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extremely interesting thing to follow up. He has given us the cue, and no doubt attention will be called to that, and at a future time we shall see whether Mr. Milne's theories are true or not. No doubt there are a great many slips under the sea, but I am a little bit doubtful about some of his evidence as to the actual slopes. I am rather more struck by his suggestion—which is not absolutely new, though he has put it in a new way to me—of the breaking out of submarine springs, and a great many telegraph engineers have very strong ideas on the subject of these springs causing the cables to be broken by moving the material along the bottom of the sea. I have never thought that possible to any extent where cables are broken and found buried, and think it more probable that the cables are broken by the slipping of material, as Mr. Milne suggests. I am inclined to think that undermining by submarine springs is as likely to be a fertile source of slipping as earthquakes. I have had the advantage of carefully reading the paper which he has summarized to-night, and he mentions submarine springs as another cause of sub-oceanic changes.

If he succeeds in getting a sufficient number of instruments established in different parts of the world, on which shocks and tremors can be recorded, there will be more opportunities of finding out whether certain breaks of cable are caused by earthquake, or in some other way. A great many of these breaks, as is well known to telegraph engineers, occur at certain times of the year, which rather points to some such source as submarine springs instead of earthquakes. All these things are complicated.

You will, I am sure, all join with me in thanking Prof. Milne for the most interesting and humorous lecture he has given to-night.

THE PHYSIOGRAPHICAL FEATURES OF THE NYASA AND TANGANYIKA DISTRICTS OF CENTRAL AFRICA.*

By J. E. S. MOORE, A.R.C.S.

THE following is a *résumé* of the topographical notes which I collected concerning the character of the country traversed during a recent journey to Lake Tanganyika *viâ* the Zambesi river and Lake Nyasa. The information was gathered in order to obtain the kind of grasp of the physiographical characters of the country surrounding and separating the two great lakes, which would be useful in comprehending the special zoological problems I had in hand. It may be said, at the outset, that there exists a great deal of misconception concerning the physiographical characters, not only of the "far interior," but also of many aspects of the country which lies east and west of the Shire river, and which constitutes the southern three-quarters of the environment of Lake Nyasa. The assumption seems to have been implicitly, if not explicitly, made that this lake, because it is long, narrow, and deep, owes its origin to the formation of the great series of rift-valleys which are such a conspicuous feature of the country further north. But a very little acquaintance with the shores east and west, and of the adjacent country to the south, is sufficient to show that the changes in the level of the land which have enabled Nyasa to stand where it is now, 1500

* Map, p. 348.

feet above the sea, had nothing to do with a rift; in fact, when one has reached the foot of Morumbala, facing the Shire river, a country has been entered which is typical of by far the greater part, not only of the Nyasa districts, but of the region known as the Shire highlands also. Here the country is composed of more or less lofty granitic masses, the axes of which run approximately north and south, but which divaricate from one another and enclose wide areas of land, which are now filled with modern alluvium, and form the extensive malarial flats or dambos which are the chief features of the country to-day. In fact, except for narrow rocky eminences visible in all directions, the whole region is composed of a succession of swampy plains at different levels and of widely different areas, many of which have undoubtedly at one time been covered with water, but are now more or less completely filled up with the decomposed granite and gneiss annually swept down into them from the hills by the prolonged tropical rain.

From the Kirk range and the higher portion of the Angoni country on the west, to the lofty mountains behind Lake Shirwa on the east, the whole country, as one moves northward towards Nyasa, is seen, on examination of different portions of it, to be made up in this simple way of successive modern flats and ancient mountain ranges, entirely composed of gneiss and granite, and this necessarily renders the whole district, geologically speaking, without a history.

On ascending from the great Zambesi and Shire river-beds near Katunga, and passing northward across the mountains through the new Blantyre settlement, one reaches a plain which descends slowly towards the east, and stretches between the Zomba mountains on the north and the still greater heights of Mlanje on the south. The eastern extremity of this plain is occupied by the immense reed swamps and foul open salt water of Lake Shirwa, and it terminates still further to the east in the unknown mountainous districts south of the Lujenda river, which flows east and north towards the northern boundary of the province of Mozambique. The horrible nature of the country round Lake Shirwa is almost indescribable, but every objectionable feature of a tropical quagmire seems to have become accentuated about its dismal, sweltering shores, and the crowds of cranes, flamingoes, and screaming water-birds, which jostle one another for room among the reeds, only add to the peculiarly depressing nature of the scene. Above the surface of this detestable lake, which is always blurred by a mirage effect (that seems to be related to the miasmatic stench lying over its surface, and which one can escape by standing up in a canoe), there are two conspicuous islands exactly similar in structure to the granite kopjes which rise above the surface of the plain near the lake.

To the north of the Zomba mountains the Shirwa plain bends west and north, and in the latter direction, as Mr. Hetherwick showed some time ago, the surface of the lake is little more than 50 feet below the

top of the watershed, which slopes down the course of the Lugenda river to the east coast. Westward the plain extends round the mountains north of Zomba, and is in reality only separated by a very slightly elevated tract of forest from the wide extent of marsh which skirts the eastern shore of Lake Pamalombe.

Like Shirwa, Pamalombe forms the umbilicus of another great plain, which is bounded on the east by the western face of the Shire highlands, and on the west by the Kirk range and its northern extensions, while it is shut in and terminated towards the south by an elevated ridge, through a gap in which the Shire river finds its way to the lower plains, down the Murchison cataracts. To the north, this plain is really continuous with the great alluvial flat surrounding the southern shores of Lake Nyasa. Thus it will be seen that beyond the southern extremity of Nyasa there exists to-day a series of great alluvial flats which are approximately of the same height, and throughout their entire extent these flats show abundant evidence of having been covered at one time, or a succession of times, with water. There are many places in which the dry mud and sandy clay which form the soil contain the remains of *Melania*s and *Viviparas* now living in Shirwa and Nyasa.

Unfortunately, I was not able to make observations on the plain between Lakes Shirwa and Pamalombe, and consequently am ignorant of its height, but if it is not higher than the top of the watershed north of Shirwa, an elevation in the water of Nyasa sufficient to cover this tract would not only connect Shirwa with Nyasa, but would cover a great part of the Mlanje plain, and the whole of the flats east and west of Pamalombe, as well as those about Fort Johnston south of Lake Nyasa. It would, in fact, extend Nyasa enormously to the south; but such an extension is now impossible, owing to the level of the outlet of the Shire river at the Murchison falls being what it is. This outlet, however, is lower than it was once, owing to the erosion and cutting down of the river-bed by the rains. I shall return to this again.

The depression in which Nyasa lies is divided towards the south into two great arms, one of which to the east is, as I have said, geographically continuous with the Mlanji, Shirwa, and Pamalombe plains; while the other terminates more abruptly in the mountains near Manganga's. The lofty neck which separates these two branches of the lake is a rugged continuation of the branch of the Kirk range which faces Pamalombe to the west, and is terminated to the north in the wild mountain headland above the site of the old Livingstonia Mission. Like the high mountain masses which flank the lake east and west, this tongue is composed almost entirely of granite and granitoid rocks, and the lake lies thus, towards its southern extremity, in a series of deep valleys (see Fig. 1), similar in all geological aspects to those encountered in the Shire highlands. There is nothing suggestive of great faults or the formation of rift-valleys, and what is true of the

southern moiety of the lake is also true of the middle and as far as the commencement of the upper third of the lake's extent.

From Rifu, where the two southern arms unite, the mountain ranges which flank the lake east and west gradually increase in height and grandeur until they produce the sublime scenery about Nkata bay. Beyond this, however, there is a sudden change. Voyaging up the lake as I did along the west coast, one becomes aware of a mountain mass projecting beyond the general coast-line, the contour of which is totally

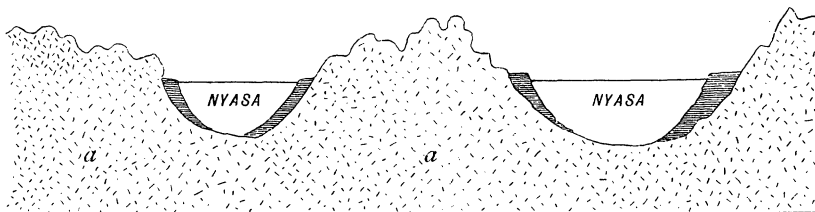


FIG. 1.—SECTION THROUGH THE TWO SOUTHERN ARMS OF NYASA: *a, a*, GRANITE AND GNEISS.

unlike that of any previously seen. Here, instead of the jagged profile or massive form of the gneiss and granite mountains, one sees the terraced outline of a lofty stratified scarp, which, on approaching nearer, is seen to be part of a V-shaped mass of stratified rock, sandwiched in between the gneiss and granite ranges on either side. The top of this mass forms the summit of Mount Waller, the surface of which is approximately flat; but the whole of the strata has a slight dip to

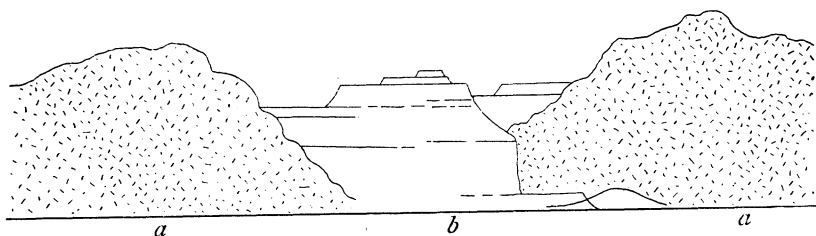


FIG. 2.—THE COAST ROUND MOUNT WALLER: *a, a*, GNEISS MOUNTAINS TO THE NORTH AND SOUTH OF THE STRATIFIED MASS OF MOUNT WALLER, SANDSTONES, ETC., IN BETWEEN (*b*).

the west, so that the crest of the scarp is higher than the plain behind it.

On the north and south this mass is bounded by the gneiss and granite mountains, and the stratified material rests in what appears to be its original position between the hills (Fig. 2). The most characteristic feature which this succession of scarps present to a spectator on the lake is a series of massive red sandstone cliffs. These rest upon a conglomerate base, and this in turn is supported upon a mass of granitoid material

and gneiss. The red sandstone, which is about 800 feet thick, is covered by a series of fine yellow sandstones, and is finally topped by a species of shale, and this is probably related to the displaced coal (which has already been described by Stewart *) from a deep gorge in the south. The exposed faces of red sandstone are much contorted in places, especially towards the north, giving one the impression that this twisting has been produced by the upthrusting of the igneous material upon which they rest. The granitoid base upon which the whole series rests is visible in places just above the present water-level of the lake. Here the great stratified cliffs rise to a height 2500 feet above the water's edge, and their northern extension stands equally perpendicular above a low neck of land which stretches out into the lake to the north. This neck is also composed of stratified material, but the surface rocks themselves are here similar to the yellow sandstones and shales of the top crest of the scarp of Mount Waller. Thus we have here, not only the existence for the first time in the Nyasa region of what are clearly aqueous deposits, but also the existence of a gigantic fault producing the series of imposing sandstone cliffs which in this place face the lake to the east. On ascending Mount Waller in company with Lieut. Rhodes, we saw that the stratified mass lying between the higher igneous ranges extended far inland from the lake-shores, seeming, indeed, to pass completely through the bold coast ranges which fringe the lake, and I subsequently came to the same conclusion when viewing this region from a point on the great Nyika plateau 7700 feet above the level of the sea, and between 20 and 30 miles to the north.

Now, on crossing the lake and looking to the east towards Amelia bay, on the opposite coast, it is curious to find the same set of features again repeating themselves—the same stratified masses lying between granitoid ranges, the same faults and scarps; but this time they look the other way. Thus one encounters at this point on Nyasa, for the first time, all the appearance of a double succession of scarps and intervening lower land, or rather lake bottom, characteristic of the so-called rift-valleys further north.

To the north of Mount Waller, the superficial strata on the neck of land which projects out into the lake have the same tilt as the top of Mount Waller, and are composed, as I have said, of the same material as the upper portion of the Mount Waller scarps; and on this neck there are, as Mr. Swann pointed out to me, above the lowlying forest near the lake, some conspicuous white hillocks. These stand some distance back from the lake-shore, and have been freely denuded by rain, etc., into cliffy faces which look in all directions. The white material of which they are composed is a species of limestone, and the strata have the same dip to

* *Proceedings Geo. Soc.*, vol. iii. No. 5, p. 264. See also Drummond's description, 'Tropical Africa,' p. 187.

the west as the yellow sandstones and shales on which they stand. These beds contain fossilized remains of the shells of the molluscs now living in Nyasa, and as their flat tops are some 80 to 100 feet above the water-level, it is pretty clear that they must have been carried upward through the operation of the same great up-push which raised Mount Waller and the adjacent country to its present height. There is every indication here that the formation of the rift has been produced by a crumpling and consequent upthrust of the igneous base (which carries the stratified material) along two parallel lines, one of these being coincident with the hills behind Bandawe and Deep bay, and the other being really a continuation of the great Livingstone range on the other side of the lake. It is, moreover, clear that this elevation must have gone on long after Lake Nyasa had become a lake, as it has thrust up also what were once portions of its deep floor, so that they are now exposed along the flanks of this elevated country as the white masses I have just described; and, lastly, as these beds contain the remains of molluscs identical with those now living in the lake, it is obvious that the faulting which produced Mount Waller must have occurred at what is, geologically speaking, no very remote period of time.

This brings us to a question which was always before me while journeying round Nyasa, as to whether these changes of level of the coasts are still going on, for one of the most marked features of the shores all round the lake are the widely different levels at which the water has stood at different times. The above examples of colossal earth-movements in comparatively recent geological periods lead naturally to the questions, first, whether the apparent changes in the water-level have been, or are in any way connected with such movements; and, lastly, whether such changes in the relative heights of the country are still in progress. It was not, however, until I reached Karonga, some 40 miles north of Deep bay, that I discovered indisputable evidence of localized change of level in the coast-line of the lake. The flat sandy beach of this part of the lake is continued as a great marshy plain, which extends for many miles north, and which has at some time been covered by an extension of the lake itself. This extension of the lake must have reached to, or near, the semi-circle of hills which bound the plain on the east, west, and north. Now there are, in almost every part of Nyasa, evidences of at least three successive beaches. The first of these is 4 or 5 feet above the present wet-season water-level; the next some 10 or 12 feet above this, forming a beach which is almost always covered by enormous baobab trees. For the sake of clearness, therefore, I shall speak of this as the baobab beach. Lastly, there are in some places distinct traces of a third shore 30 or 40 feet above the baobab beach. On the sandy flat at the north end of the lake, the baobab beach is naturally not so easy to trace, as the sand and dust of which the plain is

composed has been blown into the low places and partially fills them up, together with the rank tropical vegetation which springs up on such plains whenever there is sufficient moisture for it to live. But there are here in some places traces of the baobab beach having existed 400 or 500 yards back from the present lake-shore.

About half a mile east of Karonga, where the Kambwi river enters the lake, there are some low sand bluffs forming soft cliffs about 10 feet high; and at one point, where they are most conspicuous, I found the sand to be underlain by a mass of clayey material, which contains the remains of an old plain covered by forest trees, the fragmentary remains of which are now quite blackened, and buried in this clay. The clay dips east and west, and, after a couple of hundred feet, is lost at both ends below the water-level of the lake. Thus we have here a forest which must have existed not only before the baobab beach some 20 to 25 feet above it, but before the much higher third water-level. Either, therefore, this forest must have been lowered before these two beaches were formed, or Nyasa must once have stood a great deal lower than it does even at the present day. There is, however, direct evidence of *local* change of level near this place, which is going on at the present time. Not more than 2 miles west of the clay, Dr. Cross took me to a spot where are to be seen, about 50 feet out in the water of the lake, some trees standing in their original positions, the trunks of which are now covered to the height of 5 or 6 feet; and these trees, the natives assured us, were alive and accessible not many seasons back, although the water of Nyasa has been persistently lower on the whole for several successive years. We have, therefore, evidence of two kinds relating to the level of Nyasa—one afforded by old beaches, which are a general feature of the lake, and the other by the existence of elevations and depressions of localized areas. The latter phenomenon exhibits the action of forces which have produced gigantic effects in the past, and which are seen, by the existence of the raised limestone beds near Mount Waller, to have been operating long after Nyasa had become a lake; and they are still in operation near Karonga at the present day. Thus it would appear that the great granitoid mountain cores which form the lateral walls of the Nyasa valley have been accentuated, if not produced, by the same superficial crumpling and upthrust which is apparent in so many parts of the Earth, and that this localized elevation, where stratified material stretches from ridge to ridge, has given rise to the gigantic faults seen about Mount Waller. Further, owing to the parallel nature of this ridging, parallel faults have been produced on opposite sides of the lake, whereby the sandstone beds, resting almost in their original positions on the igneous cores behind them, have been thrust up into the air, and stand now as conspicuous scarps facing one another on opposite sides. I have laid stress on the apparent manner

of formation of this particular strip of rift-valley, because it is not quite the same as that ascribed by Gregory and others to the numerous structures of the same kind further north. There is no evidence, then, zoological, geological, or otherwise, to show that Nyasa is at all of ancient origin; but it is older than the faults among the sandstone beds along its shores, and this is a point of some considerable interest, to which, when speaking of the relation of Nyasa to Tanganyika, I shall immediately return.

It has already been ascertained that the extreme north of Nyasa is bounded by a number of recent though extinct volcanic cones, the former activity of which has produced the floating pumice stone often found about the northern shores of the lake. According to Joseph Thomson's* geological sketch-map, the country which this volcanic material covers is shown as extending far down the Livingstone range to the south. This is not strictly accurate. The

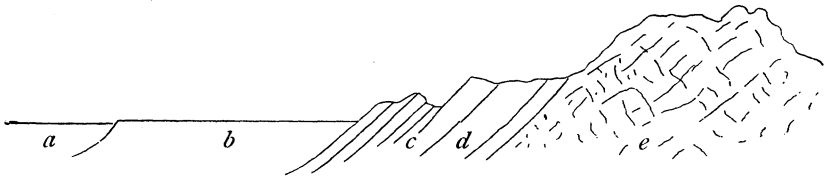


FIG. 3.—SECTION OF COUNTRY FROM KARONGA TO TOP OF PLATEAU, NORTH-WEST: *a*, LAKE; *b*, ALLUVIUM OF LAKE-SHORES; *c*, TRIASSIC BEDS; *d*, SANDSTONES AND CONGLOMERATES; *e*, GRANITE AND GNEISS.

volcanic material extends in reality but a little way beyond the extreme north of the lake, and most, if not all, of the western counter slopes of the Livingstone range show a structure of mixed granitoid and gneiss rocks, similar to those of the country further south.

On leaving Karonga, *en route* for Tanganyika, one passes first over the long alluvial plain which skirts the lake, and then up over some forest-clad hills, which form the outer rampart of the great interior plateau; and it is on these lower spurs of the higher mountains beyond that the Triassic beds described by the late Mr. Henry Drummond† occur. This stratified material lies on the flanks of the higher mountains, in a series of beds with a high dip to the south-east towards the lake, and one consequently passes over their denuded extremities in reversed order, the upper being traversed first (see Fig. 3). These beds, however, are not placed directly on the granitic cores which rise clear of all stratified material further inland, but rest on a great thickness of upturned sandstone (Fig. 3), similar in all respects to the massive beds in the Mount Waller series. These red and yellow sandstones and conglomerates are continued up to the top of the plateau to the height of about 4500 to 5000 feet; but they are here seen to be broken through in all

* 'To the Central African Lakes and Back.' 1881. † 'Tropical Africa.' 1888.

directions, by masses of granitic material, which rise in places to the height of fully 7000 feet. These gneiss and granite masses spread out from one another at this point of entry to the plateau into two lofty ranges, one being continued in a north and the other in a south-westerly direction. The entire space between them is filled by an elevated flat of immense extent, covered with forest, and sloping slightly away to the west. This plain carries the Chambezi river, the headwaters of the Congo, and, as far as I could ascertain, is everywhere composed of the sandstones and conglomerates described above. The average height of this plain is about 4500 feet, and it will be remembered that this is about the height to which the flat top of the Mount Waller district reached in the neighbourhood of Deep bay. The plain is certainly extended to an immense distance west and south, and it is in the highest degree probable that the neck of elevated sandstone formation which crosses the granitic ranges in the locality of Deep bay is continuous with this plain, round the so-called Nyika region, to the west, the lofty northern boundary of which is visible as the Konde mountains from the point I have now reached. If this is so—and I have very little doubt of it myself—it will be seen that the great elevated sandstone plain is really continued through the Mount Waller neck, across the bottom of Lake Nyasa to Amelia bay, and there may be in connection with the similar formations which are known to exist further east towards the coast. Now, this sandstone plain is unbroken in its continuity westward to Tanganyika, but a succession of rugged gneiss and granite mountains break through it in a north-easterly direction all the way. On the other side, that is, on the east of this range, the sandstone formations are again encountered, and Mr. Bell informed me that a few miles east of Fife he saw lofty sandstone escarpments, which suggest a reappearance of the rift about Mount Waller to the north of Lake Nyasa. In fact, travelling from Karonga on Nyasa in the direction of Lake Tanganyika, one is nearly always on the western face of a more or less broken-up range of hills, which gradually pass off the track to the east on nearing the country round the southern end of Tanganyika. While on these hills, which are a continuation of the gneiss and granite cores extending north-west from the Karonga plains, every point of vantage which renders a view to the west over the interminable forests possible, discloses the existence of an equally interminable series of western plains which form the great Awemba country. These plains slope everywhere slightly to the west, and their lowest parts in that direction are filled by the vast swamps and open water of Lake Bangweolo. Beyond this lake the plains are terminated by a broken mountainous country, continuous with the hills flanking the shores of Lake Mwero, and about the nature and structure of which little or nothing is known. This description of the country lying along and west of the route from

Karonga to the south end of Tanganyika will be seen to differ markedly from that given by Joseph Thomson in his journey over what might appear at first sight the same track; but this disagreement arises, in part at least, from Thomson's route having been along the top, if not on the eastern counter-slope, of the broken mountain ranges running north-west, which I have just described. He therefore missed the sandstone plains to the west through the greater part of his route, but I am at a loss to understand how he can have come to the conclusion that schists, gneiss, and clay slates extended over the country north of Mambwe, since passing from this point I found no such formation, but passed almost immediately from granite and gneiss to the typical sandstone plains.

On leaving the mountains to the east at Mpanda, and passing north-west towards Tanganyika, the country is *still* composed of sandstone and conglomerates, but here they are much broken and thrown up and down into a rough forest country, the details of which it is exceedingly difficult to understand. These irregularities soon give place, after passing Fwambo's village, to regular faulting, which extends north-west in the same general direction as the axis of Lake Tanganyika itself, and these faults in the high country are in reality the continuation or tailing out of the great Tanganyika series. Still keeping on the elevated plain, but approaching Tanganyika from the south-west corner above the little village of Mbete, the elevated crests of the great northern range are still occasionally visible further and further away to the north-east, until they seem to terminate that way in a solitary mountain peak. The southern arm of Tanganyika, which lies between these hills and the foot of the plateau at Mbete, is not, however, visible until one stands on the crests of the great sandstone cliffs which rise 2000 feet above its western shore. The sublime views from this and similar points along the western escarpments of the lake can be imagined from the colossal magnitude of the physical features which compose the country around, but they are not repeated on the eastern shore. There the country rises gradually from the water's edge, the shore being covered with the broken fragments of the underlying sandstones, which have here the characters of the upper layers along the western cliffs. The eastern slopes are covered with the usual forest, and rise gradually towards that continuation of the north-west range which I have described. In fact, throughout the whole of the southern portion of the lake the country to the east of it appears, so to speak, to be piled upon this range.

Northwards the lake widens out on its western side, into the great gulf known as Cameron bay, and this gap is in reality caused by one of a series of faults the long axes of which lie at right angles to the axis of the lake as a whole. There is evidence of considerable outpouring of lava at Sumbu, the western extremity of this gulf, and a little to the

south, along the lower course of the Lofu river, there is the best example of a rift-valley which I have seen. This valley is simply the exact inverse of what is known as a block mountain, and consists of an oval mass of land, some 35 miles long and 8 to 10 miles broad, which has bodily sunk, so as to leave an enclosing fringe of lofty sandstone cliffs all round. North of this district my observations differ from those of Thomson in a marked degree. In Thomson's geological map the whole of the point marked Kassava in mine is indicated as composed of felspathic rocks. I have travelled over this region twice by land, and been round its shores several times by water, and I can affirm that it is certainly composed, apparently entirely, of the sandstones and conglomerates which compose the adjacent hills. Further, the tract of country covered by the route from Kassava point to Sumbu is also included by Thomson as being within his felspathic area; but I have examples of rocks gathered in this very place, which are indistinguishable from the sandstones and conglomerates in the cliffs above Mbete. There is a species of ironstone here which is not found at Mbete, but otherwise the series appear to be identical. Further, the point of land between Sumbu and Teleka's village is also composed of the sandstone series; and, again, the great cliffs on the northern shore of Cameron bay as far as Pamlelo's repeat the same story. Thomson must therefore have fallen into some error over this, or have confused these districts with something which he observed further north. Anyway, it is quite clear that the southern part of what he calls the felspathic area is not at the place where he supposed it to be. The map of this author also represents that part of the east coast of Tanganyika which lies between the Kilambo and Kawa (?) rivers as being composed of gneiss and slate. The shores of this region, however, appear to be composed of sandstones of different varieties, comparable to the upper series of the western coast. The reason of this difference, however, is not so difficult to see, because Thomson left the coast at this point, and journeyed inland and up, thereby coming upon the geological formations characteristic of the mountains inland from the coast; continuing inland, he seems to have come across metamorphic rocks beyond the Kawa (?) river, and to have jumped to the conclusion that these were also present on the lake-coast. This, however, does not appear to be the case, metamorphic rocks not being encountered for many miles north of this point along the shore.

Thus it will be seen that the southern half of Tanganyika lies at the bottom of a succession of great faults in a series of massive sandstones and conglomerates, which seem to extend in unbroken continuity through the great elevated plain of the Awemba country, as far as Nyasa and Angoni land to the south. These massive stratified formations extend thus over a vast area of the African interior; they extend east as well as west along Nyasa, and are

connected together across the Nyasa valley, first by the narrow neck in the region of Mount Waller, and, secondly, beyond the lake to the north. The whole of the high interior plateau, which extends in unbroken continuity far up the coasts of Tanganyika, and is encountered again round the southern shores of Lake Rukwa to the east, stands nearly everywhere about the same average height above the sea. Thus the top of Mount Waller is about 4000 feet; the great sandstone plain west of Mweinwanda's is the same. Lake Bangweolo, which fills the southern portion of this plain, and which is not more than 10 or 12 feet deep, stands between 3000 and 4000 feet. The great plains west of Tanganyika fall to the west from 4500 to 3500 feet. But this vast area of sandstone is pierced in all directions by high upstanding masses of gneiss and granite rocks, which rise as mountain chains above the general level of the sandstone plains, like islands above an ancient sea, and as the sandstone formations rest approximately in their natural positions upon these upthrust igneous rocks, it is by no means impossible that this is what they really are.

Unlike Nyasa, Tanganyika lies wholly in a series of valleys formed by faults running north and south along the interior plateau, and it is obvious that this lake may be as old, but it cannot be older, than the date of formation of the valleys at the bottom of which it now exists. Nyasa, on the other hand, was evidently in existence as a lake (as is evidenced by the limestone beds near Deep bay, which I have described) at a time when similar faulting was going on. But as the fossils in the beds about its shores are similar to the animals now living in the lake, it is obvious that the time of their upheaval cannot have been, geologically speaking, very long ago. There is no geological evidence, that I am aware of, from which any notion of the date of the formation of the Tanganyika faults can be formed, but, according to Gregory, similar rifting has been of comparatively recent date further north. The geological evidence concerning the date of origin of these lakes and their ages relative to each other, therefore, cannot be pushed to any definite conclusion; but there is, on the whole, a certain amount of evidence that Nyasa, as a lake, is the older of the two! I would draw attention to this point, because it has a most important bearing on the zoological problems with which I have been primarily concerned.

THE ROMAN ROADS OF MOROCCO.

By WALTER B. HARRIS.

THE "road-book," or "Itineraries," of Antoninus Augustus have left us sufficient information to gather some tolerably correct idea of the positions of the towns, etc., that existed at stated intervals along the two main Roman roads of Northern Morocco, for it must be remembered that there

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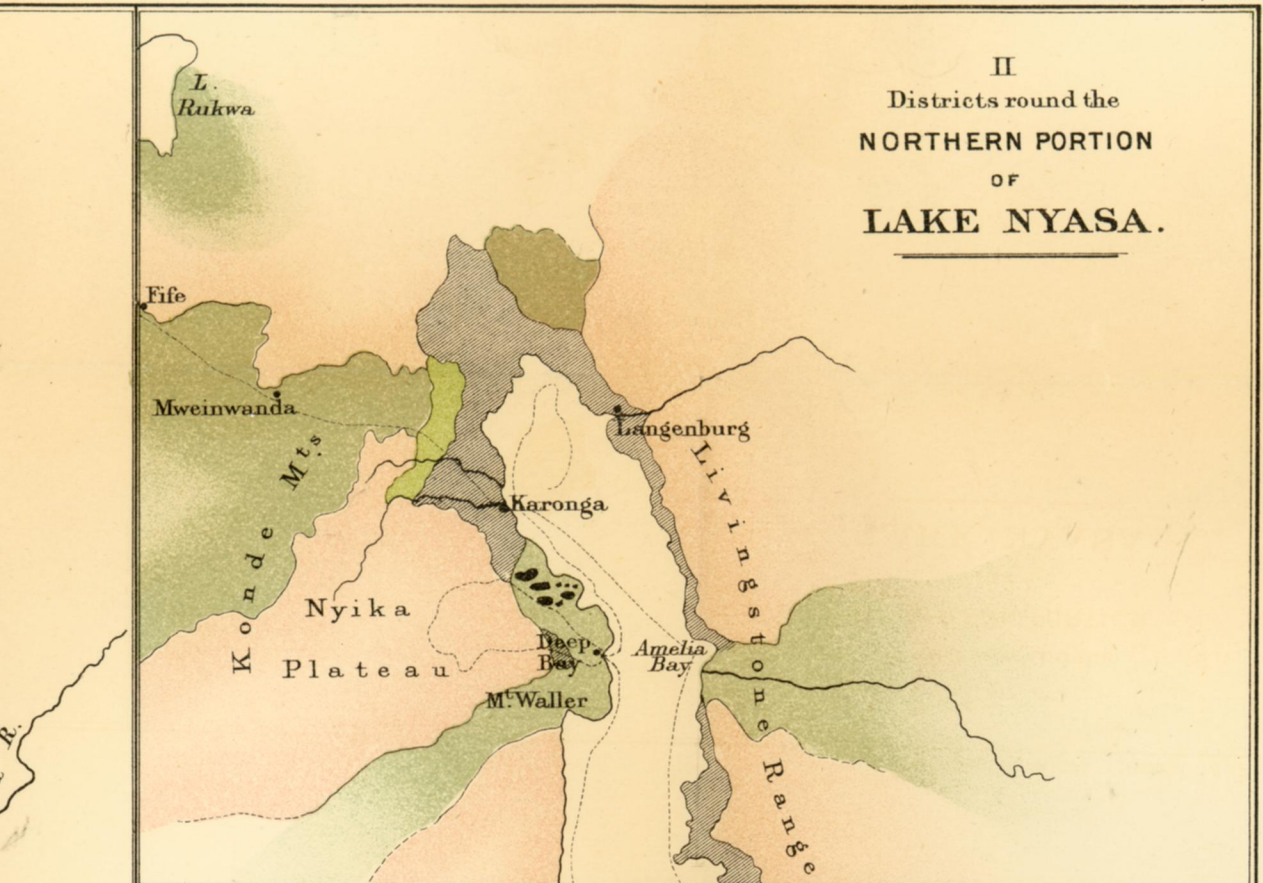
I
Sketch Map of the
Districts round the
SOUTHERN PORTION
OF
LAKE NYASA.

Showing the Distribution of the
Geological Formations
by
J.E.S. Moore, A.R.C.S.

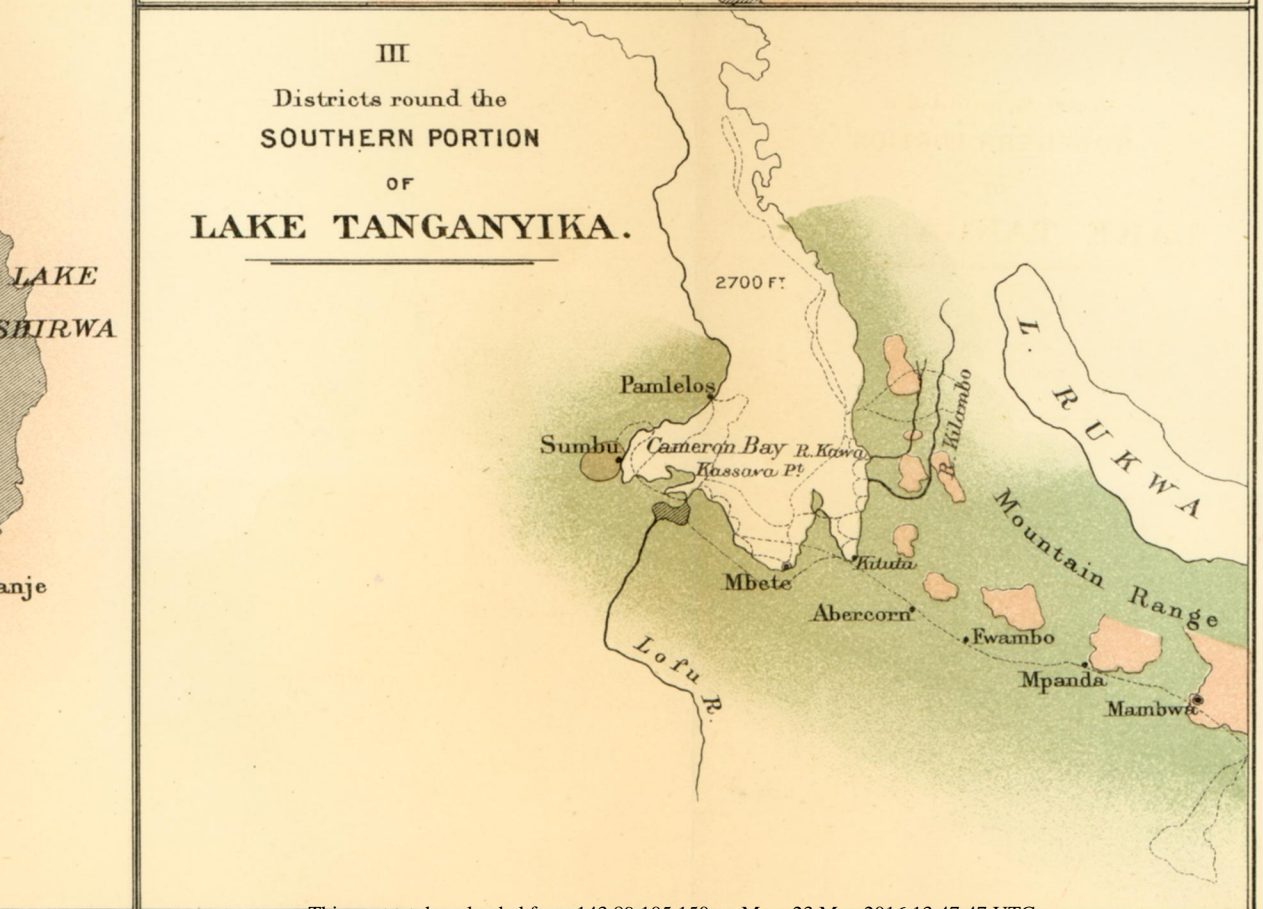


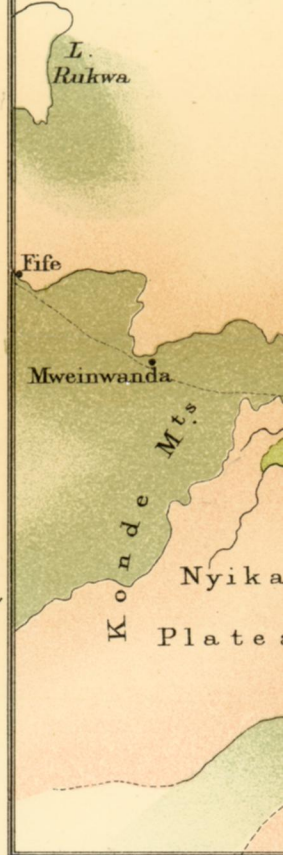
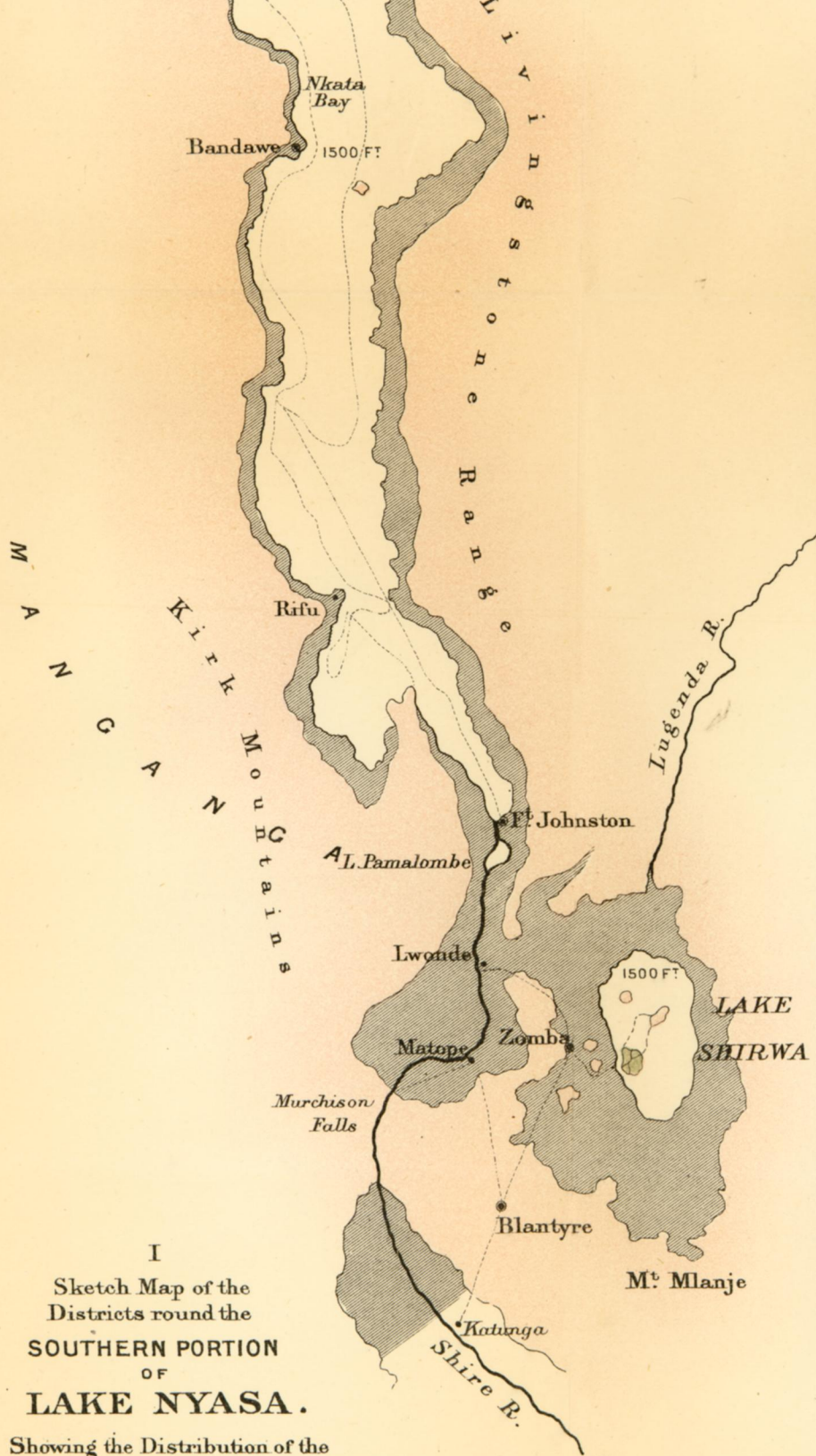
III
Districts round the
SOUTHERN PORTION
OF
LAKE TANGANYIKA.

II
Districts round the
NORTHERN PORTION
OF
LAKE NYASA.



III
Districts round the
SOUTHERN PORTION
OF
LAKE TANGANYIKA.



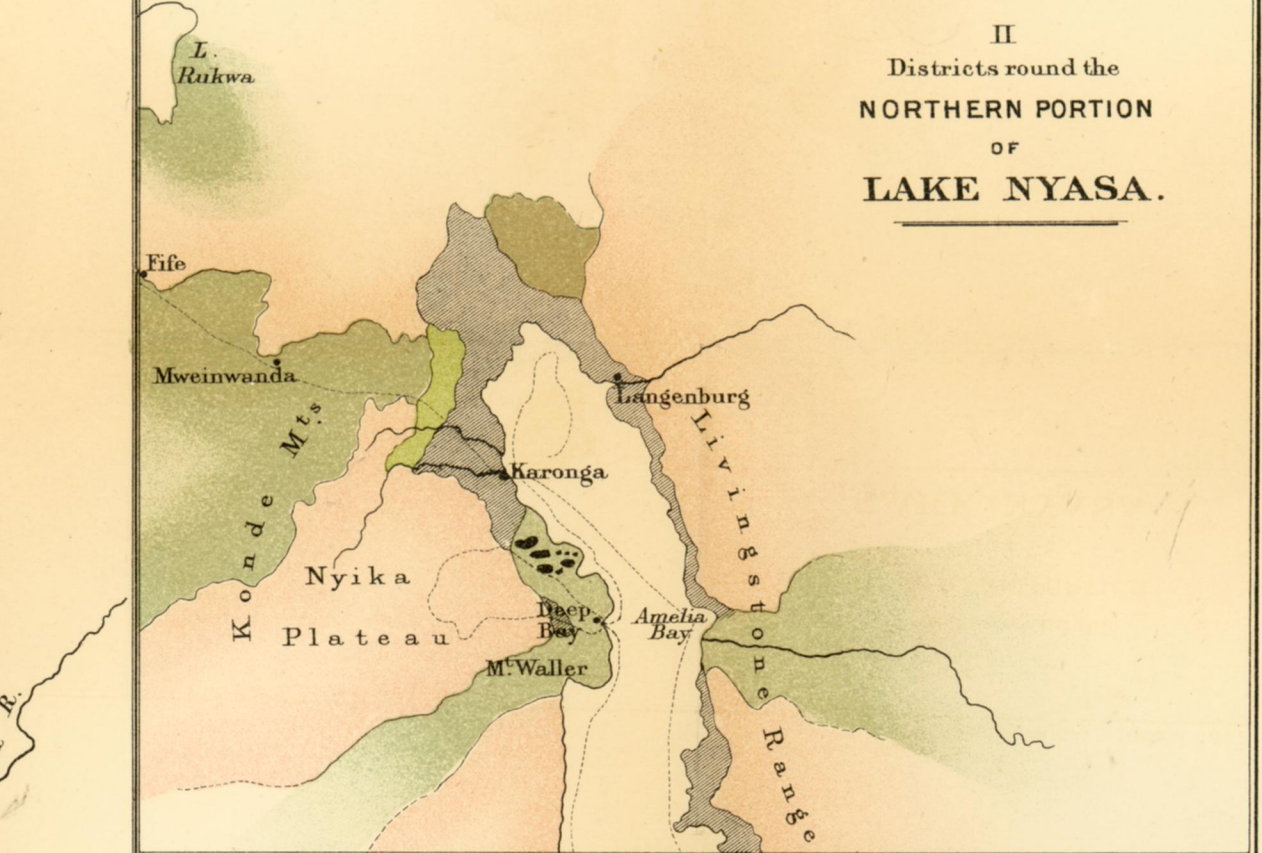


III

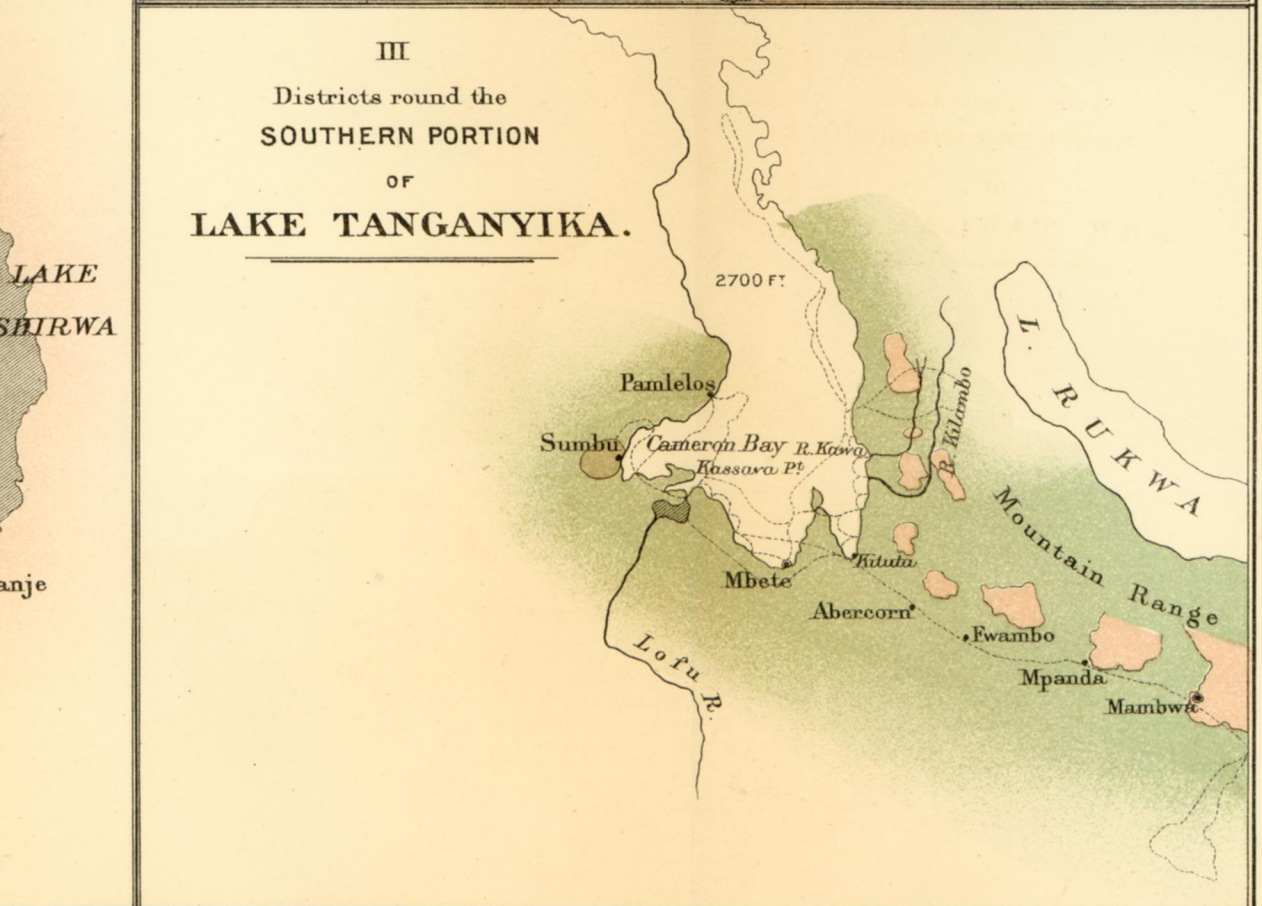
Districts round the SOUTHERN PORTION OF LAKE TANZANIA.

Published by the Royal Geographical Society, 1897.

II
Districts round the
NORTHERN PORTION
OF
LAKE NYASA.



III
Districts round the
SOUTHERN PORTION
OF
LAKE TANGANYIKA.



by the Royal Geographical Society, 1897.

interior plateau. Triassic Formations. Volcanic. Modern Calne Limestone. Alluvium of the lake shores.

F. S. Weller, F.R.G.S.