they grade imperceptibly into each other. The granite gneiss constitutes between 30 and 50 per cent. of the composite rock. It is clear that the porphyritic granite inherited its foliation from the granite gneiss (Fig. 6).

Inclusions are abundant around Iba village. They range from indurated gneiss to a rock which approaches the porphyritic granite in texture and mineralogical composition. Both microcline and plagioclase metacrysts are present in the granitized inclusions, and individual phenocrysts in the granite frequently project across the contacts into the inclusions (Fig. 7). Xenoliths of gneiss are scattered through the marginal granite, but they tend to occur in disconnected lenses parallel with the foliation. The foliation in the granite may abut against the inclusions, but as a rule it curves concentrically around them. Most of the inclusions are surrounded by a fringe of coarse biotite which separates them from the granite. These biotite fringes probably represent a basic episode of granitization which preceded the formation of the granite. When the inclusions are completely granitized, the biotite is reconcentrated in coarse aggregates and schlieren.

THE MIGMATITES

The migmatite zone is characterized by the rapid alternation of granite, biotite gneiss and biotite schist, all of which grade into one another. Granitization has produced granitic rocks in which the original gneissic banding has been preserved in detail. The biotite flakes have been rotated slightly and, together with the large felspar "insets", they follow a new foliation direction slightly inclined to the relic banding. Granitization has been selective. The biotite-rich layers in the gneisses have been converted into porphyritic granite, while the leucocratic bands have been altered to aplitic granite. Along the Awin River, about two miles north-north-east of Inisa Station, coarse biotite schists have been granitized. They contain numerous metacrysts of pink potash felspar similar to the phenocrysts in the porphyritic granite. In the migmatite zone, examples of granitization and contemporaneous mobilization of the gneisses can be seen in the same outcrop. Intrusive granites grade into metacrystic

rocks with undisturbed relic gneissic banding. Near the contacts the mobilized members show signs of drag and plastic folding. The migmatites in the Inisa area are biotite-rich, and they probably represent an early basification induced by the main granite. Patches of granite, a few yards across, occur in gneiss and schist inliers in the amphibolite complex to the north-west of Oba. The country rocks grade imperceptibly into porphyritic granite. The first stage in the transition is the appearance of small areas of quartz and irregular patches of microcline. Biotite becomes progressively more abundant, and the microcline gradually assumes a subhedral habit. The gneissic groundmass is coarsened and the rock becomes indistinguishable from the marginal porphyritic granite of the Ire area.

PETROGRAPHY OF THE PORPHYRITIC GRANITES

The coarse porphyritic granites are similar to the metacrystic granite gneisses which have already been described (pp. 15-18). The main differences in the various facies are due to variation in the proportions, and to a lesser extent in the textural relationships of the essential minerals.

The Coarse Porphyritic Granite is an inequigranular rock with subhedral microcline phenocrysts up to 3 cm. in length, in a medium to coarse matrix composed of microcline, oligoclase, quartz and biotite. The granite is similar to the granite gneisses of Ikirun, and it is often impossible to distinguish between them under the microscope. Microcline is a little more abundant and coarser in the porphyritic granite. As in the granite gneisses it occurs in an early mosaic and as large, late crystals enclosing fragments of the earlier minerals (cf. Pl. IIB). Perthitic albite is common. Besides the usual inclusions, the microcline sometimes contains vermicular lenses of optically continuous quartz (A173). A similar association is found in the graphic intergrowths of the muscovite pegmatites. The large crystals of oligoclase contain grains of quartz and small inclusions of early plagioclase (A153). Albite selvedges are invariably present along contacts with microcline, while myrmekite is also common. The segregation of microcline and oligoclase is often pronounced. When oligoclase predominates, the microcline forms interstitial patches and replacement blebs in the earlier felspar. Where the oligoclase has not been deformed the biotite shows a rude linear arrangement (A213), but when potash felspar predominates, it is usually orientated at random (A212). Hornblende is occasionally present in the porphyritic granites. The pleochroism ranges from yellow-brown through pale green to deep green, while $2V_x = 78°$ and $X/c = 16°$. Late quartz is abundant between oligoclase and microcline aggregates and in some cases forms pinching veins.

The Migmatites consist of a gneissic mosaic of oligoclase, quartz and biotite. The oligoclase is untwinned and averages $Ab_{77}An_{23}$ in composition (A158). A late generation of oligoclase forms plates up to 3 mm. in diameter, with marginal inclusions of early oligoclase and biotite (A145). It is weakly zoned, and is polysynthetically twinned (Pl. IIC). The composition ranges from $Ab_{70}An_{30}$ to $Ab_{75}An_{25}$. Early microcline is present interstitially and late microcline forms large plates with relics of the other minerals (A145). Late quartz is present in coarse veinlike masses enclosing late oligoclase.

Most of the inclusions in the porphyritic granite are composed mainly of oligoclase in a typical gneissic mosaic (A159, 180). With progressive granitization, interstitial microcline makes its appearance, and coarse microcline develops at a later stage. Most of the quartz occurs as grains partly enclosed by the oligoclase. Biotite is always present and hornblende is common in some inclusions.

TRANSFORMATIONS IN THE IKIRUN GRANITE GNEISSES

With the exception of the Eko Ajala mass, all the granite gneisses have been extensively modified by the introduction of microcline and quartz during the porphyritic granite cycle. This is especially noticeable in the Ikirun mass. The transition from granite gneiss to the metacrystic facies is always gradual, and becomes more marked towards the porphyritic granite contact. On the eastern outskirts of Ikirun and in Obagun village, pink grains of potash felspar make their appearance in the granite gneiss. Towards the east they become more abundant, and near Iragbiji beacon the rock is studded with metacrysts of microcline ranging up to 2.5 cm. in length. The original foliation of the granite gneiss is however perfectly preserved, and retains its constant direction. Metacrystic granite gneiss, which is almost identical with the Iba marginal granite, occurs near the main granite contact, and the divergence in the direction of foliation is often the only criterion by which the two rock types can be distinguished.

HORNBLENDE SYENITE

Outcrops of hornblende syenite occur between Otun and Ilare, but owing to the scarcity of outcrops the contact relations are obscure. The syenite is a medium-grained rock composed of pink felspar in a fine-grained matrix containing small blades of hornblende.

Under the microscope it is seen to be composed mainly of strongly twinned microcline (A277). The potash felspar contains numerous small patches of albite, but true perthite is absent. The matrix is composed of irregular aggre-

gates of oligoclase which may be of cataclastic origin. Hornblende is present in ragged plates. The potash felspar contains inclusions of hornblende and oligoclase rimmed by albite. Occasional grains of quartz are found in the matrix. The hornblende syenite occurs in amphibolite near the porphyritic granite contact, and is of interest since it illustrates the effects of the granite cycle on amphibolite, which entailed the introduction of potash felspar. The other minerals have been inherited from the country rocks.

THE MEDIUM-GRAINED GRANITES

South of Otun, the Igbajo granite is bordered for two miles by a zone of medium-grained granite up to half a mile in width. It has a sugary texture and contains sparse flakes of biotite which impart a faint foliation. Another body of medium-grained biotite-muscovite granite, about three miles in length, forms a hill to the east of Milepost 61 on the Ife-Ilesha road. It has a faint foliation and contains equal proportions of biotite and muscovite. The granite forms the end of a large body of muscovite pegmatite and is traversed by numerous dykes of coarse pegmatite. A third small body of medium-grained granite outcrops about two miles north of Tonkerre.

In thin section the medium-grained granite consists of an interlocking aggregate of oligoclase, microcline and quartz. The two felspars are present in about equal proportions, and the potash felspar marginally invades the plagioclase. Large grains of quartz and short laths of muscovite and biotite are present.

THE BIOTITE PEGMATITES

The biotite pegmatites, which can be related to the porphyritic granite, are widely distributed in the Ilesha area. Two types can be distinguished, the semi-conformable pegmatites and the dyke pegmatites.

The Semi-Conformable Pegmatites correspond closely in texture and composition to the replacement pegmatites of the Osi area, where they represent a pre-main granite phase of the porphyritic granite cycle (King and de Swardt, 1949). There is a complete gradation between the semi-conformable pegmatites and the gneisses. Individual pegmatites taper off along the strike into small disconnected lenses of pegmatite and large porphyroblasts of potash felspar (Fig. 8).

The semi-conformable pegmatites are coarse-grained rocks composed of large pink felspars in a groundmass of quartz, felspar and biotite. The microcline phenocrysts contain embayed relics of the gneiss mosaic, and the oligoclase inclusions are rimmed by albite and have been transformed into myrme-

kite. Where the pegmatite grades into gneiss, microcline becomes abundant in a granular mosaic with quartz. The mica occurs in streaks which sometimes link up with the biotite folia in the adjacent gneisses, and there is also a concentration of biotite along the contacts. These features strongly suggest a replacement origin for the semi-conformable pegmatites.

The Composite Sheets of Pegmatite and Gold-bearing Quartz near Iperindo, nine miles south of Ilesha, are related to the semi-conformable pegmatites. They are described on page 38.

Composite Bodies of Granite, Pegmatite and Vein Quartz are also present (Fig. 9). They consist of medium-grained granite with a central pegmatitic facies grading into a core of glassy vein quartz. The granite gneiss bordering these composite bodies has been noticeably enriched in biotite.

The Dyke Pegmatites, which occur in the porphyritic granite and granite gneiss, include quartz-felspar and quartz-felspar-biotite pegmatites. The former are found as swarms of thin dykes in the Ikirun granite gneiss, while the latter are common in the coarse porphyritic granites. Diffuse patches of pegmatite grading into the surrounding granite also occur (Fig. 6).

The Quartz-felspar Pegmatites consist of microcline and quartz in a matrix similar to that of the host rock. A little biotite may also be present. The microcline phenocrysts, especially along the contacts, enclose aggregates of oligoclase, microcline and quartz inherited from the host rock. The *quartz-felspar-biotite pegmatites* contain perthite crystals up to six inches in length in a matrix of quartz, felspar and coarse biotite. A little rutile and magnetite are sometimes present. The central part of the dyke is often composed of very coarse microcline and quartz, but graphic intergrowths are not common in these pegmatites.

The field evidence, as illustrated in Figs. 7, 10A, 11, 12A and 13, suggest that the dyke pegmatites may have been formed by replacement.

THE APLOGRANITES

Aplogranites, which antedate the dyke pegmatites, are found in both the porphyritic granite and granite gneiss. They range from six inches to over 15 feet in width. North of Eripa there are two intersecting sets of dykes trending NW.—SE. and N.—S. respectively. Some of these occupy shear faults of small displacement, but more often they follow monoclinal flexures (Fig. 10B). The foliation in the aplogranites is generally parallel with that of the host rocks, and lenses of porphyritic granite are present in some large dykes (Fig. 14). Where they terminate, the aplogranites may grade into the porphyritic granite as shown in Fig. 15.

The aplogranites are composed of a fine-grained aggregate of quartz and felspar with subordinate biotite. Small, scattered phenocrysts of microcline are sometimes present, and the general textural relationships are similar to those in the porphyritic granites. The oligoclase occurs in cataclastic aggregates with albite selvedges (A535). Contact sections show a gradual transition from aplogranite to the host rock (A536), and there is little doubt that they are of replacement origin.

ANALYSES OF THE GRANITIC ROCKS

Five analyses of the granitic rocks and one of the felspathized gneiss associated with the pegmatite complex were made by the Mineral Resources Division of the Directorate of Colonial Geological Surveys. The analyses and norms are given in Table IV.

The Eko Ajala granite gneiss (A805), which is related to the marginal granite gneiss of the Ikirun area, has a high content of FeO and MgO due to the relatively large proportion of biotite present. In chemical and mineralogical composition the Eko Ajala granite gneiss is a typical granodiorite. The transformation into the metacrystic granite gneiss (A803 and A804) entails enrichment in SiO_2 and K_2O, small increases in Al_2O_3 and Na_2O, and decreases in CaO, MgO and FeO. This is in accordance with the displacement of the ferromagnesian constituents during the porphyritic granite cycle. The two specimens of the Ikirun granite gneiss (A803 and A804) differ considerably in composition. The percentage of K_2O is nearly the same in both rocks while CaO, Na_2O and Al_2O_3, the oxides which enter into oligoclase, are appreciably lower in specimen A804 which contains a high percentage of silica. The difference in composition is probably due to variations in the degree of replacement of oligoclase by quartz.

The coarse porphyritic granite (A901) is similar in composition to the granite gneiss (A803). The mobilized granite formed during the porphyritic granite cycle was therefore similar in composition to the granite gneiss formed by reconstitution of the pre-existing rocks *in situ*.

The aplogranite (A802), compared with the porphyritic granite, contains slightly less Na_2O, but considerably more K_2O and SiO_2. There is also marked reduction in CaO, MgO and FeO.

The specimen of gneiss analysed (A806) was selected to illustrate the effects of the porphyritic granite cycle on the gneisses. In column 7 of Table IV the analysis of the altered gneiss has been recalculated on a basis of the same Al_2O_3 content as the porphyritic granite given in column 1, the SiO_2 percentage being

TABLE IV

ANALYSES OF GRANITIC ROCKS FROM THE ILESHA AREA

A CHEMICAL COMPOSITION	1	2	3	4	5	6	7
SiO_2	69.04	73.31	69.08	74.19	64.64	77.17	67.48
Al_2O_3	15.47	14.21	14.57	12.94	15.77	10.79	15.47
Fe_2O_3	0.66	0.50	0.87	0.51	1.45	0.70	1.00
FeO	2.25	0.44	2.40	1.56	4.09	2.54	3.65
MgO	0.47	0.17	0.67	0.29	2.10	0.25	0.36
CaO	1.40	0.39	2.13	1.08	4.31	1.19	1.71
Na_2O	3.67	3.20	3.57	3.21	3.05	2.29	3.28
K_2O	5.63	6.60	5.10	5.02	2.27	3.39	4.85
H_2O+	0.79	0.60	0.68	0.60	1.10	0.66	0.95
H_2O-	0.10	0.09	0.14	0.11	0.11	0.14	0.20
CO_2	0.04	0.02	0.03	0.02	0.04	0.04	0.06
TiO_2	0.30	0.06	0.40	0.17	0.64	0.42	0.60
ZrO_2	0.03	n.d.	0.03	0.02	0.02	0.09	0.13
P_2O_5	0.11	0.11	0.15	0.06	0.14	0.05	0.07
F	0.07	0.01	0.10	0.05	0.04	n.d.	n.d.
S	0.01	0.01	0.01	0.02	0.04	0.01	0.01
Cr_2O_3	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
V_2O_5	n.d.	n.d.	n.d.	n.d.	0.02	n.d.	n.d.
MnO	0.06	0.02	0.07	0.03	0.10	0.05	0.07
BaO	0.07	0.03	0.08	0.03	0.14	0.05	0.07
SrO	trace	trace	0.01	trace	0.01	trace	trace
Li_2O	0.06	0.02	0.05	0.06	0.02	0.03	0.04
	100.23	99.79	100.14	99.97	100.10	99.86	100.00
Less O	0.03	0.01	0.04	0.02	0.03	—	—
Total	100.20	99.78	100.10	99.95	100.07	99.86	—
Sp.gr.	2.65	2.60	2.67	2.66	2.76	2.64	—
B NORMATIVE COMPOSITION							
Quartz ..	21.66	28.68	22.80	33.00	25.20	46.38	—
Orthoclase	33.36	38.92	30.02	29.47	13.34	20.02	—
Albite ..	30.92	27.25	29.87	27.25	25.68	19.39	—
Anorthite	5.84	0.83	8.90	4.45	20.29	5.84	—
Diopside $CaO.SiO_2$	—	—	0.23	—	—	—	—
Diopside $MgO.SiO_2$	—	—	0.10	—	—	—	—
Diopside $FeO.SiO_2$	—	—	0.13	—	—	—	—
Hypersthene .. $MgO.SiO_2$	1.00	0.40	1.60	0.70	5.20	0.60	—
Hypersthene .. $FeO.SiO_2$	3.17	0.26	2.77	2.24	5.41	4.75	—
Corundum	1.22	1.43	—	0.51	0.92	1.22	—
Magnetite	0.93	0.70	1.39	0.70	2.09	0.93	—
Ilmenite ..	0.61	0.15	0.76	0.30	1.22	0.76	—
Apatite ..	0.34	0.34	0.34	0.34	0.34	—	—

n.d. = not detected

Analysts : W. H. Bennett, M.Sc., F.R.I.C., and L. C. Chadwick, M.A., A.R.I.C., Mineral Resources Division of the Directorate of Colonial Geological Surveys.

1. (A801) Coarse porphyritic granite, half a mile north of Eripa.
2. (A802) Aplogranite, half a mile north of Eripa.
3. (A803) Metacrystic granite gneiss, milepost 25 on the Ikirun-Ire road (4 miles from Ikirun).
4. (A804) Metacrystic granite gneiss, 300 yds. outside Ikirun on the Ire road.
5. (A805) Dark granite gneiss (granodiorite), where the Ikirun-Iliye track crosses the Awin River.
6. (A806) Felspathized gneiss, one mile south of suspension bridge, Oshogbo.
7. (A806) No. 6 recalculated on basis of 15.47 per cent Al_2O_3.

reduced to bring the total to 100. It will be seen that the ratios between the principal oxides are similar to those in the porphyritic granite, indicating that the final stage of equilibrium during the porphyritic granite cycle was nearly the same, regardless of the texture and physical state of the rocks.

The ratios of the principal oxides to Al_2O_3 are given in Fig. 20. It will be seen that as the K_2O:Al_2O_3 ratio rises, there is a sharp fall in the ratios of MgO, FeO and CaO, and a small decrease in the ratio of Fe_2O_3. The smooth curves strongly suggest that a single granitic sequence is represented, and notable departures are found only in the case of the felspathized gneiss. These results are in accordance with the chemical changes involved in the progressive replacement of oligoclase and biotite by potash felspar. The chemical analyses therefore confirm the genetic sequence indicated by the textural relationships seen in thin section. The principal modifications brought about during granitization were the introduction of K_2O and SiO_2. The Na_2O:Al_2O_3 ratio shows only a small increase, and broadly speaking, the proportion of Na_2O has remained constant throughout the granite gneiss and porphyritic granite cycles. Much of the Na_2O liberated during the replacement of oligoclase by potash felspar was probably incorporated in the albite component of the microcline perthite.

Fig. 21 illustrates the gradual increase in modal quartz and microcline, mainly at the expense of oligoclase, during the granite gneiss and porphyritic granite cycles. There is also a noticeable decrease in mafic constituents towards the coarse porphyritic granite.

THE MUSCOVITE PEGMATITE COMPLEX

A muscovite pegmatite complex occupies a large area around Oshogbo. Lesser bodies are also found around Iliye and to the east of the Igbajo granite. In the Oshogbo area relics of altered gneiss constitute from 20 to 70 per cent. of the pegmatite complex, which also grades laterally into the gneisses. Two types of muscovite pegmatites can be distinguished, namely the oligoclase-muscovite-quartz, and the microcline-oligoclase-muscovite-quartz pegmatites. The former are probably related to the granite gneiss cycle, while the latter may represent a late phase of the porphyritic granite cycle.

THE OLIGOCLASE-MUSCOVITE-QUARTZ PEGMATITES

The oligoclase pegmatites are coarse-grained rocks composed of felspar, quartz and muscovite. Garnet is a constant accessory constituent, and tourmaline is occasionally present. Exposures in the railway cuttings to the north and south of Oshogbo indicate that the oligoclase pegmatites form irregular bodies ranging from a few inches to half a mile in width. The contacts with the gneisses are highly irregular and range from sharp to gradational.

In some cases the transformation of gneiss to pegmatite is marked by the development of aggregates of muscovite and irregular patches of quartz, with only subordinate felspar, while elsewhere the transition involves felspathization of the gneisses and the replacement of biotite by muscovite. Half a mile north of Oshogbo the gneisses show all stages of replacement by an aggregate of quartz, felspar and muscovite, in which the gneissic foliation has been retained in detail. South-west of Oshogbo the characteristic banding and shear zones of the gneisses can still be identified in the replacement pegmatites. The gneisses in contact with the Oshogbo pegmatite complex are rich in coarse biotite and quartz, but felspar is subordinate or completely absent.

As a rule the amphibolites have resisted pegmatization, but along the Ejinle River west of Oshogbo they have been extensively modified during the oligoclase pegmatite cycle. They have been transformed into a rock composed of quartz, felspar and abundant chlorite, which is traversed by numerous thin veins of epidote.

THE MICROCLINE-OLIGOCLASE-MUSCOVITE-QUARTZ PEGMATITES

The microcline pegmatites represent altered oligoclase pegmatites which have been reconstituted by the introduction of potash felspar and a further development of quartz and muscovite. The replacement of the oligoclase by microcline can be clearly seen in the hand specimen. Microcline pegmatites

containing both biotite and muscovite, but little oligoclase, are found along the Oshun River to the south of Oshogbo. Graphic intergrowths of perthite and quartz, forming crystals up to three feet long, are common in the microcline pegmatites. Similar intergrowths of late quartz are also present in the oligoclase and the matrix of the pegmatites, and peculiar radial intergrowths of quartz and muscovite are common. Irregular veins of coarse microcline pegmatite, tapering off into disconnected patches of pegmatite, are sometimes found in the oligoclase pegmatites (cf. Fig. 16).

The *Muscovite Pegmatites* are composed of oligoclase, microcline perthite, quartz and muscovite. The oligoclase ranges from $Ab_{85}An_{15}$ to $Ab_{75}An_{25}$ in composition, and almost invariably shows signs of intense deformation (A199). Quartz is present in large aggregates, and vermicular and graphic intergrowths with felspar are common (A126, 127). Muscovite occurs in flakes, large books and feathery aggregates replacing oligoclase. A little biotite is sometimes found in the oligoclase (A139). In the oligoclase-muscovite-quartz pegmatites interstitial microcline is usually present, but it may be entirely absent. It replaces the plagioclase along cracks and twin lamellae (A128). In the microcline-bearing pegmatities, however, the mineral forms very large plates. In the coarse microcline vein perthite the albite lamellae range up to 1 mm. and more in width. The perthitic veins post-date the quartz-microcline graphic intergrowths, and they frequently follow the boundaries between the host felspar and quartz (Pl. IID). Coarse intergrowths with quartz grading into typical graphic granite are very common. Almandine-spessartite garnet with about 20 per cent. of the spessartite molecule is a constant accessory constituent, and a little interstitial late albite is present (A185B).

GENESIS OF THE PEGMATITE COMPLEX

The field evidence indicates that the oligoclase pegmatites were formed *in situ* during the granite gneiss cycle, followed by extensive modification during the porphyritic granite cycle. The pseudomorphic gneiss structures preserved in many of the pegmatites and the transitional contacts between the gneisses and pegmatites lend support to this hypothesis. Indeed, in some localities the pegmatite is largely composed of felspathized gneiss veined and impregnated with pegmatite. To the west of Okinni brecciation of the gneiss appears to have preceded pegmatization.

It is thought that the iron in the parent gneisses was driven out to form the garnet fringes surrounding the gneiss inclusions. The first period of pegmatization was characterized by the formation of oligoclase and the substitution of muscovite for biotite. As the parent gneisses were composed largely of oligoclase and quartz, very little material was introduced during pegmatization. The

reconstitution of the pegmatites during the porphyritic granite cycle was marked by the introduction of microcline, late quartz and muscovite. It is thought that the graphic intergrowths of quartz and felspar in the Oshogbo complex were formed by replacement of the oligoclase pegmatites. The muscovite-quartz intergrowths are the final products of sericitization of the oligoclase. They are roughly contemporaneous with the graphic felspars, and it appears that muscovite had locally taken the place of the potash felspar.

QUARTZ VEINS

Three types of quartz veins, including semi-conformable and discordant veins of quartz and quartz-tourmaline, can be distinguished.

The *Semi-conformable Quartz Sheets* are most commonly found in the amphibolite complex, but they also occur in the gneisses. They are related to the semi-conformable pegmatites and sometimes form the core of composite quartz-pegmatite bodies. The semi-conformable quartz veins range from a few inches to several hundred yards in thickness, the larger bodies generally being found along faulted contacts. In addition to quartz, a little biotite and pink garnet are often present. In places, traces of the original banding of the country rock can be seen in the vein quartz, which has obviously been formed by replacement.

The *Discordant Quartz Veins* commonly consist of a core of glassy vein quartz with a few thin partings of sericite, grading laterally into a typical quartz schist with numerous closely spaced partings of sericite. The quartz veins in the Okinni area, which form a series of small ridges, are located along fault zones. The prominent ridge one mile south of Iliye is composed of vein quartz and quartz-sericite schist. It follows a major NNE.—SSW. shear zone.

The *Quartz-tourmaline Veins* are composed of milky quartz and black tourmaline. The tourmaline which may constitute up to 60 per cent. of the rock, ranges from large striated prisms to fine fibrous aggregates. Along the walls of the veins the country rock has frequently been impregnated with quartz and tourmaline, sometimes with a banded structure. The quartz-tourmaline veins are younger than the quartz-sericite schists.

Under the microscope the conformable quartz veins are seen to be composed of a granular mosaic of quartz averaging from 0.5 to 1 mm. in diameter. The quartz is clear and unstrained. In the amphibolites the quartz veins may contain up to 50 per cent. of garnet, and a little chlorite is occasionally present. The quartz-sericite veins are characterized by an uneven quartz mosaic and thin partings of sericite with a foliated structure. In the schistose varieties the quartz is intensely strained. The quartz-tourmaline veins are composed of

granular quartz and large crystals and fine fibrous aggregates of strongly pleochroic tourmaline. The larger crystals often contain numerous inclusions of quartz. Apatite is occasionally present.

DEFORMATION ASSOCIATED WITH THE PORPHYRITIC GRANITE CYCLE

Prior to and during the emplacement of the coarse porphyritic granites, the rocks of the Ilesha area were subjected to a prolonged period of intense deformation. Although this cycle culminated before the emplacement of the granites, it imparted a strong foliation to them, and also controlled the structural pattern of the post-granite dykes.

THE MAJOR FAULTING

During the deformation cycle, extensive shear faulting and close folding on a small scale took place. The small folds frequently pass into minor shear faults. The foliation on opposite sides of many of the major geological boundaries is strikingly discordant, and suggests that they are of structural origin. On the map only definite faulted boundaries are shown as faults, but there is little doubt that many of the other interformational boundaries also represent shear displacements.

The deformation has had little effect on the rocks in the immediate vicinity of the faults, but at Ijebu-Ijesha and Iwara sericite and muscovite have been developed which impart a well-defined secondary schistosity. East of Itagunmodi, the gneisses have also acquired a secondary schistosity at an oblique angle to the gneissic structure. The talc-tremolite and marginal chlorite schists of the amphibolite complex occur along shear zones and faulted junctions which may belong to the porphyritic granite cycle of deformation.

The granitization which led to the formation of the potash granite gneisses in the variegated gneisses around Iwara can probably be related to the Iwara fault, and the persistence and regular trend of the thin band of potash granite gneiss to the north possibly represents its continuation. The outcrop form of the gneisses and amphibolites suggests that they may have been duplicated by folding. While it is probable that many of the faults ante-date the porphyritic granite, some of them, as for example the Ikirun fault, appear to be younger.

DEFORMATION DURING AND AFTER THE EMPLACEMENT OF THE GRANITE

Planar and Linear Structures in the Granite. There is reason to believe that the granite was at least partially mobilized at one stage in its history and that it

remained in this state until after it had been emplaced. The major E.-W. stress induced partial re-orientation of the biotite, and the microcline crystals grew with their (010) faces at right angles to the direction of maximum compressive stress. The foliation is much less noticeable in the central, coarsely crystalline part of the granite, and though the mass was foliated in response to regional stress, the marginal facies is invariably foliated roughly parallel with the contacts.

A rude lineation, plunging to the north, is also present in the granites. The direction and dip of the foliation indicates that the least axis of the strain ellipsoid trends almost E.-W. and dips at about 25° to the east. The axis of greatest strain, which parallels the lineation, trends almost due north and plunges at a low angle to the north, while the intermediate axis is almost vertical.

Aplogranites, Pegmatites and Joints. The strikes and dips of a large number of aplogranite and pegmatite dykes and joints have been plotted in Figs. 17, 18 and 19. Apart from the dykes following the foliation in the granite, nearly all the dykes and joints are vertical or dip steeply to the south-east, south and south-west.

Most of the aplogranites strike almost due north, and it is probable that they follow the L-joint directions of Cloos' classification, since they parallel the foliation (Balk, 1937). Other prominent aplogranites strike SSE.-NNW. at an angle of 60° to the direction of maximum compression. It is probable that these dykes follow planes of weakness formed in response to E.-W. compressive stress.

While the N.-S. trend is still prominent in the case of the pegmatities, there are three other directions of importance. The N.-S. set apparently follows the L-joint or foliation direction. The set trending SSE.-NNW. follows the plane of maximum shear under E.-W. compressive stress. The two prominent conjugate sets trending NE.-SW. and E.30° S. are symmetrically disposed around the E.-W. direction of maximum stress. The fractures occupied by these pegmatites were probably formed under E.-W. tensional stress.

The fact that many of the aplogranite dykes follow shear zones formed under compressive stress, while many of the pegmatites follow conjugate tensional fractures indicates that the aplogranites and pegmatites are related to periods of compression and tension respectively. The aplogranites are older than the pegmatites, and it appears that the intensity of compressive stress gradually waned during and after the consolidation of the granite.

The quartz veins and joints were generally found to follow the same directions, and they have been grouped together in Fig. 19. Many of the quartz veins and joints strike SSE.-NNW. Two other prominent sets of joints strike N. 35°

E. and ESE.-WSW. respectively. The angle between them is 80°, and they are symmetrically disposed about a ENE.-WSW. axis.

MYLONITIZATION

During a late phase of deformation, the variegated gneisses around Iwara were subjected to intense microbrecciation with the development of augen structures. In the amphibolites to the west of the fault, dark, dense mylonitic zones occur. Under the microscope they are seen to be composed of rounded grains of microcline and plagioclase in a fine-grained micaceous matrix with aggregates of quartz. The fact that microcline is affected by the mylonitization suggests that the deformation post-dates the porphyritic granite cycle. Mylonitic zones have also been encountered in the granite gneisses around Iliye and in the gneisses along the Awin River to the West of Oba.

THE QUARTZ-SERICITE SCHISTS

Towards the eastern boundary of the map there is a series of prominent strike ridges of quartz schist with a northerly trend. At Oke Illa only one belt is present, but around Erin Odo in the south, eight separate belts of schist occur. The quartz schists range from massive, granular, glassy rocks to schistose varieties with closely spaced sericite partings, the latter being found along the margins of the schist belts. A little sillimanite is often present, and lenses of pink quartz-sillimanite schist are found here and there. To the west of Ido Irapa the schists also contain scattered grains of colourless garnet.

The quartz schists are probably much younger than the gneisses and schists of the Basement Complex. To the west of Effon Alaiye there is a strong discordance between the schists and gneisses, and the most westerly belt of quartz schist cuts across the Iwara fault. Although quartz-tourmaline veins are found in the quartz schists, pegmatites are completely absent, and it is possible that the schists are younger than the porphyritic granites. The schists may represent a younger sedimentary formation, metamorphosed and infolded in the Basement Complex, but it is also possible that they were formed by silicification along major planes of dislocation.

Under the microscope the quartz-sericite schists are seen to be composed of irregular grains of quartz elongated in the direction of schistosity. Sericite is present in thin folia which traverse the quartz grains, and in interstitial aggregates with quartz. Radiating clusters of sillimanite are sometimes present.

THE DOLERITES

Dykes of dolerite, up to three feet in thickness, are widely distributed in the Basement Complex. Outcrops are scarce, and the only indications of the presence of these dykes may be boulders on the surface. The dykes are constant in width, but are seldom straight, and chilled margins are often present. Under the microscope, the dolerites are seen to be composed of small phenocrysts of plagioclase in a fine-grained groundmass of plagioclase laths, granules of augite and abundant iron ore. The felspar has been intensely saussuritized, and interstitial chlorite is abundant.

PETROGENETIC CONCLUSIONS

Within the Ilesha area there are granitic rocks belonging to two different periods of emplacement which can be related to two separate orogenic cycles. The contrast between the gneissic structure of the predominantly oligoclase-bearing granite gneisses, and the granitic texture of the younger microcline granites finds interesting parallels in other ancient shields.

A connection between the form and contact relations of granites and the depths at which they were emplaced was recognized by Sederholm (1936). An increasing number of granites is found in the older formations and the greatest concentrations occur in the earliest Basement rocks. Nearly all of these ancient intrusions are granodiorites which are of moderate dimensions and show no signs of an ordered distribution. Granite masses of batholithic dimensions in the oldest rocks can usually be correlated with relatively late periods of injection which have affected the younger systems. The country rocks associated with the early granites have been subjected to intense regional metamorphism which bears no relation to the intrusives. Metamorphic aureoles are absent and the gneissic granites appear to be syntectonic.

The ancient granodiorites are mostly concordant with the structures in the country rocks, while the later batholiths are for the greater part cross-cutting. Even where the former are transgressive they grade into the country rocks and have the same foliation direction. A statistical study of the structural habit of North American batholiths by Blackwelder and Baddley (1925) indicates that about ten per cent. have concordant contacts, while the rest are cross-cutting. These writers are of the opinion that the transgressive bodies are characteristic of the higher levels of the crust, concordant relations being more common at the lower levels.

Jenks (1948, p. 119) is of the opinion that the granitic bodies of the pre-Cambrian were formed in the roots of mountains or disturbed belts by aggressive replacement of a kind distinctive of extreme conditions of depth, pressure and

possibly stress. The younger batholiths on the other hand were derived from below and actively intruded their way into the country rocks. According to Read (1946, p. 66) the French geologists "correlated the style of contact with the depth of granite formation, clean and definite in the upper levels, hazy in the lower."

The existence of relatively small granite bodies at the lowest levels of the crust in contrast with the large batholiths of the higher levels suggests that the latter may have been formed by a process of integration (cf. Andrews, 1926). Grout (1948) states that the Saganaga granite, which has probably been eroded to a depth of twenty-five miles, is divided in its deepest parts into root-like projections by gneiss. He believes that granites arise from the gneissic zone by partial melting above the basalt zone and that small bodies of magma form and grow until the volume is great enough to enable them to rise. On reaching the more coherent crust they may spread and merge into large batholiths.

The granite gneisses of the Ilesha area appear to be typical syngenetic bodies, formed largely by granitization *in situ* under strong directed stress. During the period of relief which followed the deformation, the oligoclase pegmatites were formed. A later cycle of orogenesis led to the formation of new bodies of granite at depth both by granitization and remelting, accompanied by granulation of the oligoclase in the granite gneiss and pegmatite. The younger granite was mobilized and intruded into its present position, and the entire process could be called granitic rejuvenation. When movement had practically ceased, potash felspar was formed in the granite and in the peripheral rocks with the production of a coarse porphyritic granite and associated metacrystic rocks. The new granite can be regarded as a typical late-tectonic product.

Since the microcline phenocrysts have not been affected by the strong deformation which granulated and distorted the other minerals, it seems likely that they were formed after the granite had been emplaced. The presence of identical microcline crystals in the gneiss inclusions and migmatites supports this view. Similar relations in other parts of the world have been adduced as evidence of granitization, but Grout (1948, p. 49) believes that such crystals can be formed by reaction between a magma and solid rocks. It is probable that the physical condition of the wall rocks did not differ much from that of the porphyritic granite and that the late crystals were able to form in both. It is of interest to note that Walker and Mathias (1947) regard both the porphyritic and porphyroblastic felspars at the granite-slate contact, Sea Point, Cape Town, as potash replacements at a late stage.

The pegmatitic stage normally associated with granitic intrusions is represented by the pegmatite dykes and veins, and by the regional pegmatization of

the Oshogbo area. The semi-conformable pegmatites which were found to be earlier than the porphyritic granite in the neighbouring Osi area (King and de Swardt, 1949) may have formed in the region of tension which existed in the country rocks above the rising granite mass (cf. Grout, 1945).

ECONOMIC GEOLOGY

GOLD

The discovery of gold in the Ife-Ilesha area in the early forties raised hopes that a large productive goldfield had been discovered in Nigeria, but these hopes have proved unfounded. Gold was first reported in September 1940 from the Owena River north of the Ife-Ondo road, to the south of the area mapped, but it received little attention at the time. Later, in December 1941, mining began south of Yemogun. The presence of gold-bearing deposits may have been known to the local inhabitants before 1940, probably since 1936 when the number of goldsmiths in the neighbourhood rose sharply. In 1946 interest increased and several mining companies were attracted to the area ; one acquired an option over a large area west and south of Ilesha, while another started prospecting east of Ife. These companies, however, found the detrital deposits too small to interest them. Payable gold deposits are worked south of the area mapped, but the most important are those south of Ilesha. Almost the entire production has been from the basal layer of the recent river deposits. Some gold has been won from the weathered zone above a vein near Iperindo, while a little gold has been recovered from the vein itself by hand crushing and panning.

The Gold-bearing Veins. There are only two localities in the Ilesha area where quartz veins with a notable content of gold have been found. These occur near Iperindo, a village about nine miles south-east of Ilesha, and in a tributary of the Eriperi River a mile and a half north of Itagunmodi.

(*a*) *The Iperindo Vein System.* During the working of an isolated occurrence of gold-bearing alluvials near Iperindo, it was found that payable values persisted up the slope of the valley into eluvial ground. Further work led to the discovery of an auriferous quartz vein. Intensive surface prospecting followed and about twenty trenches were dug and a shaft was sunk on the thickest part of the main vein.

The Iperindo veins occur in a parallel swarm over a zone about 90 feet wide. The average strike is ten degrees east of north and the mean dip is 80 degrees to the west. The veins vary considerably in thickness along the strike from six inches to more than 17 feet, and a ten-foot vein may disappear completely in

less than a hundred yards. The zone comprises up to six veins, but in some trenches only diffuse silicification was observed, with no well-marked ore bodies. The veins are from six to 24 feet apart. The quartz is granular and of medium grain, and oval grains of felspar are nearly always present. Muscovite flakes become abundant where the proportion of felspar decreases, and the two minerals appear to have an antipathetic relation. Inclusions of gneiss, in which the felspars are coarser than usual, are common. They are lenticular and aligned parallel with the walls. Towards the contacts the amount of felspar in the veins increases and either or both walls may have a six-inch band of pegmatitic material. In addition the veins contain irregular bodies of coarse pegmatite, composed of pink felspar, quartz and biotite, with a thin fringe of finer biotite flakes.

The contacts of the veins range from sharp to completely gradational. Transitional contacts are characteristic of the more felspathic veins. Thin veins, stringers and lenses of quartz or granitic material may occur over a width of several feet in the country rock beyond the main contacts. A foliation which is well shown on weathered outcrops is present in some of the veins. It is parallel to the grain of the country and may make a small angle with the contact and be continued beyond into the gneiss. The gneiss inclusions also have the same foliation direction and fade gradually into the surrounding vein material. There are no signs of movement associated with the veins and it is probable that they are of the replacement type and of hypothermal origin.

Gold is seldom visible in hand specimen, but both pyrite and arsenopyrite can be seen in the payable parts of the main vein. The gold content appears to be related to the thickness of the veins ; the main vein contains 40 dwts. of gold per long ton over a 16-foot section, but only a trace remains where it thins to a few feet. The other veins gave variable but low values. The grade is erratic and stretches with a high gold content are of limited length. A certain amount of gold has been won from the outcrop by hand crushing and panning.

Fragments of felspathic quartz are found on the surface over a wide area around Iperindo, indicating that the felspathic type of vein is common. A large number of these fragments was crushed and panned, but none showed any colours.

(*b*) *The Itagunmodi Gold-Quartz Bodies.* The gold-bearing quartz near Iperindo was discovered at the bottom of alluvial workings. The exposures were incomplete, but several bodies of vein quartz up to six feet wide were laid bare. Extensive trenching has shown a complete lack of persistence, and the quartz appears to form short, conformable lenses, arranged *en echelon*. The

country rock is amphibolite and the lenses occur near an unconformable contact with biotite gneisses.

The lenses are composed of alternating bands and streaks of white granular quartz and a very fine-grained dark grey to black material. Under the microscope the latter is resolved into minute grains of quartz with aggregates of small micaceous flakes traversed by veinlets of quartz. The rock may be a silicified mylonite. The quartz lenses give good colours, but they are too small and far apart to be of economic interest. Near the exposures the laterites on the valley slopes usually show one or two colours to the pan.

There are certain similarities between the gold-bearing veins of the Ilesha area and those of the Sokoto goldfield (Tattam, 1941). In Sokoto the quartz forms lenses, stringers, narrow veins and dykes and, as in the Ilesha district, the lenses and stringers are conformable to the grain of the country. Gold-bearing, quartz-felspar dykes are also found in the Sokoto field. Felspathic quartz veins appear to be common around Ilesha, and the granular quartz cores may be related to the auriferous quartz sheets. The Iperindo lodes grade marginally into the semi-conformable pegmatites. In the Ilesha area most of the potash felspar appears to be related to the porphyritic granite, hence it is probable that the auriferous veins represent a late product of this cycle.

The Detrital Deposits. Though nuggets are found occasionally, most of the gold is present as fine scales and less often as dendritic aggregates. Gold occurs from top to bottom, but only the basal pebbly zone of the deposits is payable. Abundant magnetite, ilmenite and zircon are also present. Where the bedrock is deeply weathered, gold particles have been found up to six inches below its surface, and decomposed amphibolite below the wash may constitute an important source of gold. Most of the gold particles show no signs of rounding, and even when they are slightly worn, the associated quartz fragments remain angular. It is evident that the detrital deposits are of local origin and that the gold has not travelled far. This conclusion is supported by the presence of payable gold to within a few hundred yards of the sources of many of the minor tributaries.

The gold content of the deposits is roughly constant, and there are no rich concentrations which might indicate the position of lodes. In some cases the gold is found to persist laterally into angular debris at the base of the soil profile, which must have been derived from auriferous veins further up the slope. In the Ijana area a few promising leads of this type were followed for short distances, but trenching failed to disclose payable lodes. The quartz occurs in impersistent narrow veins and stringers, and many fragments of quartz with visible gold are to be found. Several nuggets have been recovered, the largest of which weighed ten and a half ounces.

On page 3 it was shown that the Ilesha area has been subjected to three recent erosion cycles. During each cycle gold and rock detritus were concentrated along the streams, and to a lesser extent on the successive land surfaces. When the third period of erosion began, most of the surface was covered by laterite, from which the majority of the present payable deposits were derived. In other words, gold was concentrated in stages, by the removal of the other products of weathering, and by river action. The laterite is gold-bearing even far from the present stream channels, and near the auriferous quartz veins north of Itagunmodi it carries appreciable, although not payable, amounts of gold.

Practically every stream deposit in the Ilesha area carries traces of gold, even where tributaries flow entirely over granite or muscovite pegmatite. The economic map of the goldfield shows that, with the exception of the small lode and detrital deposits of the Iperindo area, all the payable gravels are confined to valleys draining country underlain by the amphibolite complex. Beyond the amphibolite complex the gold content decreases rapidly and payable deposits are seldom found at a distance of more than a mile. Thus the extensive alluvial deposits along the Oshun and Eriperi Rivers do not carry payable gold. The most important gold-producing area is that around Ijana village, in the headwaters of streams on both sides of the Owena-Eriperi watershed.

The Provenance of the Alluvial Gold. Most of the gold has been derived from the semi-conformable granular quartz veins or sheets in the amphibolites. Some of the veins contain traces of gold, but seldom enough to be of economic significance. The lack of localization of payable deposits except in relation to the major amphibolite masses, indicates that the alluvial gold has been derived from these veins, and from the small inconspicuous quartz stringers. It is difficult and costly to prospect for lodes because of the great thickness of overburden and the dense vegetation. All the auriferous veins are conformable to the grain of the country, but gold has not been found in the cross-cutting tourmaline-bearing veins, or in the quartz schists. Weathering products of the latter tend to obscure surface indications of the auriferous veins.

Tattam (1941) considers that the gold in Sokoto is concentrated in schist belts which comprise greenstones and other mafic rocks. It is possible that these schists belong, as in the Ilesha district, to an amphibolite complex. He also showed that the quartz veins in the hornblende gneisses are richer in gold than those in other gneisses. It is of interest to note that the gold-bearing veins at Okalom in Kabba Province also occur in amphibolite.

In the amphibolites near the coarse porphyritic granite and the granite gneiss, there are no payable alluvials. Small deposits are present around Ibokun, but it is only at Idokka, ten miles from the granite contact, that payable deposits are found.

The Quality of the Ilesha Gold. A large proportion of the production from the Ilesha area was exported to the United Kingdom during the first few years of operations. Table V shows the bank assays of the gold that was shipped by Mr. J. Passman in the period February 1942 to July 1945. The figures were kindly supplied by Mr. Passman. The export of gold subsequently ceased as a result of a great increase in the local demand.

TABLE V

ASSAYS OF GOLD BULLION

Month	Bullion After Melting	Silver	Gold	Silver Ounces	Gold Ounces
1942					
Feb. & Mar. ..	440.100	33	960.5	14.52	422.716
April	379.400	34	961.5	12.89	364.793
May	804.050	32	964	25.72	775.104
June	1190.300	29	963	34.51	1146.258
July	1209.250	35	960	42.32	1160.880
Aug.	904.800	43	937.5	38.90	848.250
Sept.	805.050	32	961.5	25.76	774.055
Oct.	873.050	30	964.5	26.19	842.056
Nov.	747.800	30	965.5	22.43	722.000
Dec.	801.550	31	964.5	24.84	773.094
1943					
Jan.	511.400	30	965.5	15.34	493.756
Feb.	437.200	31	964.5	13.55	421.679
Mar.	450.150	35	960	15.75	432.144
April	530.000	30	963	15.90	510.390
May	250.600	33	964	8.26	241.578
June	189.450	37	955.5	7.00	181.019
July	186.150	26	970	4.83	180.565
Aug.	148.300	31	962	4.59	142.664
Sept.	304.000	20	962	6.08	292.448
Oct.	392.650	29	967	11.38	379.692
Nov.	304.850	30	963.5	9.14	293.722
Dec.	381.550	31	965	11.82	368.195
1944					
Jan.	290.700	27	965.5	7.84	280.670
Feb.	201.100	28	967	5.63	194.463
Mar.	267.200	26	967.5	6.94	258.516
April	170.350	29	966	4.76	164.558
May	262.600	42	949.5	11.02	249.338
June	142.200	40	956	5.68	135.943
July	109.900	33	960	3.62	105.504
Aug.	89.900	35	958.5	3.14	86.169
Dec.	42.650	32	963	1.36	41.071
1945					
Jan.	150.300	28	968	4.20	145.490
Feb.	287.900	37	958	10.65	275.808
Mar.	297.050	29	966	8.61	286.950
April	307.150	30	965	9.21	296.399
May & June ..	446.200	32	963.5	14.27	429.913
July	162.550	30	965.5	4.87	156.942

The above figures show that the gold is of high fineness. The 15,469 ounces assayed contained 14,875 ounces of gold, giving an average fineness of 961.5 parts per thousand. This high figure may be the result of secondary enrichment in the zone of weathering.

Production and Prospects. The annual gold production in the Ilesha area is given in Table VI. The total amounts to more than half the Nigerian output for the years 1942 - 50.

Production dropped sharply after 1942, owing to wartime restrictions on prospecting, and exhaustion of the rich deposits. The low output in 1947 was due to the suspension of work by certain operators while mining companies were prospecting their ground.

TABLE VI

NIGERIAN GOLD PRODUCTION IN OUNCES (UNREFINED)

1942-52 *

Year	Ilesha Goldfield	Total for Nigeria
1942	22,898	43,747
1943	9,363	17,413
1944	4,255	8,995
1945	5,856	9,214
1946	3,390	5,548
1947	1,535	2,503
1948	2,030	3,294
1949	2,084	2,858
1950	2,037	2,543
1951	1,663	1,780
1952	1,278	1,348
Total 1942-52	56,389	99,243

* Mines Department Annual Reports 1942-52

Most of the river gravels in the Itagunmodi, Ijana and Ibodi areas have already been worked. Practically all the mining has been done by tributers, who pan the gold, and thus much of the finely divided gold is lost. Gravels which may be payable occur along the Ora River and its tributaries in the Iregun area, and along some of the tributaries of the Eriperi near Oke Ibode. The deposits along the Erinwo River near Ibokin are also worth further investigation. Although it is clear that the goldfield has passed its peak, mining on the present

ECONOMIC MAP
OF THE
ILESHA GOLDFIELD
SCALE - 1: 125,000
LEGEND

- Areas mainly worked out.
- Areas being worked, December 1951.
- Areas probably gold-bearing.
- Areas possibly gold-bearing.
- Auriferous lodes.
- Amphibolite complex.

Idoko
Essum
Ere
Ibala
Idoka
Idominasi
Iwoye
OkeIbodi
Ijaregbe
Ijebu Ijesha
Ipoye
Iregun
Iloro
Ila
Osin
OkeAsawa
Isola
Ijeda
Odo
Iloko
OkeAwa
Iloba
Osaobi
Quarry
Inisha
Iwaraja
Imo
ILESHA
Akola
Uwara
Uwara
Ibodi
Umelu
Oshu
Igila
Damadu
Irogbo
Okepe
Ijeri
Jamnaku
Ijamba
Okeku
Iremegun
Ijana
Agbeo
Igbadai
Epe
Ise
Odo
Obaloba
Itagunmodi
Igun
Iwara
Ayegunle
Araromi
Oke Igbo
Gill's Camp
Odogbo
Ararorin
Mukura Reservoir

A.M.J. de S./E.I.W.
620/603/9-52

G.S.N./D.O.2/86.

scale will probably continue for some years. The rise in the price of gold after devaluation did not lead to increased production, but it has probably lengthened the life of the field.

TALC

Impure talc-schists are found in the larger amphibolite bodies. The best deposit is found one mile to the south-west of Iregun, where a body of talc-schist, about three miles long and 250 yards wide, is found along a major fault zone. It contains a small proportion of coarse tremolite. The talc is of no economic importance at this time.

TINSTONE

Traces of tinstone are found in the heavy mineral concentrates from the streams draining the pegmatite complex round Oshogbo. Cassiterite is also found in a stream one mile west of Iregun village. The wash contains small pieces of quartz-felspar pegmatite with occasional crystals of cassiterite and abundant tourmaline. Surface indications of tourmaline-muscovite pegmatite are found near the stream, while outcrops of a coarse tourmaline-quartz rock are abundant. About two tons of cassiterite have been won from these alluvial deposits.

REFERENCES

ANDREWS, E.C., 1926 : Igneous Intrusions and Ore Deposits of the "Zone of Rock Flowage." *Econ. Geol.*, Vol. 21, pp. 81-90.

BALK, R., 1937 : Structural Behaviour of Igneous Rocks. *Geol. Soc. Amer., Mem.* 5.

BLACKWELDER, E., and BADDLEY, E. R., 1925 : Relations between Batholiths and Schistosity. *Bull. Geol. Soc. Amer.*, Vol. 36, pp. 208-9.

GROUT, F. F., 1945 : Scale Models of Structures Related to Batholiths. *Amer. Journ. Sci.*, Vol. 243—A, pp. 260-84.

GROUT, F. F. 1948 : Origin of Granite : *Geol. Soc. Amer., Mem.* 28, pp. 45-54.

JENKS, W. F., 1948 : In Discussion of Papers on " Origin of Granite." *Geol. Soc. Amer., Mem.*28, pp.128-9.

KING, B. C., and DE SWARDT, A. M. J., 1949 : The Geology of the Osi Area, Ilorin Province. *Geol. Surv. Nigeria, Bulletin No.* 20.

READ, H. H., 1946 : The Subject of Granite. *Sci. Prog., London*, Vol. 34, pp. 659-69.

SEDERHOLM, J. J., 1936 : Batholiths and the Origin of Granitic Magma. *Inter. Geol. Congr.*, Rept. XVI, 1, pp. 283-8.

TATTAM, C. M., 1941 : The Sokoto Goldfield. *Ann. Rept. Geol. Surv. Nigeria*, pp. 4-11.

WALKER, F., and MATHIAS, M. 1947 : The Petrology of Two Granite-Slate Contacts at Cape Town. *Quart. Journ. Geol. Soc. London*, Vol. 102, pp. 499-518.

WILSON, R. C., BAIN, A. D. N., and RUSS, W., 1922 : The Geology of the Western Railway. *Geol. Surv. Nigeria, Bulletin No.* 2.

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APPENDIX.

THE SOILS OF THE ILESHA-IKIRUN-EFFON ALAIYE AREA

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Systematic soil surveys were begun by the Cocoa Soil Survey Section of the Department of Agriculture in 1951. The Survey of an area which includes most of that described in this Bulletin was started in July, 1952, and will take about a year to complete. The following is a preliminary account of the soils. Most of the soil series found have already been studied in a similar survey of the south-eastern part of Ibadan Province, where the predominant parent rocks appear to be very similar to those of the Gneiss and Biotite Schist Complex of the present area.

Typical profiles of the main soils are illustrated by diagrams, drawn according to a system which has been used by C. F. Charter, whose work has provided the basis for classification of the soils of the cocoa-growing areas of West Africa into units for mapping purposes [references (1), (2)].

MAPPING UNITS

The soils are being classified into "Soil Series" in the generally accepted manner—a soil series being a mapping unit forming as far as possible a recognisable part of the landscape, having similar drainage conditions throughout, and including a limited range of variation in the profile. The soil series form a number of "associations", consisting of topographical sequences (soil "catenas") which have one or more soil series on the hill-tops and upper slopes, and several soil series in the valleys.

The soils have been divided into three drainage classes:—(A) well drained and fairly well drained, (B) poorly drained, (C) seasonally flooded or swampy.

All the soils on sloping ground in this area have a friable porous consistency and free internal drainage, even when they contain high percentages of clay. Very few analyses of the clay fraction have been done, but this appears to consist mainly of kaolin and hydrated iron oxide.

In subdividing the soils of each drainage class into series, account is taken of the presence or absence of boulders or of signs of decomposed rock *in situ*, the depth of gravel layers, the mechanical composition, the colour of the soil, and the main type of rock from which the soil appears to be formed. The first

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three of these factors are largely determined by the detailed geomorphology and the mode of origin of the parent materials of the soils.

The soil series which have been distinguished are considered to fall into five groups, as regards the type and mode of origin of the parent material, with two or three exceptions. These groups are the following :—

(I) "Eluvial Mottled Earths", coinciding with very large parts of the intermediate erosion level described by de Swardt, and included by him in the "laterites"; the profile has about three feet of rather gravelly material which has been mixed and moved by processes of hill-creep and by the action of roots and soil fauna, over a layer of clay (which is usually clearly mottled) formed from the parent rock *in situ*, and often of great depth (10 to 15 feet or more).

(II) "Hill-Creep Soils", in which the material mixed and moved by hill creep, roots and fauna (about two feet to eight feet thick) directly overlies or merges into rotting rock, with no intervening layer of mottled clay formed *in situ*.

(III) Shallow "Skeletal Soils" with gravel and rock fragments, over hard rock, on hills.

(IV) "Hill-Wash Soils", formed from non-gravelly hill-wash material or local alluvium at least 18 inches (typically 30 to 60 inches or more) in depth, overlying hill-creep material or material formed *in situ*.

(V) Soils formed from river and stream alluvium.

In order to classify and map the soils rapidly and in units which can readily be recognised by persons using the maps, it is necessary to concentrate attention on the top two to three feet of the profile. For this purpose it is not essential to define the origin of the soils more fully than in the classification given above. However, there is much research still to be done on the processes by which the various typical soil profiles and the catenas of soil types have been developed, which must include detailed studies of the geomorphology, and this will be at least illuminating to the soil surveyor.

The main soils omitted from the above classification are those which have concretionary ironstone or layers consisting dominantly of ferruginous concretions i.e., the material defined as "laterite" by du Preez* [reference (3)] and others.

* "Laterite is a vesicular, concretionary, cellular, vermicular, slag-like, pisolitic or concrete-like mass consisting chiefly of ferric iron oxides with or without mechanically entangled quartz and minor quantities of alumina and manganese; it is of varying hardness but it is usually easily shattered when struck a sharp blow with the hammer."

Hard ironstone overlain by very shallow soil forms a capping to remnants of the older erosion surface, as described by de Swardt; this forms a negligible total area.

Sandy soils having broken-up ironstone or dominant quantities of concretions between one and three feet from the surface occur in two different ways. Firstly, such soils are frequently found in an irregular and usually narrow zone along the slope, marking the lower edge of the remains of the intermediate erosion surface; the zone is generally too narrow for these soils to be mapped separately, and they are at present being recorded only as "variants" or exceptional variations of the soil series with which they are associated. Secondly, soils of this type occur extensively on the upper slopes of the intermediate erosion surface over granitic rocks and gneisses in some areas of savannah country, and one soil series, the Odeomu Series, has been set up to include these; there are probably a few places near Oshogbo where this series will be mapped, within the area described in this Bulletin.

SOME GENERAL FEATURES OF THE SOILS

In these climatic conditions plant remains are decomposed rapidly in the surface soil by insects, worms and micro-organisms, giving rise to an intimate mixture of inorganic material and humus. The activity of insects, etc., causes gravel and stones to be buried under a non-gravelly topsoil, and in all except the swampy and seasonally flooded soils and skeletal soils, the surface is commonly completely covered with worm-casts. As a result there is generally a distinct dark, crumbly and fine grained top layer about two inches thick. containing about four or five per cent of humus, formed from broken-up worm-casts, over a paler non-gravelly but coarser-grained layer to a depth of about six inches, containing about two or three per cent of humus, overlying the subsoil layers which contain smaller and decreasing amounts of humus. The topsoil layers and upper layer of subsoil tend to be mixed during cultivation but become clearly separated again after two or more years of fallow under natural regrowth of trees and shrubs. In general, finer-texture topsoils, overlying the more clayey subsoils, contain appreciably more humus than those which are coarser-grained and overlie the more sandy subsoils.

Under the moderate rainfall of this area leaching is sufficient to make the topsoil weakly acid to neutral (pH value 6.0 to 7.0), the base-exchange capacity of the humic and clay colloids being almost or completely saturated by the ions of calcium, magnesium, potassium and sodium set free by decomposition of

plant remains; calcium forms about 80 per cent of the total exchangeable cations. The subsoils are moderately acid (pH value about 5.0 to 5.5) below about 18 inches, and the layer above this is intermediate.

The fertility of the soils is largely dependent on the action of the vegetation in taking up small quantities of nutrient elements from the deeper layers of subsoil, as well as from the main rooting zone in the topsoil, and returning these to the surface in the form of leaf litter and other residues. The reserves of fertility present therefore vary with the nature of the decomposing parent rock and its depth.

When these soils are cleared from forest or from fallow growth consisting of trees and bushes, they have a remarkably abundant supply of nitrate, as the conditions are very favourable for micro-organic activity and for a satisfactory balance between the substances making up the humus, indicated by a carbon : nitrogen ratio of about 10 to 12. Nitrate continues to be produced for some years by the decomposition of the stored-up humus, but becomes depleted if cultivation is prolonged for more than about six years.

Where the vegetation has changed to "savannah" (grass with some trees and bushes) the carbon : nitrogen ratio is higher and the supply of nitrate tends to be seriously deficient for at least the first season when the land is brought into cultivation.

With regard to the vegetation, it should be observed that the whole of the area under discussion is in the forest zone [reference (4)] and that the savannah vegetation covering a large part of the north-western quarter is the result of the spread of fires. Encroachment of savannah has been more rapid on shallow and very sandy soils than on deep and more clayey soils, because the better supplies of moisture in the latter have favoured the survival of the original forest species during repeated clearing and burning.

NOTES ON THE MAIN SOIL PROFILES

The diagrams and the following notes refer to the typical soil of each series, and certain less important variations which are included with these for mapping purposes need not be considered here.

A. WELL DRAINED AND FAIRLY WELL DRAINED SOILS

Eluvial Mottled Earths

Figure 1 (Sandy clays).

(a) *Egbeda Series*—reddish-brown to red subsoil; occurs over the Gneiss-Biotite Schist Complex, and is apparently derived mainly from fine-grained

gneiss rich in biotite. Good cocoa soils generally, on account of retention of moisture; at present occupied by large areas of cocoa west of Ilesha, but elsewhere mainly used for food-farming in rotation with bush fallows.

(b) *Olorunda Series*—pale brownish subsoil; apparently derived from various fine-grained gneisses, but similar pale soil over the Amphibolite Complex near Ikirun is provisionally included in the series. Less satisfactory soils for cocoa than the Egbeda Series.

(c) *Iwo Series*—brownish to reddish subsoil; coarser texture on the average than Egbeda and Olorunda Series, but not clearly separated from these; associated with more granitic types of gneisses, particularly in the Pegmatite Complex and Potash Granite Gneiss areas. The more clayey patches form fairly good cocoa soils.

Figure 2 (Clayey sands).

(a) *Ibadan Series*—loose sandy subsoil which may contain much gravel, to about 24 or 30 inches; occurs commonly over the Pegmatite Complex and coarser gneisses, associated with the Iwo Series. Not sufficiently retentive of moisture for cocoa.

(b) *Ife Series*—subsoil consists of gravel with not much sand and clay ; occurs in patches over the Pegmatite Complex. Poor soil, sometimes found under cultivation but often left under forest.

Creep Soils

Figure 3. *Asejire Series*—brown sandy soil over granite and gneiss; most common in the Coarse Porphyritic Granite and Granite Gneiss areas.

Figure 4. *Okemessi Series*—brown very stony sandy soil on the quartz schist and quartzite ridges. Most suitable for forest, but at present fairly large areas are cultivated; liable to severe erosion.

Figure 5.

(a) *Effon Series*—brown to reddish colour and distinctly more clayey than Okemessi Series, occurring in the Quartz Schist and Sericite Schist areas.

(b) *Balogun Series*—derived from granite and gneiss in some areas of rock outcrops; shallow profiles are similar to Asejire Series, but more clayey deeper profiles are similar to Akure Series but brown instead of red. Not extensive. Fairly good cocoa soil.

Figure 6. *Akure Series*—dark brownish-red sandy clay subsoil; occurs on the middle part of the slopes of some granite or gneiss hills, having large rock outcrops on the slope above; not common in the present area, but particularly found associated with the Potash Granite Gneiss ridge about 14 to 18 miles west of Ilesha. Generally forms a good cocoa soil.

Figure 7. *Itagunmodi Series*—reddish-brown crumbly fine-sandy clay topsoil and dark brownish-red friable clay subsoil with few concretions or none; frequently containing decomposing fragments and boulders of amphibolite in the top 30 inches; occurs over much of the Amphibolite Complex, especially west of Ilesha, in rather broken topography. Very good cocoa soils, already planted extensively with this crop.

Hill-Wash Soils

Figure 8. *Apomu Series*—loose very sandy soils; subsoil pale brown to reddish-brown. Occurring very extensively on lower slopes and parts of the upper slopes in areas of granite, coarse-grained gneiss, sericite schist and quartz schist, and fairly extensively on lower slopes over the Gneiss and Biotite Schist Complex. The soils dry out too rapidly for satisfactory growth of cocoa. Large quantities of concretions or blocks of ironstone are sometines found at a depth of about two to three feet, and (as pointed out to the writer by Dr. de Swardt) these appear to be residues of material formed on the intermediate erosion surface which has been undercut by lateral erosion of the softer underlying layers and subsequently covered by transported sand.

Figure 9. *Iregun Series*—pale brown to reddish subsoil, very clayey sand to sandy clay in texture. Typically found on lower slopes, associated with Egbeda, Olorunda and Iwo Series on the upper slopes; but in the Ilesha area also occurring extensively on gentle upper slopes, being derived from a non-gravelly "drift" about two to three feet deep overlying an eluvial-mottled-earth profile, in areas of the Gneiss and Biotite Schist Complex and the Amphibolite Complex.

Soils Formed From Diverse Parent Materials

Figure 10. *Odeomu Series*—occurring on upper slopes and hill-tops; not extensive in this area. Vegetation consists of Derived Savannah, formed by spread of fires.

Figure 11. *Igbajo Series*—shallow brownish-red sandy clay, directly overlying thoroughly kaolinised porphyritic granite; lacking any layer of accumulated quartz gravel. Occurs on a 1,600 ft. plateau around Igbajo, mostly covered by forest. Not suitable for cocoa, on account of shallowness. Liable to severe erosion.

B. POORLY DRAINED SOILS

Formed Mainly From Hill-Wash And Local Alluvium

Figure 12. *Matako Series*—very pale washed-out soil, often used as builders' sand. Unsuitable for cultivation owing to moisture supply, but oil-palms grow well. Water table rises during the rainy season, to about two feet from surface, and then falls rapidly.

Figure 13. *Jago Series*—more clayey than Matako Series; gives luxuriant growth of oil-palms.

Figure 14. *Adio Series*—texture varies from very clayey sand to sandy clay. Occurs very commonly in small areas in valleys. Fairly good cocoa soils.

Formed From River And Stream Alluvium

Figure 15. *Shasha Series*—loose fine sand with very little clay. Occurs as recognisable levées.

Formed From Diverse Parent Material

Figure 16. *Majeroku Series*—sandy transported material about 18 to 24 inches deep, over a very compact clay layer (probably illuvial). Occurs on sloping ground, particularly in some of the larger valleys; not extensive. Forest vegetation readily destroyed by burning, owing to shallowness of rooting.

C. SWAMPY AND SEASONALLY-FLOODED SOILS

Figure 17. *Ikire Series*—very sandy greyish subsoil with dark grey or black topsoil. Occurs in narrow strips along streams.

Figure 18. *Oshu Series*—sandy clay subsoil with dark grey or black topsoil Occurs in patches only.

REFERENCES

(1) C. F. CHARTER, "Cocoa Soils Good and Bad", cyclostyled pamphlet issued by West African Cocoa Research Institute, Tafo, Gold Coast, 1947.

(2) C. F. CHARTER, Report of Cocoa Conference, 1949, Confectionary and Chocolate Alliance, London; pp. 105-112.

(3) J. W. DU PREEZ, Report of African Soils Conference, Goma, 1948; pp. 53-66.

(4) R. J. W. KEAY, "An Outline of Nigerian Vegetation", Government Printer, Lagos, 1949.

FIGURES 1—21

PLATES 1 & 11

Fig. 1 Diagrammatic representation of the development of a secondary banded gneiss In A the primary gneiss has been closely folded on a small scale. B shows the development of oblique shears along the limbs of the folds. In C the mica is aggregated along the shear zones. D represents the final stage in which the earlier structures have been entirely obliterated.

Fig. 2. Relics of ancient close folds in hornblende gneisses along the Oshun River, south of Ilesha. B shows rib-structure caused by a late leucocratic vein which cuts across a number of early conformable veins. In C the later vein occupies a minor shear zone.

Fig. 3. Secondary streaky gneiss from Ijaregbe developed from one with early conformable leucocratic veins.

Fig. 4. Structures in the biotite gneisses one and a half miles north-west of Itagunmodi. The irregular body of amphibolite in A shows a discordant contact with the gneisses, which becomes concordant along the strike. A leucocratic vein cuts across both the gneiss and the amphibolite. B represents the late, interconnected leucocratic veins which are related to the microcline pegmatite dykes.

FIG. 1

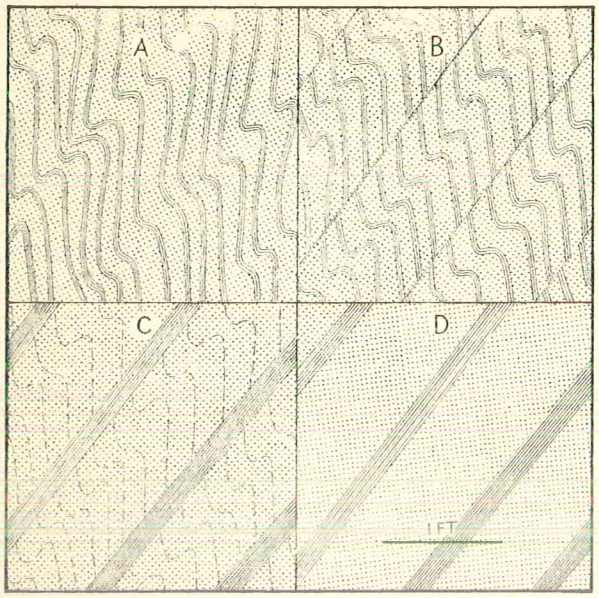


FIG. 2

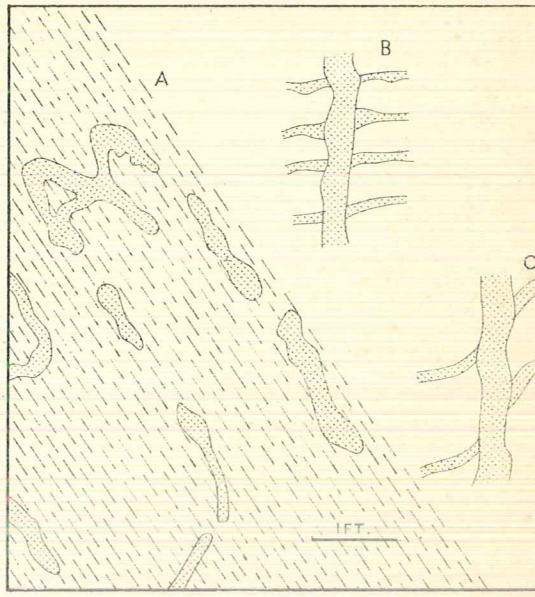


FIG. 3

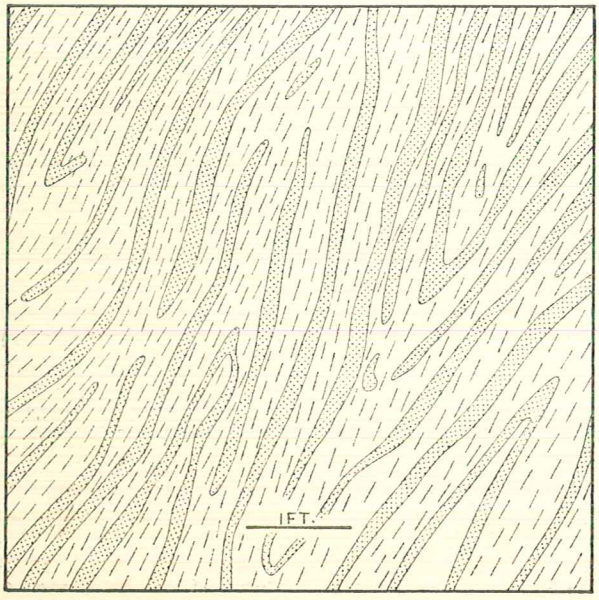
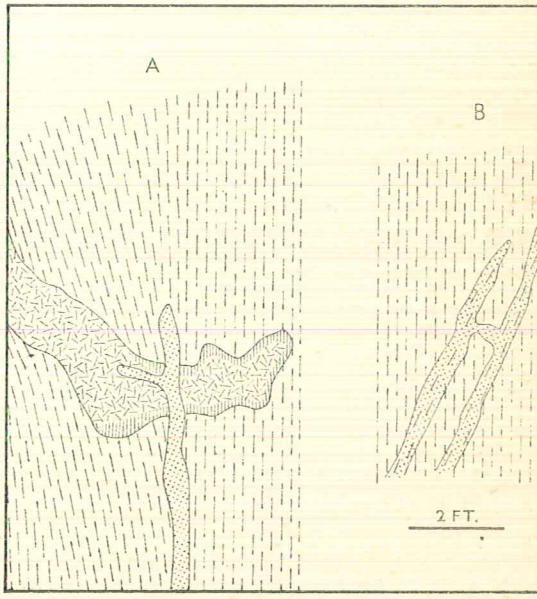


FIG. 4



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FIG. 5

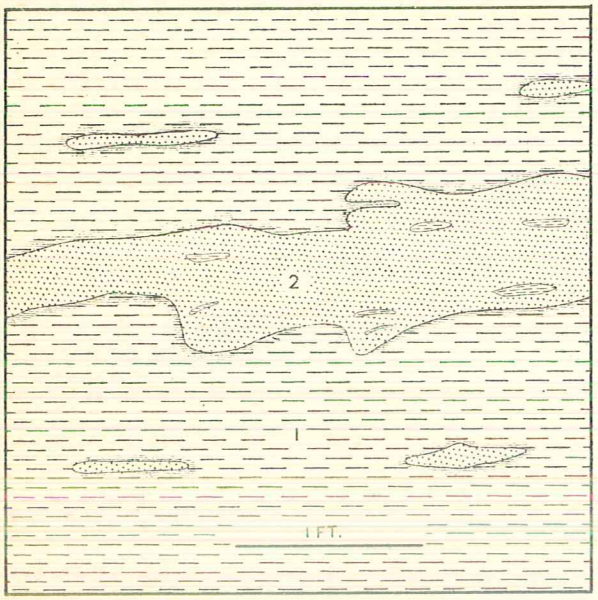


FIG. 6

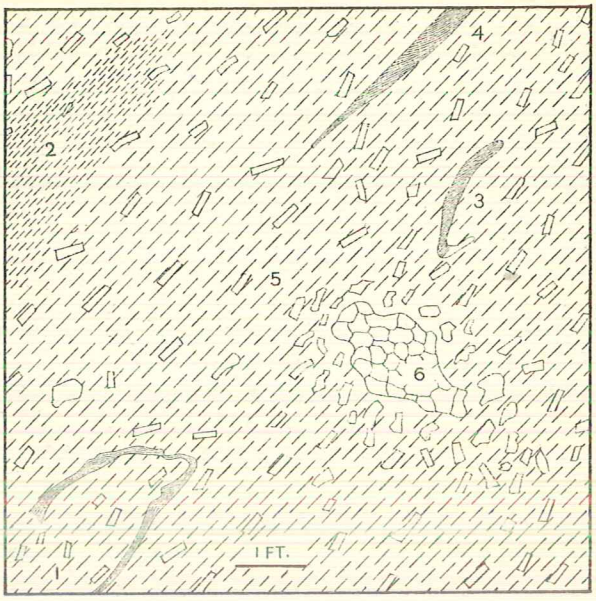


FIG. 7

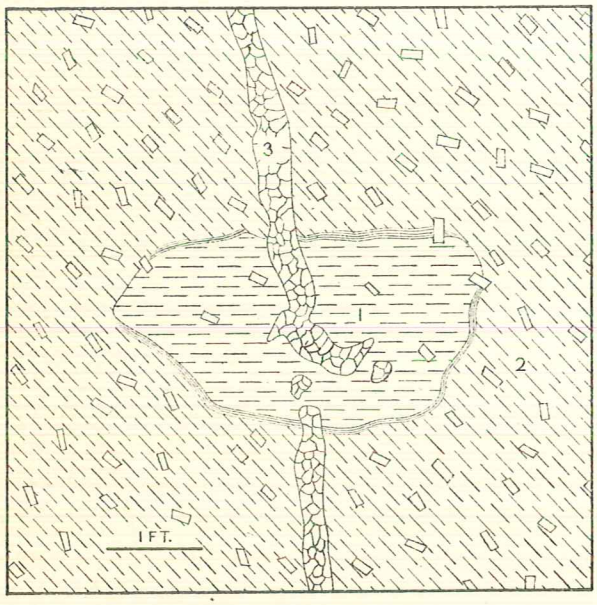
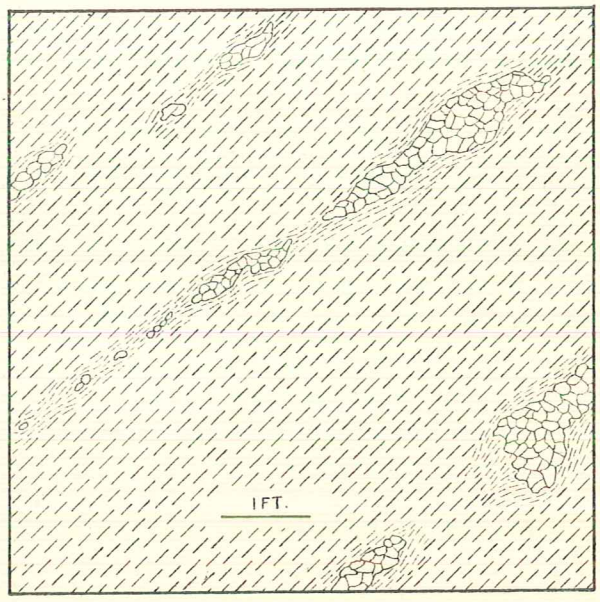


FIG. 8



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Fig. 5. Semi-conformable leucocratic vein (2) in biotite gneiss (1) two miles west of Ikirun in the Awin River bed. Along the contact the gneiss has been noticeably enriched in biotite.

Fig. 6. Sketch showing the marginal porphyritic granite at Iba. The size of the phenocrysts has been exaggerated. The inclusion (1) of partially granitised gneiss is fringed by an incomplete rim of coarse biotite, but in places the granite (5) grades into the inclusion. The basic biotite schlieren which result from complete replacement are represented by (3), while (4) indicates a biotite-rich streak in the granite. (2) represents a conformable lens of granite gneiss, and (6) a concentration of microcline phenocrysts grading into pegmatite.

Fig. 7. A pegmatite dyke (3) branching across a biotite gneiss inclusion (1) in coarse porphyritic granite (2) near Iba. A biotite fringe is present and phenocrysts of microcline project from the granite into the inclusion.

Fig. 8. Semi-conformable veins of biotite pegmatite in the Ijeda gneisses, terminating abruptly, or in a series of disconnected lenses of single, isolated crystals of microcline.

Fig. 9. A composite body of granite, pegmatite and quartz in granite gneiss (1) behind Ibokun Rest-house. The foliation in the granite gneiss continues into the granite (2). The latter grades into pegmatite (3) which in turn passes into a core of quartz (4). The composite body connects with an irregular granite dyke.

Fig. 10. Intersecting aplogranite and pegmatite dykes one mile north of Ire. In A the pegmatite dyke has been emplaced along an incipient shear zone while the later aplogranite dyke in B follows a similar zone. No signs of offsetting are present.

Fig. 11. Features suggesting a replacement origin for some of the biotite pegmatite dykes in the porphyritic granite. In A an inclusion of coarse biotite schist projects from the granite into the pegmatite B illustrates the way in which microcline phenocrysts projecting from the granite into the pegmatite have been coarsened. Large microclines in the pegmatite have the same orientation as the phenocrysts in the granite.

Fig. 12. Association of pegmatite and aplogranite one mile north of Eripa. In A the pegmatite divides into two branches where it enters the aplogranite dyke. In B the pegmatite thins and shows a slight offset where it crosses the earlier aplogranite.

FIG. 9

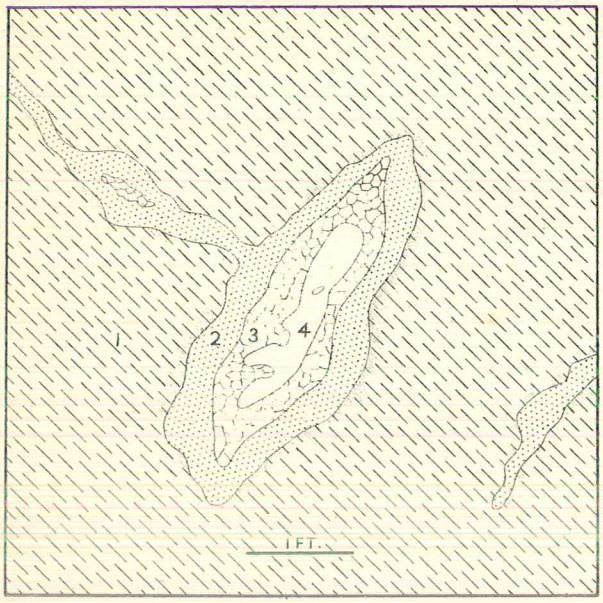


FIG. 10

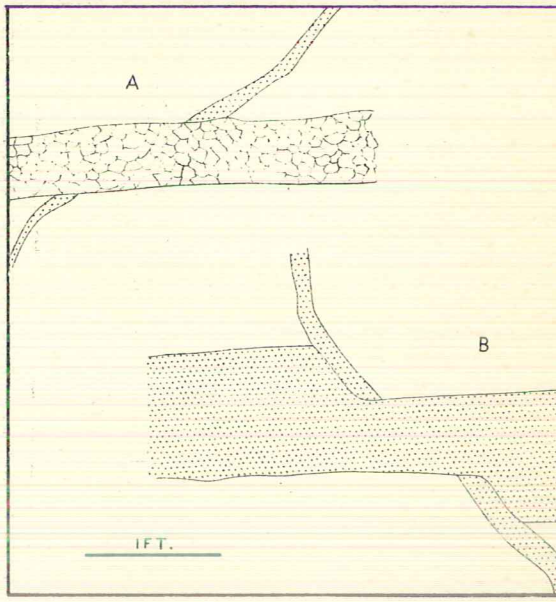


FIG. 11

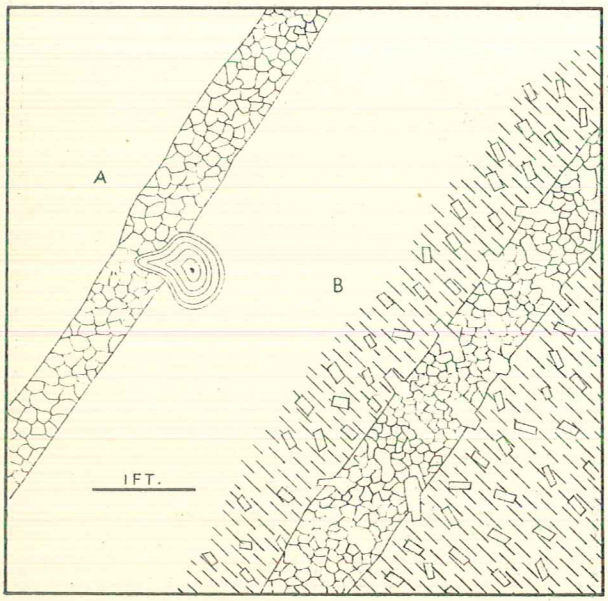
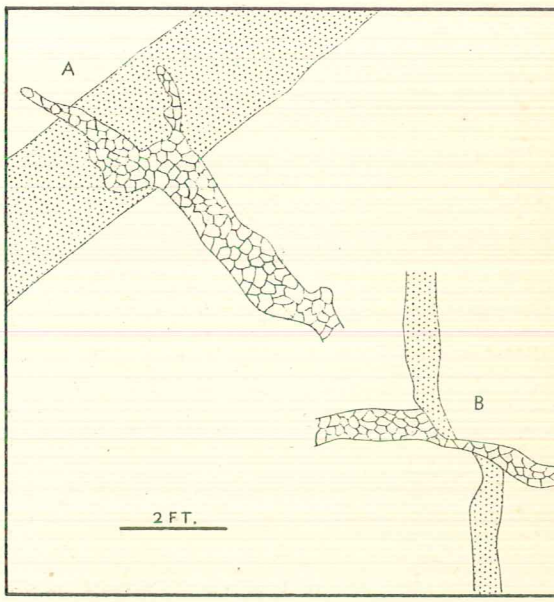


FIG. 12



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FIG. 13

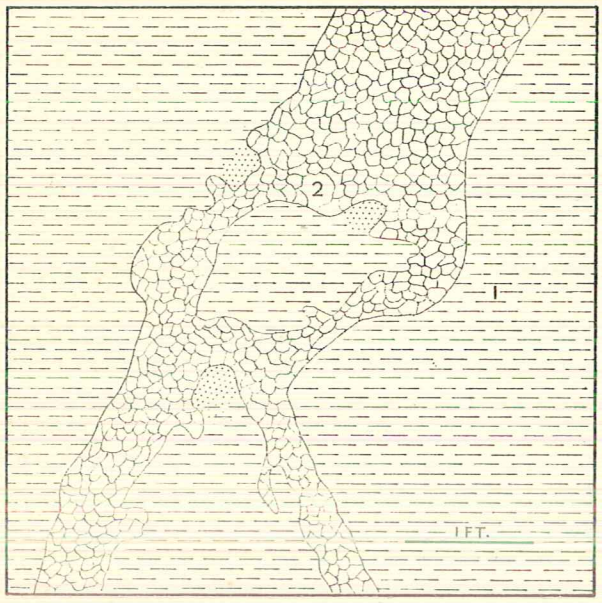


FIG. 14

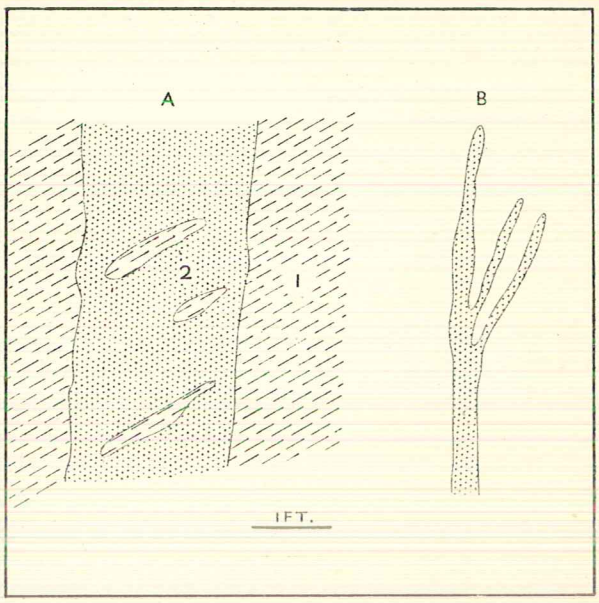


FIG. 15

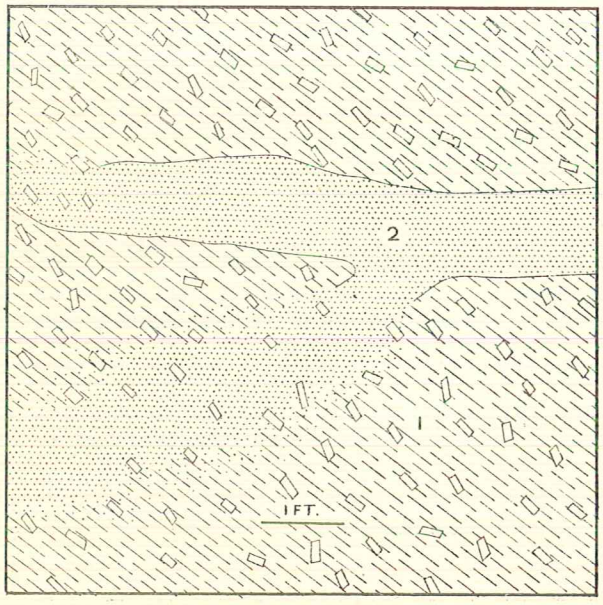
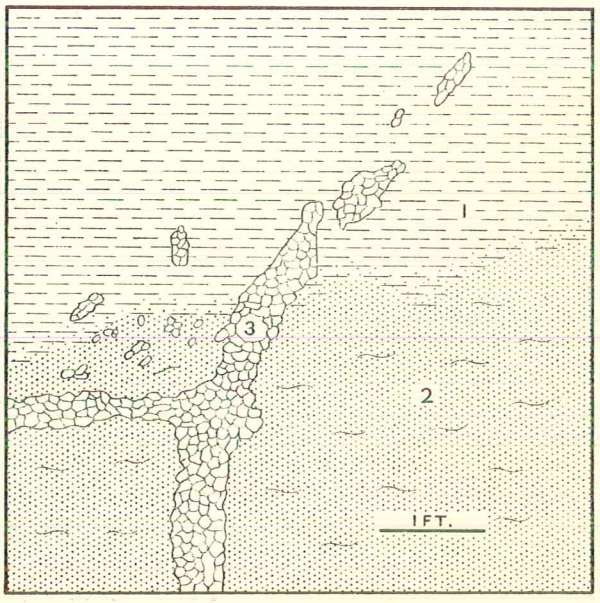


FIG. 16



Prepared by A.M.J. de S.

Drawn by O.O.B.B.

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Fig. 13. Irregular vein of biotite pegmatite (2) in granite gneiss (1) passing into a normal dyke along the strike. Stippled areas represent lobes of granite gneiss which have become coarsened in contact with the pegmatite. The dyke dips at an angle of 50° away from the exposed surface. About 3 miles from Ikirun on the Ire road.

Fig. 14. Relations of the aplogranite dykes one mile north of Ire. A shows a thick dyke of aplogranite (2) which is foliated in the same direction as the coarse porphyritic granite (1). Lens-like inclusions of the latter show no signs of rotation. B illustrates the forking habit of many aplogranite dykes.

Fig. 15. A bifurcating dyke of aplogranite (2) showing a direct passage into porphyritic granite (1) along the strike.

Fig. 16. Transitional contacts in the muscovite pegmatite complex. A medium grained oligoclase pegmatite (2) encroaches uniformly on a fine-grained muscovite gneiss (1). A later coarse microcline pegmatite (3) forms a branching vein terminating in a series of disconnected pegmatite bodies.

Fig. 17. Strike pattern of the aplogranite dykes.

Fig. 18. Strike pattern of the biotite pegmatite dykes.

FIG. 17

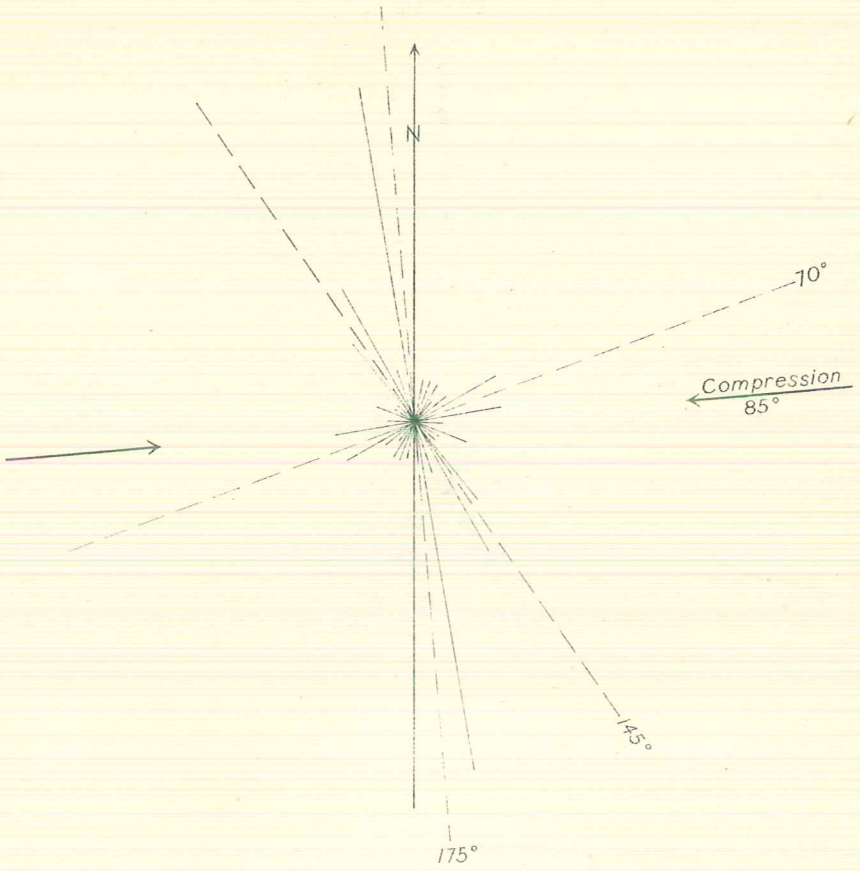
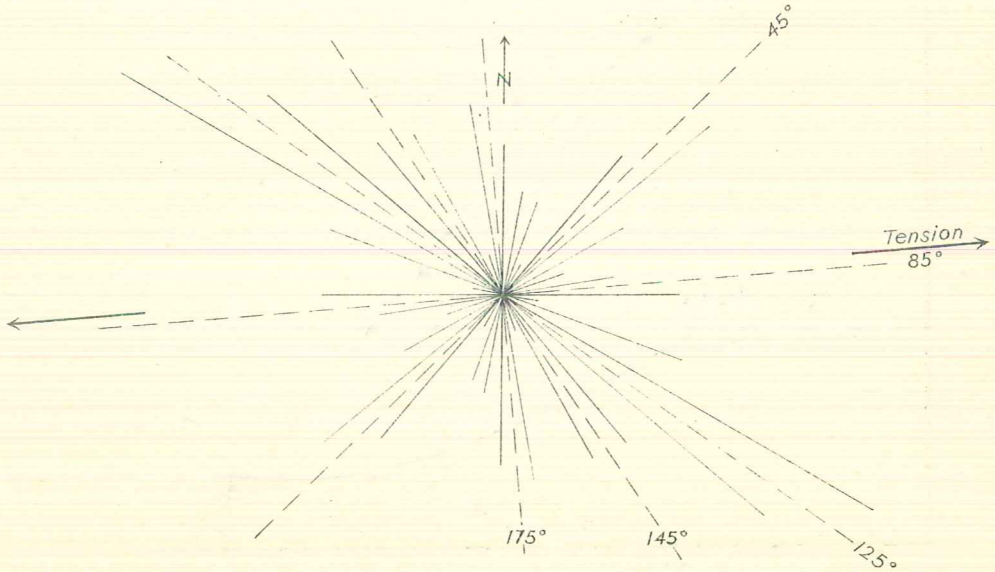


FIG. 18



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FIG. 19

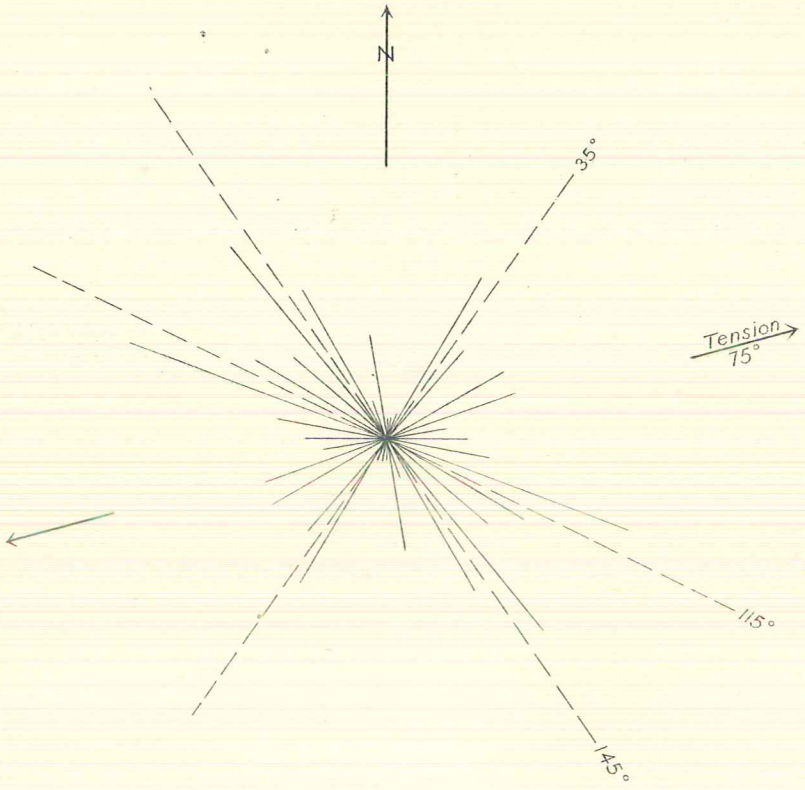
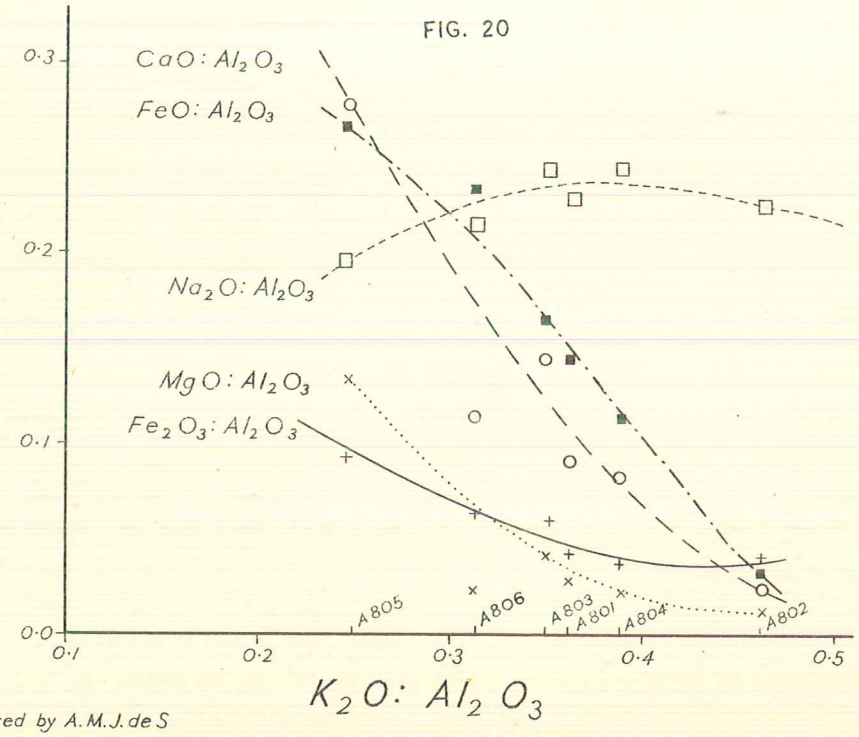


FIG. 20



Prepared by A. M. J. de S

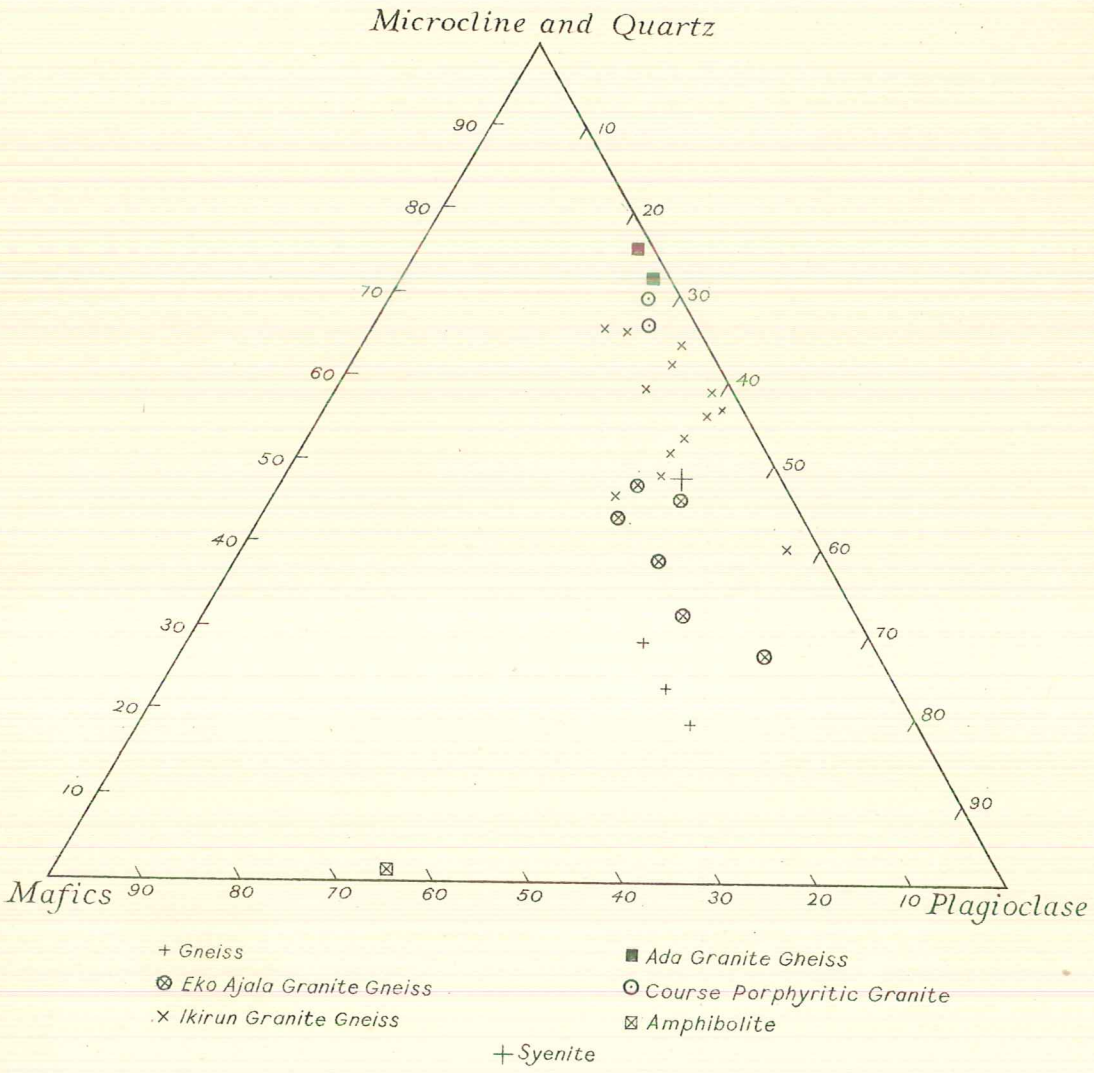
Drawn by O. O. B. B

Fig. 19. Strike pattern of the quartz veins and joints.

Fig. 20. Variation diagram showing the relationship between the principal oxides in the granitic rocks.

Fig. 21. Diagram illustrating the gradual enrichment of the Ilesha rocks in quartz and microcline during the granitic cycles.

FIG. 21



Prepared by A. M. J. de S.

Drawn by O.O.B.B.

SURVEY DEPT., 520/454/12-51

Plate I



A



B



C



D

PLATE I. A. Hornblende plates with poikiloblastic quartz in a matrix of coarse bytownite. The texture appears to be inherited from an original gabbro. Ordinary light, x 32.5.

B. Needles of tremolite in a fine, felted groundmass of talc flakes. The dark patch is composed of fine grains of iron ore. Ordinary light, x 32.5.

C. Micro-inclusion of gneiss in the Eko Ajala granite gneiss. The marginal coarsening of the small biotite flakes of the gneiss is well shown. Ordinary light, x 20.

D. Early microcline mosaic of the Ikirun granite gneiss containing small embayed grains of plagioclase. Crossed nicols, x 20.

PLATE II. A. Myrmekitic oligoclase in a large plate of late microcline in the Ikirun granite gneiss. The marginal albite selvedge is clearly visible. Crossed nicols, x 45.

B. Phenocrystic microcline in the coarse porphyritic granite. Some of the irregular inclusions of oligoclase have been transformed into myrmekite while others contain only occasional blebs of quartz. Crossed nicols, x 43.

C. Porphyroblasts of microcline and oligoclase in a fine-grained gneiss mosaic. This texture is characteristic of the migmatites east of Inisha. Crossed nicols, x 32.5.

D. Graphic intergrowth of quartz (black) and microcline in muscovite pegmatite. Perthitic albite forms a complete halo around one quartz area. Crossed nicols, x 20.

GEOLOGICAL SURVEY OF NIGERIA

ILESHA

SHEET NORTH EAST 62

EXPLANATION of Geological Signs and Colours

OLDER GRANITES

- Sy — Hornblende Syenite
- P — Muscovite Pegmatite Complex.
- MᵍG — Medium-Grained Granite
- CPG — Coarse Porphyritic Granite
- PGG — Potash Granite Gneiss.
- GG — Granite Gneiss (Granodiorite).
- QS — Quartz Schist
- TS — Talc Schist
- SS — Sericite and Chlorite Schist.
- Aᵐ — Amphibolite Complex
- GBS — Gneiss and Biotite Schist.
- Approximate Contacts
- Concealed Contacts
- Faults (approximate).
- 30/ Strike and Dip of Foliation.
- Strike of Vertical Foliation.

Motor Roads (All Season)
" " (Dry Season)
Tracks
Paths
Railways

Mapped by A.M.J. de Swardt and J.D. Van Coppenhagen, Geologists; 1946-49.
Published 1952. R.R.E. Jacobson, Director.
1000/410/9-52.

Scale 1:125,000

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

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Index to adjoining sheets

OGOMOSHO	ILORIN	OSI
IWO	ILESHA	ADO-EKITI
APOMU	ONDO	AKURE

Drawn by the Geological Survey of Nigeria;
Printed by the Survey Department, Lagos.

ELUVIAL MOTTLED EARTHS.

(Well drained)

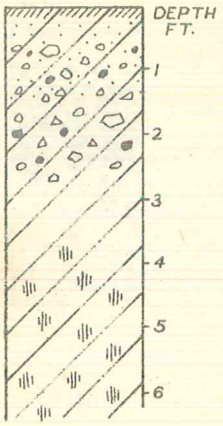


Fig. 1 Egbeda, Olorunda, and Iwo series.

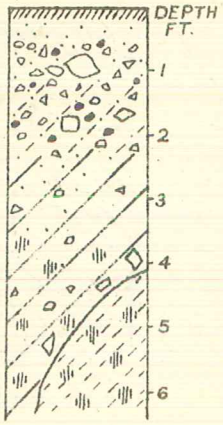


Fig. 2 Ibadan, and Ife series.

HILL CREEP SOILS

(Well drained)

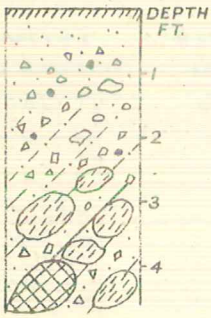


Fig. 3 Asejire Series

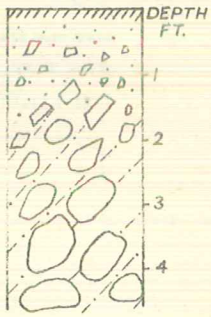


Fig. 4 Okemessi Series

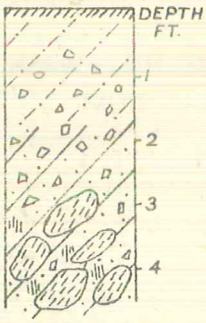


Fig. 5 Effon and Balogun Series

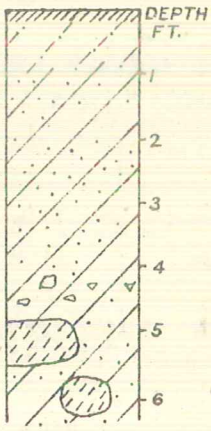


Fig. 6 Akure Series

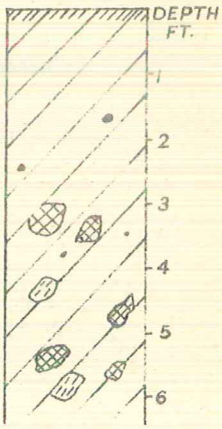


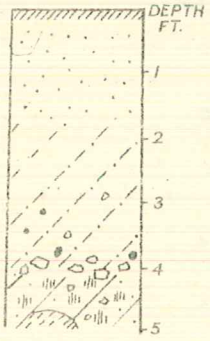
Fig. 7 Itagunmodi Series

KEY TO SOIL PROFILE DIAGRAMS.

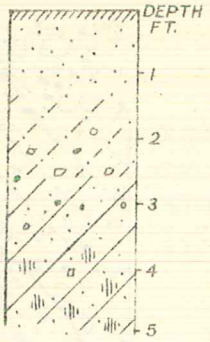
- Sand to slightly clayey sand.
- Clayey sand to very clayey sand.
- Sandy clay.
- Clay.
- Humic fine sandy topsoil.
- W.T. – – – – Water table (Maximum height).
- Quartz gravel and stones.
- Ferruginous concretions.
- Mottling.
- Rotten rock.
- Hard rock.

S.D. 550/173/3-53

WELL DRAINED HILL-WASH SOILS



Lower slope soil



Upper slope soil

Fig. 8. Apomu Series.

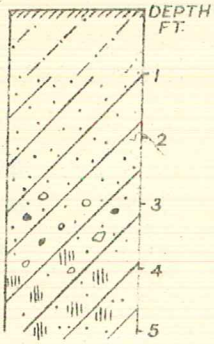


Fig. 9 Iregun Series.

WELL DRAINED SOIL FORMED FROM DIVERSE PARENT MATERIALS.

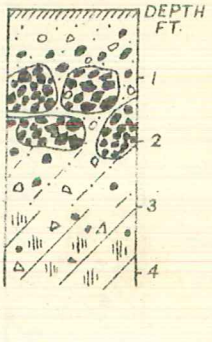


Fig. 10 Odeomu Series.

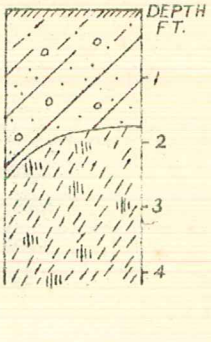


Fig. 11 Igbajo Series.

POORLY DRAINED SOILS

FORMED MAINLY FROM HILL-WASH AND LOCAL ALLUVIUM

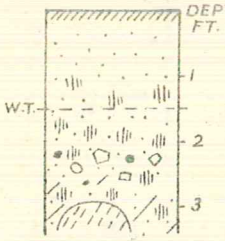


Fig. 12 Matako Series.

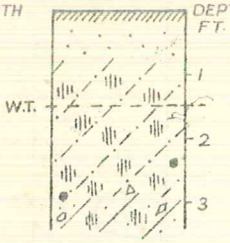


Fig. 13 Jago Series.

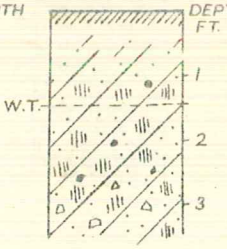


Fig. 14 Adio Series.

FROM RIVER & STREAM ALLUVIUM

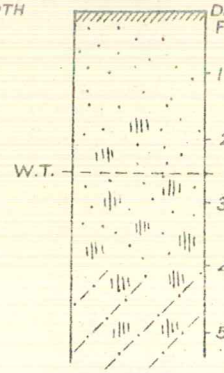


Fig. 15 Shasha Series

FROM DIVERSE PARENT MATERIAL

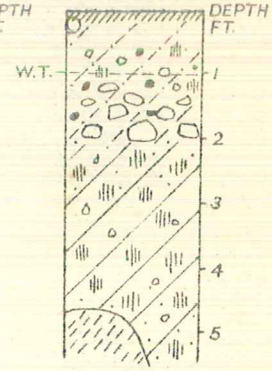


Fig. 16 Majeroku Series

SWAMPY SOILS FORMED FROM ALLUVIUM

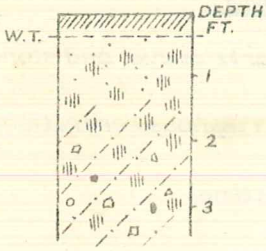


Fig. 17 Ikire Series.

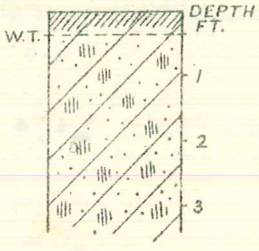


Fig. 18 Oshun Series.

S.D. 550/173/3·53.

Plate II



A



B



C



D