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**MINISTRY OF ENVIRONMENT AND NATURAL RESOURCES**

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# **GEOLOGICAL SURVEY**

## **Notes on the Geological Succession, Tectonics, and Economic Geology of the Western Half of Kenya Colony**

**WITH TWO SKETCH PLANS ILLUSTRATING THE SOLID AND  
TECTONIC GEOLOGY**

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# Notes on the Geological Succession, Tectonics, and Economic Geology of the Western Half of Kenya Colony

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## I—INTRODUCTION.

The sketch geological plans which accompany the report make no claim to anything but approximate accuracy, but they are published for what they are worth and in the hope that interest may be stimulated to the extent of the inaccuracies being reported.

The work of the Tanganyika and Uganda Geological Surveys has been closely followed and the classification of the various rock groups and systems correspond with that presented by those two surveys. No detailed field work has been attempted and the correlation of Kenya rocks with those of the adjoining territories is based purely on lithological grounds, an admittedly dangerous procedure, but the only constructive one possible in the circumstances.

During 1928, at the request of Government, an officer of the Uganda Geological Survey was detailed to examine a part of Central Kavirondo. This work was done by A. D. Combe in an area approximately bounded by the Kisumu-Butere railway line to the east, by the Nzoia River and Yala Swamp to the west, by a line drawn through the Kisaina River and Lubinga to the north, and by a line drawn due west from Messeno. Combe's work was of great importance for he defined the Muva-Ankolean System, describing its representative divisions in some detail, and showed that it had been intruded by a younger granite. He stated that although the area that he had examined held no great promise of useful mineral deposits being discovered, the area to the east was well worth prospecting. Fuller reference is made under the heads of the various divisions to Combe's report. Later, in 1929, Mr. E. J. Wayland, Director of the Uganda Geological Survey made a report to the Kenya Government that was based on a hurried traverse through Central and Southern Kavirondo. This report was published in 1931 and also drew attention to the economic possibilities of Southern Kavirondo.

The late Professor J. W. Gregory described the general geological conditions underlying almost the entire Colony and, again, reference to his work will be made in the appropriate divisions.

Sir Albert Kitson, invited by Government to advise on the situation that had arisen from the application by Tanganyika Concessions, Limited, for an Exclusive Prospective Licence over the whole of the Kavirondos, was the next authority to report on that area and the result of his work had been published in two separate Government reports.

The writer has now travelled over nearly every existing road in Kenya with the exception of those in the Ukamba Reserve and the Northern Frontier Province, and it seems desirable that what information is available should be published without delay.

## II—GEOLOGICAL SUCCESSION.

### (1) BASEMENT COMPLEX.

#### *Lower Division.*

This formation covers a far greater area in Kenya than current geological thought of the Colony, culled both locally and abroad, would convey. The many scientific expeditions which have visited Kenya have been financed principally by academic institutions particularly concerned with the formation and rocks of the Great Rift Valley, and the tendency has been for the geology of the older rocks to be neglected.

Professor Gregory, however, showed that the Eozic rocks covered a vast tract of country and the distribution of them indicated on his map, which extends to latitude  $2^{\circ}$  N., is generally correct. In the extreme north-western part of the Colony, the Primitive System extends throughout the Suk country, where Parkinson and Glenday have described two sections in some detail, and thence into Southern and Northern Turkana, where it forms the massif of Muroto and outcrops as "monadnocks", or as "windows", in the overlying Turkana grits and volcanics.

Gregory's lines have been moved to fit the exposures discovered in the course of the current work and it will be noted that in Northern Kavirondo, a number of sub-divisions has been made. Instead of covering the whole of the area, the rocks under consideration outcrop only in the north-eastern section, extending up to a point eastwards where they are covered by the Uasin Gishu lava, but appearing as a narrow belt between Elgon and the Uasin Gishu Plateau to expand into the greater mass of the Cherangani Hills.

The rocks themselves are typical schists and gneisses, and consist of composite gneiss mainly composed of microcline and quartz, closely associated with a biotite gneiss; coarse amphibolite, hornblende-schist, and garnet-hornblende-schist are also common types, and there occurs also a very characteristic member of marble, coarsely crystalline with scattered flakes of graphite, and which emits a foetid odour on breaking.

From the Nyangoris scarp in the Sotik area, and extending south-easterly, but covered over large areas by younger lacustrine beds, is a different type of complex comprised of a red granitoid rock and an highly jointed quartzite containing authigenous tourmaline and green mica. This quartzite is a particularly interesting rock as its extent may be traced southwards as far as Northern Rhodesia.

### *Upper Division.*

In this division is placed a very characteristic group of rocks, which, up to the present, has been noticed in the extreme west of Central and Northern Kavirondo and in the southern part of South Kavirondo. The group is composed of quartzite, sericite-schist, banded magnetite-quartzite, jaspilite, and greenstone-schist. Altered igneous rocks are still recognizable under the microscope and some are of definite pyroclastic origin. (Specimens 660 and 661). Lithologically they resemble closely the "Upper Group" of Tanganyika. It is probable that the "Banded Ironstone" of Lolgorien (Masai Reserve) and its associated rocks fall into this division.

This division forms the Samia-Wamia range of hills and extends from Wamia down to Port Victoria in a belt about eight miles wide. Gregory mentions them, referring to a paper by Scott Elliot and Gregory, 1895, in which it was suggested that they form a part of the Karagwe-Ankolean, or Muva-Ankolean System, as it is known now. In this assumption, I think the authors were possibly incorrect.

The evidence for the "roof pendant" appearing in the centre of the Kitoshi granite is based only on one or two isolated outcrops, but from their general appearance I believe the pendant to be of rocks of this division rather than of Muva Ankolean.

### (2) PRE-MUVA-ANKOLEAN IGNEOUS ROCKS.

Combe makes reference to "light green grey rocks of intermediate composition" and finds difficulty in deciding whether these rocks are post-Muva-Ankolean or pre-Muva-Ankolean owing to the obscure contacts. He tends to regard them, however, as post-Muva-Ankolean owing to the induration of the Muva-Ankolean rocks close to the hidden contact of the two groups south of Malanga, and to the thinning-out of the lower division of the Muva-Ankolean in passing from south-west of Malanga to south-east.

Combe describes these rocks as follows:—

"A series of fine grained light green-grey microcrystalline rocks of intermediate composition form a belt several miles in width extending from Malanga in a west-south-west

direction to the Yala Swamp to the south-east of Lake Kanyaboli. The term 'light green-grey igneous rocks' is used for convenience sake pending the results of a detailed microscopic examination.

These rocks have not been mapped or examined in detail but they are known to include a wide range of rock types. Over much of the area occupied by them there are few masked by a covering of residual lateritic ironstone, which in many cases completely masks the relationships of different rock types occurring on the slopes on either side of a ridge.

In the hand specimen, these rocks are mostly very fine grained and of a light green-grey colour and they consist of a microcrystalline aggregate composed of a light and a dark portion, the nature of which can hardly be ascertained without the aid of the microscope. In some of them porphyritic feldspars occur in varying proportions, and in others a porphyritic dark green pyroxene (?) now much altered, while both may occur in the same specimen. The rocks containing the porphyritic feldspars and pyroxene (?) have an andesitic appearance.

The weathered types of some of these rocks are pink and brown and have the appearance of weathered feldspathic sandstones.

In this section they are seen to be much altered and many of them apparently are altered andesites and dolerites, while there are others which may be completely altered phonolites. A light blue-grey felsite showing a marked flow. A structure occurs in this group of rocks immediately to the south-east of Malanga."

From observations made by the writer south of the area examined by Combe, and where the rocks are not so highly altered, the grouping into more defined rhyolitic, andesitic, and basaltic types is possible and corresponds fairly closely with the Ndembera Volcanic Series of Tanganyika, described by D. R. Grantham.

Until more definite field evidence is forthcoming, it is proposed, therefore, to refer to them as the Asembo Greenstone Group and place them as Pre-Muva-Ankolean.

#### MUVA-ANKOLEAN SYSTEM.

In this system are found conglomerates, quartzites, and phyllites. Combe has divided it into three divisions: (1) a lower division of shales and phyllites; (2) an higher division of feldspathic quartzites and grits containing the "Kisendo Conglomerate" and (3) an upper division of shales and phyllites with interbedded argillaceous sandstones.

Before such a division can be confirmed considerable field mapping must be accomplished (as Combe indicates) and the only statement that can be added is in connection with the "Kisendo Conglomerate." This is an interesting occurrence owing to the variety of its constituents, which vary in general character from east to west. In the Kakamega area most of the pebbles are of volcanic rocks, no indication of the source of which has been discovered. The matrix is also composed of volcanic material and many investigators working in a confined area might well consider the rock to be an ancient agglomerate.

The conglomerate does not form a continuous horizon, but appears as large lenses distributed along lines running east and west, with each lens containing its characteristic group of pebbles.

#### POST-MUVA-ANKOLEAN GRANITES.

It has not been possible on the map to distinguish between non-foliated Pre-Muva-Ankolean Granites and those intruded later, but the granite occurring in the Kakamega area, in the No. 2 area of the Kitson Report and which lies to the west of Kakamega, and in the Kisii Area, is definitely intrusive into the Muva-Ankolean rocks.

No petrographical work has yet been done in connexion with these rocks, but from the hurried inspection made in the field, it is obvious that some of the exposures indicate strong differentiation and that the Kakamega "Granites", for example, will prove to be differentiation facies of the one unit rather than separate intrusions. This differentiation is well exemplified in No. 2 area, where, in the vicinity of Abbom, diorite and "spessartite" grade into the principle granite mass.

Dykes of granite-porphry, granophyre, felsite, and lamprophyre are common in the younger granite areas, but it has not been possible to indicate them on the map.

Mention must be made here of the gabbroic rocks which are intrusive into the Muva-Ankolean, but which are intruded by the younger granite. These rocks are very highly altered and not determinable in the field, but Capt. T. Oates, Petrographer to the Tanganyika Geological Survey, has kindly examined a few sections and states that they are derivatives of a grano-gabbro.

Fresh grano-dolerite dykes are very common and cut both the Muva-Ankolean and younger granite. They are thought to be slightly earlier than the period of "mineralization" because broken pieces have been found in quartz veins and, in places, they have been replaced by sulphidic minerals to form typical "replacement deposits."

## KISII SERIES.

Wayland refers to these rocks in his report and mentions the occurrence of detrital Cassiterite in the sandstone members.

The beds are generally flat-lying and comprise conglomerates, purple to red mottled quartzites, sandstones, and shaley beds in which are found numerous sills and flows of basic rocks. Some of these are amygdaloidal and have given rise to a heavy crop of agate and chalcedony in the stream beds.

## TURKANA GRIT.

This group comprises flat-lying pebbly conglomerates, felspathic grits, and sandy shales, all the elements of which appear to have been derived from the Basement Complex on which the beds rest. Between Lodwa and Lokitaung, they are seen to be riddled with dykes and broken by volcanic activity.

The grit contains large trunks of fossil wood, lying on their sides, but the wood has not yet been identified.

A sandstone found in the Tembach Escarpment, overlying the Basement Complex and capped by lava, is tentatively classified with the same group.

## TERTIARY AND POST-TERTIARY VOLCANICS.

No attempt has been made to do more than define the area covered by these rocks. A large and representative collection awaits examination.

In parts of the country covered by lava, "windows" of the underlying rocks appear, but owing to their diminuity, are not shown on the map. In other parts, lava may form a cap to the hills and again these occurrences have had to be omitted.

## POST-TERTIARY AND OTHER LACUSTRINE AND SEDIMENTARY BEDS.

The remarks under "Tertiary Volcanics" apply to this group, their general distribution only having been attempted. The important discoveries of Oswald and Wayland bordering Lake Victoria have been omitted also.

## TECTONICS.

A separate plan illustrates the outstanding tectonic lines of the region. The information covering the south-eastern quadrant has been taken from Professor Gregory's work on the Rift Valley and it may be seen at once how outstanding are the structural lines associated with that great feature.

Such a degree of definition is due more to the recent character of the movements than to their proportion and there is evidence of equally powerful movements of the earth's crust prior to those of the Rift although it is more obscure and difficult of interpretation.

Such ancient zones of weakness are evidenced by their effect in "setting-off" or "staggering," the main North and South Rift Faulting from east to west. Discontinuity of line must be interpreted in terms of "t-t", by which is meant the irregular displacement of a fault-block.

In the north, the foliation of the ancient rocks of the Basement Complex runs north-east to south-west and on this structure is superposed a false-cleavage running north to north-east and which is an indication of the axes of later folding oriented some  $60^\circ$  west of north. This folding is magnificently exposed along the base of the Muroto Escarpment.

In a general way, every topographic unit can be interpreted in terms of the above components except where the local effect of the "younger granite" makes itself felt.

In the central part of the region, the general structure has been affected in this last way and great complexity results. East and west strike faulting is common and thrust planes dipping at a low angle to the north are also formed. Dolerite dykes follow planes of weakness running north-west to south-east and a massive injection of quartz, which forms the outstanding hills of Kisa, Amohira and Kimingini in the Kakamega area, follows another plane running east-north-east and west-south-west. These two directions probably indicate the planes of maximum shear, or of "no distortion" as they are known in structural geology.

In the south, the rocks of the Basement Complex trend from north-west to south-east, a direction which is also followed by the southern granite contact. Here, the two planes of maximum shear are marked by (a) a system of joints and faults which runs a few degrees east of north to west of south and (b) another zone of massive quartz entirely similar to the one formed in the Kakamega area, and which trends north-north-west to south-south-east.

It is hoped with further study to be able to separate the numerous movements and allocate them to the period of their origin.

#### ECONOMIC GEOLOGY.

Gold in the rocks of the African Basement Complex is ubiquitous. The writer knows of very few localities where these old rocks are exposed that a "colour" of gold cannot be found in the course of panning the streams which traverse

their outcrops. Unfortunately, there are but few cases where this type of gold occurrence has yielded deposits of economic value. The more commonly exploited deposit is that which is found associated with the so-called "younger granite" and its differentiates.

The general and common relationship is well exemplified in the Kakamega area, where the Muva-Ankolean rocks appear to be caught up in the jaws of a "granite vice."

Similar relationships are found all over the Kavirondos and wherever these contacts have been examined, gold has been found.

In considering this question of contacts, the fact of the third dimension cannot be over-emphasized. It is an accident of erosion that exposes a contact which may be indicated on a map drawn to illustrate only two dimensions, and it must be remembered that an unseen contact may be a few hundred feet below any point, or may have been at one time only a few hundred feet above.

It is not intended that this explanatory pamphlet should attempt to describe the habit of those gold occurrences which are now being developed and no details can be given, but the statements made under the head of "Recommendations" in Report No. 2 on the Lolgorien area may well be applied.

Tin (Cassiterite) has been found by the writer in the area marked to the west by the Kibisi River and to the east by the Kitale-Eldoret railway line and it is proposed to investigate the occurrence more closely when the opportunity presents itself. In the meantime the area calls for careful prospection particularly in the vicinity of the Nzoia River, where it makes a sharp sweep north.

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