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CONTRIBUTIONS TO THE PHYSICAL GEOGRAPHY OF BRITISH EAST AFRICA.*

By J. W. GREGORY, D.Sc., F.G.S., of the British Museum (Nat. Hist.).

I. INTRODUCTION.

In an examination of a map of Africa, one of the first points likely to be noticed is the number and size of its great lakes, the exploration of which has been the greatest stimulus to African travel since the discovery of the sources of the Nile and the course of the Congo. Anything beyond a most casual examination of the map shows that the lakes are all grouped in the eastern tropical region, and that they are here developed in two forms. There are those, such as the Nyanza and lake Moero, which are round in shape and have low shores, and those which are long and narrow in shape and have high precipitous shores, such as Tanganyika, Nyasa, and Basso Narok (Lake Rudolf). Further examination, moreover, shows that the lakes are not distributed haphazard, but on a certain definite plan. The long ones are arranged in two lines, which pass one on either side of the Nyanza and meet at the north end of Basso Narok; thence a line of lake-dotted low land, in places below the level of the sea, runs up to the Red Sea. But the Red Sea itself presents exactly the same type of structure; it is long and narrow, and, excluding some strips of coast deposits, has similarly high, steep shores. From its northern end the Gulf of Akaba leads to another valley, margined by deep high walls, and travelling along it we come to another lake situated in a deep depression, and a river in a long narrow valley. These are the Dead Sea and Jordan valley, which continue the

* Paper partly read at the Royal Geographical Society, January 15, 1894. Map, p. 384.
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type of structure of the East African lake chain, till it ends off in the deserts of Northern Syria.

From Lebanon, then, almost to the Cape there runs a deep and comparatively narrow valley, margined by almost vertical sides, and occupied either by the sea, by salt steppes and old lake basins, and by a series of over twenty lakes, of which only one has an outlet to the sea. This is a condition of things absolutely unlike anything else on the surface of the earth. It is, therefore, only natural to inquire whether this great valley consists merely of a series of independent basins formed by depression or erosion, the linear arrangement of which is but an accident, or whether it is all due to a common cause, which formed a great earth crack or depression at some comparatively recent period of the earth's history. All along this valley the natives have legends of great changes in the structure of the country. The Arabs tell us that the Red Sea is simply water that did not dry up after Noah's deluge; the Somalis say that when their ancestors crossed from Arabia to Africa there was a land connection across the straits of Babel-Mandeb. The natives of Ujiji have a folk-lore that goes back to the time when the lake of Tanganyika was not; while in the extreme north, there are the better, or rather more widely known, but less definite legends of the destruction of Sodom and Gomorrah.

It may be objected that if a valley such as the one suggested could have been thus formed, why are there no others of a corresponding size and arrangement? Many such valleys are known in America, where, e.g., the Yosemite can only be explained as due to the subsidence of the orographic block that formed the floor of the valley. These cases, however, are much shorter. The nearest approach in size can probably be found on the moon, whose clefts or rills no doubt represent long steeply walled valleys, and present to us much the same aspect as this East African valley would do to any inhabitants in our satellite. Not the least interesting of the points raised by the African-Red-sea-Jordan depression, is the possibility that it may explain the nature of those lunar clefts which have so long been a puzzle to astronomers.

Though the main features in the geography of most of this line of depression is now fairly well known, our information as to the geology of the African part is extremely limited, and is based mainly on the study of odd pebbles and fragments brought home by travellers. When, therefore, the offer was made to me to accompany as geologist an expedition across the Borana-Galla country to Basso Narok, and north across Somaliland to Berbera, I was naturally eager to accept it. On the kind recommendation of Sir William Flower and Dr. Woodward, the trustees of the British Museum generously granted me the necessary leave of absence.

This expedition, however, unfortunately collapsed three marches from the coast. I was extremely reluctant to return to England

without having done something to repay for the wasted time, and I resolved to make a second effort to reach the line for the study of which I had gone to Africa. Too much of my ten and a half months' leave of absence had been spent on the Tana for it still to be possible to reach Basso Narok ; moreover, the small force which my limited resources would allow me to employ would have been quite inadequate for the traverse of the country of the Wasuk. I resolved, therefore, to attempt to reach the highest part of the valley of subsidence between Lakes Naivasha and Baringo, as the maps suggested that the geological structure of this valley might be worked out even better there, than on the shores of the great northern lake—Basso Narok. In this opinion I was strengthened by a letter from Professor E. Suess.

As I could not wait for any instruments to be sent out, even from Bombay, I was compelled to start with a most inadequate geographical equipment ; this consisted only of a prismatic compass, an Abney level, a Watkin's clinometer, an aneroid graduated only to 21 inches, and two boiling-point thermometers. For the last I have to thank my friend Mr. Bennett Stanford. I was, however, encouraged to persevere by the consideration that I could, after my return, use the maps of the Railway Survey as a base, and work from these by dead reckoning, accepting Von Höhnel's determinations of the position of Kenya. This, of course, is not scientific geography, but it seemed better to work on by this rule-of-thumb method rather than abandon geographical exploration altogether.

I should here like to express my thanks to the friends who kindly helped me to organize my caravan or to ease the way. Foremost amongst these are Messrs. W. H. Harris and J. Bennett Stanford, two members of the original expedition. They did everything that men could do to raise it after its collapse ; and when they found that I was going on alone, they helped me in every possible way, and gave me a most generous present from the stores of the former expedition. To Mr. J. R. W. Piggott, the Administrator of Mombasa, I am greatly indebted for his kind hospitality during my first stay there, and for much valuable advice and help. To Drs. Macdonald and Mackinnon and Mr. C. W. Hobley I also have to express my best thanks—to the two first for some medical stores and information ; and to the last, who, as head of the transport office in Mombasa, gave me much help in fitting out and selecting trade goods. The officers of the British East Africa Company's inland stations at Machakos and Kikuyu, viz. Messrs. Ainsworth, Purkiss, and Hall, also gave me the kindest assistance when passing through the stations in their care. Dr. Charters and Mr. Watson of the Scottish Mission at Kibwezi, and Mr. George Wilson, the engineer of Sir William Mackinnon's road, both helped me most generously with food, when I should otherwise have been unable to procure it. Nor must I forget my headman, Omari ben Hamadi, to

whose pluck and energy and splendid devotion the expedition owes most of whatever success it may have had.

II. THE ROUTE AND LIST OF CAMPS.

In the first expedition we landed at Lamu, and crossed from that island to the mainland at Mkonumbi. A night's march to the east, through grass land with baobabs and forests of hyphæne palms, brought us to the historic town of Witu; by another two marches, at first across similar country, and then over the steppes and alluvial plains of the Tana, we reached Ngatana, where seven weeks later the expedition was disbanded. In the return march, Mr. Harris and I descended the right bank of the Tana to Golbanti, and thence to the coast at Marareni, passing on our way the upper marshes of the Khilifi river near Kurawa. Another march took us to Mambrui, and a rest there afforded the opportunity for a visit to the red sandhills of Magarini. Melindi is another short march along the coast, and Mombasa four days to the south of this.

The second expedition left Mombasa on the afternoon of March 23, 1893. It consisted of forty-one members, viz. a headman Omari ben Hamadi, four Askaris, thirty-three porters, a cook, a tent-boy, and myself. Though I was suffering from a severe attack of fever at the time, we started next day on our march for Machakos. We travelled *via* Taro, Maungu, Ndara, the Voi route to Ndi, and thence to Tzavo, where the river was in full flood. Crossing this, we made for Kibwezi and Nzaoi, where we entered the Iveti mountains, which we traversed till beyond Machakos. Thence we crossed the Kapte plains and through the forests and shambas of Ukikýu to Fort Smith at Kabéti. Rising steadily through woody uplands, we struck the edge of the great valley of subsidence—the Graben of Professor Suess—on the summit of the Kikúyú fault scarp. A steep descent of about 800 feet brought us to the floor of the valley by the Guaso (river) Kedong. Continuing northward, we followed the valley or great meridional rift to the ridge that crosses it north of Lake Baringo. We kept close to the east wall, leaving the track at Miviruni, and reaching Baringo by a new route past a small lake, the name of which I find to be Kibibi, and along the east shore of Lake Losuguta (*syn.* L. Hannington).

During the journey numerous branch excursions were made to examine the walls of the Mau escarpment on the west, and the Kikuyu and Laikipia fault scarps on the east.

Leaving Njemps Mdogo on June 6, we started east-south-east on to Laikipia, and, keeping along the western side of this plateau, struck for the great valley, which I expected to find between the mountains called Doenyo Kinangop and Doenyo Goyito and the Aberdare mountains. We crossed the ground whereon Höhnel has placed this range, and entered the north-eastern end of Ukikýu in the upper part

of the Thagana or Sagana valley. Two days' march from this took us to the west foot of the mountain Kenya, about an hour and a half's walk from Teleki's camp at Ndóro. Our camp there was used as the base of operations on Kenya, till the exhaustion of our food-supply compelled us to return again to Ukiikýu. We traversed this country to the south, till we descended from its rolling uplands on to the lava plains of the Tana, near Maranga. We crossed the Tana—there known as the Kiro-rúma—just above its confluence with the Thika-Thika, and followed this river over the "Nyika" steppes, and through the gorges of the northern Iveti mountains, on to the plains of the Athi. Crossing both rivers near Chanjavi, we returned to Machakos via the Kavalúki valley. Thence by the Kapté plains and the hill country of Maká, we reached Nzaoi, and retraced our steps to Tzavo. There we diverged to the east, down the Sabaki valley till below the freed-slave settlement of Makongéni. A last march of four days over the hills of Giriama, through Fuladóya, Mwaiba, and Ribe, took us to Mombasa, where we arrived on Saturday, August 19, having covered 1800 miles in four days less than five months.

The list of camps in the Appendix shows the route more in detail, and will be more convenient of reference to any who may have occasion to refer to the collections made during the expedition, especially as the paper is not written in a narrative form.

III. THE PHYSICAL FEATURES OF THE DISTRICT.

The geographical structure of British East Africa may be represented as composed of seven zones, running roughly north and south, and approximately parallel to one another. These seven zones or belts consist of three mountain ranges and four plains or plateaux.

The first of the mountain systems, both in time and proximity to the coast, is the range which may be regarded as the African "Urgebirge," as it must have formed the primitive axis of the continent, once extending from the Drakensberg of Natal to the Shoho mountains of Abyssinia, and perhaps even to the Ababd mountains of Egypt.

In British and German East Africa this primitive axis of the continent is less perfectly preserved than elsewhere, and it is often buried under vast volcanic piles, such as those of Kenya and Kilima Njaro. The principal representatives of this range consist of the Ugwéno and Paré mountains on the south side of the Anglo-German boundary; of the gneiss mountains of Bura, Taita, and Ongalea,* the numerous "bare hills" of the Railway Survey on the plains of Kikumbiliu and west of the Ndangi river, and of Bwinzau, east of Kibwezi. Further north the line is continued by the gneissose and schistose dome of the Iveti mountains and the gneiss ranges of Ithámaba, Voróni,

* The Kyulu mountains of the Railway Survey.

and Changabúbu on the south margin of Eastern Ukikúyu. Here the gneiss hills disappear below the lavas and agglomerates of Ukikúyu and Kenya; but north of this it again appears in the Doenyo lol Deika, the Loróghi mountains, and General Matthew's chain, and passes northward into regions geologically quite unknown. The continual recurrence of steep bare "hogsback" hills of gneiss, and the remarkable persistence in the north and south foliation and characters of the rocks, show that they are part of a common chain. This has, however, been lowered and broken by prolonged denudation, and is now breached by all the larger rivers of this part of the African counterslope. It is the third mountain system to the west that at present forms the main watershed.

The second mountain system is better known from the size of its two most famous peaks, Kilima Njaro and Kenya. As is usual with volcanic cones, the mountains of this series are distributed more sporadically than those of the former, and so are not so important as far as the drainage of the country is concerned. The principal mountains are arranged in a meridional line from Kilima Njaro to Kenya and to Mount Lulall on the east side of Basso Narok (Lake Rudolf). The Theuka and Kyulu* mountains occur along this line between the two first mountains; I was not, however, able to visit them, and thus cannot say whether they belong to the same period of eruption or to a later one along the old line. The latter is not unlikely, as a parallel series of later date runs up the meridional rift. The two principal mountains of this series occur at points where the meridional line is traversed by one at right angles to it; thus on the parallel west of Kenya are Settima and Longonót, and on that through Kibo—the later peak of Kilima Njaro—are Mawéni and Mount Merú.

It is important to notice that the principal rivers that have their sources on these mountains rise on the western slopes, and flow round their flanks to the east.

The third mountain belt, though the most important in Eastern African geography, does not include any very conspicuous peaks, and is overshadowed in popular estimation by the famous snowclad summits of the volcanic zone. This chain must once have been a great anticlinal or arch, extending from the Nyasa on the south to the Afar region of Abyssinia on the north; its summit then formed the main water-parting that separated the drainage into the Indian and the Atlantic oceans. A similar anticlinal may have existed further to the west in the Equatorial region; it probably diverged from the more direct one in the neighbourhood of Lake Nyasa, and curving round to the west of the Nyanza, and passing through Tanganyika, Lutan and Mwutan Nzige, reunited with the main axis to the north of Basso Narok. Between

* The Ongalea mountains of the Railway Survey.

these two lines was included the area formerly only of internal drainage, but now opening to the Congo and the Nile. That this third zone is not now recognized as a distinct mountain range is due to the fact that the centre of the arch has fallen in, forming one of those valleys of subsidence with long, steep, parallel walls which Professor Suess has called "Graben." The famous Yosemite valley may be taken as a well-known type of these "rift valleys," as they may conveniently be called.

The tops of the walls of this valley still form the water-parting, the streams on the east slope going to the Indian Ocean, and those on the west to the Congo or the Nile; but between the walls are a series of rivers which flow into lakes which, except in the single case of the Nyasa, have no outlets to the sea.

The four remaining zones are plains and plateaux which constitute the greatest superficial extent of the country. The first and lowest of these is that which is known to the Swahili as the "temborari" or coastal plain which occurs all along the shore between Lamu and Mombasa, except for a narrow strip between the estuaries of the Khilifi and Takaungu. This coast zone is formed in the main of raised coral rock and cemented coral sand, and is covered by sand-dunes, raised beaches, and a red soil of wind-borne quartzose sand. This tract of country is generally extremely fertile and well cultivated, and is the great fruit-growing district; it supports dense groves of palms, orchards of mangoes, oranges, and limes, and extensive shambas of pineapples, cotton, and coffee. It is from these that the leading Arabs of the coast have in the past derived their wealth.

The width of the temborari varies considerably. At Mombasa it is only about two miles wide; at Takaungu it is completely cut out by the red sandhills, which here slope steeply to the sea; at Melindi it has widened considerably, and from there to Lamu averages about 10 miles across. It is deeply indented along the coast by sinuous estuaries which branch repeatedly; the creeks thus formed often unite with those of the next estuary, and thus islands are cut off from the mainland. Thus have been formed the island of Mombasa and the Lamu Archipelago.

The passage from the temborari to the high inland plateau is in places well marked, but at other times it is somewhat indefinite, as a series of foothills leads gradually from one to the other. The former is well seen north of Freretown, where there is a single steep slope from the low coastal plain to the plateau of Ribe at the level of over 800 feet. The second condition is typically found west of Mombasa, where there is a slight rise from the Makupe ferry to the shambas of Chamgámwe at the height of 200 feet. Beyond this lies a well-watered undulating upland covered with shambas, with numerous groves of palms and plantains, large mango orchards, and extensive fields of dry rice, maize, and mtama (dhurra). The country is formed of Jurassic shales and sandstones,

with some beds of limestones, and with these are associated thick masses of red sands and sandstones.

In other districts the soft Jurassic beds have been either entirely removed or left only as a series of low rounded hills, such as the three to the north of Freretown, which are known as "Ngoa Mombasa" (Kiswahili), or "Coroa Mombasa" (Portuguese). To the west of these is a low estuarine plain, from which rises the steep slope of the great inland plateau. Further north the Jurassic beds have disappeared entirely, as the hills of the red sand and Carboniferous sandstone series reach the sea, and the temborari rises gradually into the higher plateau.

The Nyika, the second plateau, is in striking contrast to the lower or foot plateau both in character and extent. It is bounded on the east by the edge of a steep escarpment, the summit of which is usually at the height of about 800 feet; thence it extends to the west as the vast barren sandy steppes which separate the mountains from the sea. The soil is red and quartzose, water is scarce except in the rainy season, and the vegetation consists in the main of loose mimosa scrub. With the exception of occasional oases and a narrow tract on either side of the rivers that traverse it, the whole country is uninhabited. As some distinctive name is needed for this belt of country, the name "Nyika" has gradually come into use.*

As far as British East Africa is concerned, the Nyika extends throughout the whole country from north to south, being broken only by a narrow belt on either side of the Tana and Sabaki. Its main western limit is at the foot of the gneiss hills of the primitive mountain axis; but in places where this has been broken through, or where it is only represented by isolated bosses such as Bwinzau, the Nyika extends further west to the fertile plains of the next zone, or to the base of the mountains of the volcanic chain.

West of the Nyika, and generally separated from it by the primitive mountain axis, are the first of the series of high plateaux which form the great grazing lands of the interior, and for which the Masai name of Rangatan may be generally applied. The most important of these is that known as the "Kapte" plains, which stretched northward from Kilima Njaro between the Ongalea, Kyulu, and Iveti mountains to the east, and the mountains of Matumbato, Massimani, Ngongo Bagas, and Kikuyu on the west. It thus includes the plains that border the upper

* As the country is a distinctive geographical type, it certainly seems best to adopt some native name analogous to "prairie" or "tundra." "Nyika," or "Unyika," really means the country of the Wanyika, but the Rev. W. E. Taylor uses it in his Ki-Giriamma Vocabulary for "desert," which is probably a Swahili use of the word. "Nuka" in Ki-Chagga is applied to the same tract of country, but Mr. Taylor informs me that it there means "lifted up," and perhaps was given to it owing to its elevation, and Nyika may have originally meant the same. "Puri" might be more correctly adopted, as both the Wanyamwesi and Swahili use it for a scrubby plain, while the Ki-Giriamma "weru" might do, as it means "steppe" rather than mere desert.

Athi, and runs eastward along the Thikathika, interrupted only by a few miles of sandy Nyika, till it crosses the Kiroruma and ends at the hill land of East Ukikúyu. Due north of this, and separated from it by the comparatively narrow stretch of Ukikúyu, is the high plateau of Laikipia; this stretches northward from Ukikúyu between Kenya and the Doenyo lol Deika on the east, and Settima and the edge of the fault-scarp of the great rift-valley on the west.

A third Rangatan occurs to the west of the rift-valley, and slopes slowly down to the basin of the Nyanza. It is known, from the colour of its soil, as Rangatan Nyuki, or the "Red Plain;" it is traversed by the Guaso Nyuki.

These Rangatan resemble one another closely in their general scenery, which is in striking contrast to that of the Nyuki, for their lava soil is extremely rich; they retain moisture well, and are in consequence covered with rich long grass, which, as it ripens, turns a light golden yellow, and from its vast extent reminds one of the great corn-clad prairies of Dakota. When the grass is low and green, the springy turf and well-rounded undulations, and steep, narrow, and often dry valleys give the country the aspect of our chalk-down scenery. It is on these plains that, if the experiment of European colonization be attempted, the best sites for the first settlements may be found.

The last of the eight zones is the most remarkable of them all, consisting as it does of the floor of the great valley of subsidence which runs from Nyasa to Afar, and which in British East Africa extends from the German frontier on Lake Natron to north of Basso Narok. The valley usually has a flat, level floor, bounded on either side by the escarpments, or more correctly the fault-scarps, of Mau, Kamasia, and Karamoyo on the west, and those of Ngongo Bagas, Kikuyu, Kinangop, Laikipia, and Samburu on the east. The description of this rift-valley, with its lines of but recently extinct volcanoes, its lakes and rivers, and the scarps of its innumerable faults, will be given in Section VIII.

The following diagrammatic section will show in brief the structure of the country, on an east and west traverse from the coastal "temborari," over the foot plateau, Nyika, the primitive mountain axis, the volcanic chain, and the Rangatan zone to the rift-valley and its fault-scarp walls:—

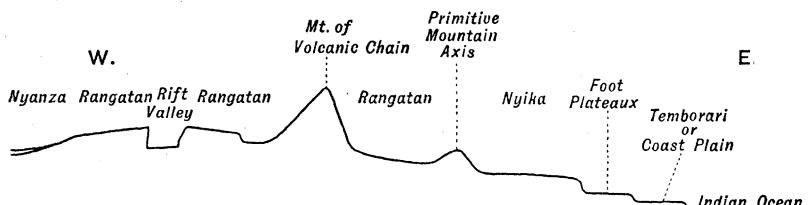


FIG. 1.

IV. THE COAST ZONE AND THE "BROADS" OF THE TANA.

Since the journeys of Von der Decken, Wakefield, and New, our knowledge of the coast zone has, in spite of its accessibility, been allowed to lag, except for the actual course of the Tana and the neighbourhood of the chief ports. Lieutenant Smith has, however, given a good account of the country south of Mombasa, in a recent memoir. A series of excursions over the estuarine plains of the Tana and Ozi, as well as the marches from Mkonumbi to Ngatana, and thence to Melindi, gave me opportunities for an examination of a good deal of the country. This may be divided into four types: (1) the actual coast deposits; (2) the river valleys; (3) the more open sandy "barra;" and (4) the hills of the "red sand series." The country as a rule is low, but the dunes are often high, reaching the height of 250 feet on Lamu Island, while they are also very conspicuous near the German cotton plantations at Ras Chagga, near Kipini, and north of the mouth of the Khilifi river, near Kurawa. The red sandhills also often attain a considerable elevation, and are about 400 feet near Magarini. The soil is often very rich, though there is a great deal of barren sandy ground. The low alluvial plains near the mouth of the Tana are especially fertile, and are flooded twice a year; they are, however, extremely unhealthy. Raised coral rock occur as far inland as Witu.

The descriptions of New and Wakefield give a good idea of the country south of the Tana, and those of Peters of the district opposite the Lamu archipelago, and between that and the Tana. The agricultural capabilities have been described by Mr. W. W. A. Fitzgerald, in a report to the British East African Company.

The new features noted in the structural geography of the country may be considered in reference to the rivers, lakes, and hills.

The Tana is the principal river, and its course has been described by New, Peters, and Gedge, the last from observations by the officers of the I.B.E.A. Company's Tana expedition. The two points to which I wish here to refer are the changes in the former course of the river and the origin of its lakes. When canoeing down the river, one sees frequent traces of false bedding in the banks, and this is often so arranged as to indicate that the Tana is now cutting across the bed of a former river almost at right angles. In the march from Witu to Ngatana, we thrice crossed a deep, dry "nullah," or channel, of approximately the size of that of the Tana, and it was obvious that at no very distant date this river flowed along a very different line to that which it occupies at present. This could have been readily inferred from the character of the country without any such direct evidence, for the whole of the great sheet of river alluvium that spreads out from the Tana must have been deposited during meanderings of the river from one side of the valley to the other. By excursions from our camp at Vuju, in Ngatana,

I was able to find the river-bed at many places, and thus to mark its course approximately on the accompanying map. Before the last great change in the direction of the river, it left its present course at Ngatana, flowed across the barra and through the woods at some distance to the east, and finally entered its present channel a little below Ngao. Both the Wapokomo and the Galla have traditions of the change, as I afterwards found from Herrn Wirth and Beking at Ngao, and the late Mr. Edmunds of Golbanti. The Gallas told the last that the change occurred a little before the time of the oldest living inhabitant of the district, but some of them remembered seeing a little water flowing along the old channel. The river had been the boundary between the Barretta and Kofira Gallas, and its old channel is still accepted as the line of demarcation.

The changes of direction must be more frequent nearer the mouth of the Tana, as they are there largely aided by the regularity of the wind. This blowing up a reach causes an eddy on the inner side of a sharp bend; sediment is deposited in the dead water above this, and a bar thus formed partially across the stream. The current is therefore directed as from a nozzle on to the opposite bank; this is rapidly eroded, and thus the surrounding country, much of which is below the level of the river, is flooded.

It is necessary to consider these changes in connection with the formation of the Tana lakes, for it is a misconception of their nature that has led many geographers to doubt the mapping of the earlier explorers. The lakes are five in number, while there are innumerable swamps which represent former lakes.

<i>Galla name.</i>	<i>Pokomo name.</i>	
Ashaka Babo.		Near Ngao, on right bank of Tana.
Kongalolo.		South of Ashaka Babo.
Musania.		Opposite Ashaka Babo, on left bank of Tana.
Nakalo (<i>i.e.</i> "the place of lions").	Somite.	Ditto, north of Musania.
	Dumi.	Near Merifano, south of Ngatana, on right bank.

The only lake of the series which has been previously recorded is Ashaka Babo, and the Tana is generally represented as flowing through it.* New first visited it by the channel just above Negao, which is now in much the same condition as when he canoed up it. It is united to the Tana by a second outlet, which passes through Lake Kongalolo, and joins the Tana at Kaekwa, just above Borabini (Golbanti).

Lake Dumi is the one furthest up the river; it also has an outlet to the river in the rainy season.

* Mr. Hobley has, however, referred to some of them in his recent paper on "People, Places, and Prospects in British East Africa," *Geographical Journal*, Aug. 1894.

Musania and Somite are both rounded in shape, and have no outlet. The origin and character of the Tana lakes can best be explained by comparing them with the well-known Norfolk Broads, which have been formed in precisely the same manner, and present remarkable analogies in scenery, shape, and position. In a paper upon "The Physical Features of the Norfolk Broads,"* I pointed out that these were due to the formation of a bar across the mouth of an estuary that once covered the site of the town of Yarmouth. The bar was formed by sand being drifted southward by the tide; sediment was deposited by the river inside the bar, and thus helped to complete it, and further to divert the river to the south. The silting thus commenced worked backwards up the estuary, while the growth of rushes and the accumulation of the sediment caught by them, caused a bank of alluvium (known in Norfolk as the "rand") to grow inwards from the margins of the valley. The rivers deposited their burdens of mud and silt where they entered the estuary, and thus built embankments out into it. Thus while the formation of the bar converted the estuary into a lake, this was cut up into a series of smaller ones, by the alluvial embankments. By the enlargement of these, a great alluvial plain was produced, with a river winding through it, and bordered by a series of lakes which are sometimes completely isolated from the river. Thus, in the case of the Norfolk Broads, there are some, such as Fritton, which are completely cut off from the present watercourse; others, such as Wroxham Broad, which are close to a river, and open into it by one or more channels; and others, such as the group of the Rollesby, Ormesby, and Filby Broads, which occupy branch valleys, and are connected with the main stream only by a very narrow overgrown channel.

The Tana "broads" have been formed in precisely the same way. Under the influence of the north-east monsoons, sand has drifted southward along the coast, barred the original mouth, and compelled the river, after it has reached 400 yards from the sea, to flow parallel to it for over 8 miles before it reaches it. The whole estuary has therefore been silted up except the narrow river-channel and a few lakes left as remnants of the great sheet of water that once covered the area. The Tana broads may, moreover, be classed into the same three types as those of Norfolk: thus Kongalolo and Dumi represent those which are situated on the alluvial plain, but are still connected with the river; Somite and Musania, those that are completely isolated; while Ashaka Babo, in its hollow in the "red sandhills," represents those in lateral branches of the main valley.

Ashaka Babo doubtless once had a greater extension to the north, and very likely was once continuous with Musania, which is now on the opposite side of the river. The Wapokomo have a tradition to this

* *Nat. Sci.*, vol. i. 1892, pp. 317-355.

effect, which was told me by Herr Wirth of the Mission Station at Ngao. If so, the two lakes would have been separated in the same way as Wroxham Broad was once cut off from Hoveton Broad by the Bure, which flows between.

The easternmost point reached by the Tana is at Charra, and less than two miles from this is the smaller but still considerable river of the Ozi. The two are connected by a narrow, artificial channel called the Belezoni Canal. At the point where this enters the Ozi the river turns eastward, which is its main direction as far as the old settlement of Kau. Here the Magagoni enters it from the north, and the two flow to the south-east. They are soon joined by the Kirimanda, which rises near Witu, and the three expand into a broad estuary, at the mouth of which is the port of Kipini.

The estuary is so large that it is not surprising that a long course has been generally assigned to the Ozi, and in the older maps it appears as a more important river than the Tana. A native, however, gave New some information which, if it had been believed or noticed, would have shown the course of the Ozi to be very short. I believe the river rises in an enormous swamp, which extends from opposite Golbanti to north of Ngao, on the left bank of the Tana. I involuntarily explored this, and in the middle found a channel flowing to the south, away from the Tana, and toward the Ozi. If so, then the river is limited—exclusive of its windings—to a length of 10 miles above the entrance to the Belezoni Canal. Had it been any longer, I must have crossed it on a march from Witu to Ngao, during which I kept well to the south of the ordinary track. The only thing at all like a river-channel then crossed was a swampy depression that must be the upper part of the Magagoni.

The Khilifi is another river much exaggerated and misrepresented on the maps. It really rises in two swamps, one of which is crossed about two hours north-west of Kurawa, and the other occupies the depression at the foot of the hill on which that well-known camping-ground is situated. The water from these two unite and expand into an enormous swamp, three miles in width. It is separated from the sea by a narrow stretch of sandhills, which turns the river to the south. The real length of the river appears to be only about 10 miles. The Mamareni marked to the south of it has practically no existence.

Most of the coast country is very low, but there is a line of hills near the coast composed of a series of red sands, to which I propose to refer as the Magarini Sands. They form picturesque, rounded, isolated hills as just west of Merifano, undulating uplands as west of Ngao, or a chain as at Magarini. At the last they rise to the level of about 400 feet. In the march along the coastal plain north of Melindi these red sandhills are conspicuous features, but south of it they appear less

important, owing to their proximity to the coast, and the greater elevation of the sandstone hills of Giriama and Shimba.

V. THE GIRIAMA HILL-LANDS.

This is the tract of upland stretching south from the Sabaki to Mombasa. It is bounded to the west by the "Nyika," and to the east by the coastal plain. The general aspect of the country has been well described by New and Wakefield, and more recently by Rev. W. E. Taylor in the admirable introduction to his Giriama Vocabulary.

A line along the western border was mapped by the Railway Survey, but as I crossed its summit, to the east of the Railway route, I was able to collect many new place-names.

VI. THE IVETI MOUNTAINS.

East of Nzaoi and south of Machakos is a great tract of rolling upland cut up by numerous sinuous and deep ravines. One part of the country is known to the Wakamba as Ulu, a name which has been extended by Von Höhnel, under the name of "Ulu Berge," to the whole group of mountains; the Railway Survey have correctly restricted the term to its proper limit. As both topographically and geologically this group of mountains and ridges forms a definite system, a name for it is wanted. Mr. J. Ainsworth, the superintendent of the Machakos station, whose knowledge of the district is unequalled, and who has prepared a most admirable map of the north-western part, recommends the name of the "Iveti Mountains," after the principal district; as this is the name by which they are known to the Swahili, it is the best that could be found.

The mountains consist of a series of concentric ridges of gneiss round a central area of elevation. This arrangement is now obscured by faulting along the west, and probably also on the south side. If this be borne in mind, the topography becomes fairly simple, though otherwise it would appear very puzzling.

The first principal ridge seen, when approaching from the coast, is that which terminates to the south in the bold gneiss peak of Nzaoi. A few isolated bosses occur outside it, such as the Wakamba watch hill of Thumba. The Nzaoi ridge runs north and south till it is breached by the valley of the Kiti, east of Kilungu. Thence the outer ridges form a series sweeping round to the north-west; those immediately to the north of the Nzaoi ridge are known as Thangu and Wangu, and are represented on the north side of the Machakos river by the ridges of Mala and Kavaluki. The trend there becomes more westerly, and then, bending to the south-west, the hills of Lukenya, Malili, etc., limit the group on this side. The south side I only saw in the distance, and the arrangement may be less simple, but there the ridges seem to form a complete east and west series, continuing the ridge of Methu, near

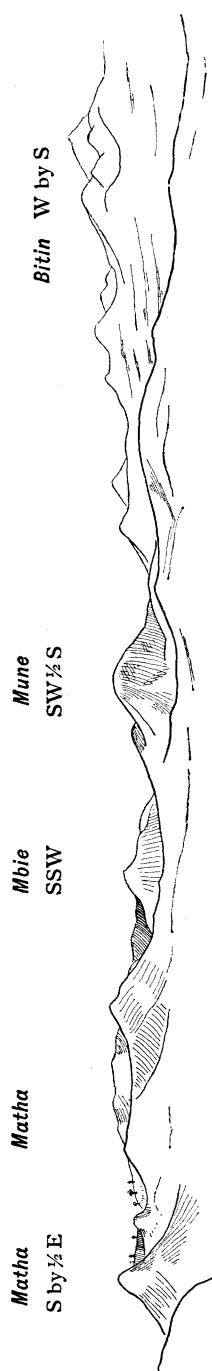


Fig. 2.—S. Iveti Mountains: View to South-west from camp at Nzaoi.

Gneiss Hills rising from the plains.



Fig. 3.—View to North from summit of Mt. Etwa near Kilungu.

Nzaoi. The central area is more complex, but the east and west direction of the southern part is seen in the ridges of Meia, Wanue, and Mavu on the right slopes of the Kiti valley. The principal ridges are shown in sketch map (inset map on Map, p. 384).

VII. THE KIKÚYU UPLANDS.

The country of the Wa-Kikúyu consists of a long belt stretching from Ngongo Bagas, north-north-eastward to the southern slopes of Kenya; it is about 100 miles long and 30 broad. It appears to be composed entirely of volcanic rocks, though some ridges of gneiss, as, e.g., Changababu, come close up to the southern margin at the eastern end; the soil is therefore very fertile, and was richly wooded. It is densely populated, though on the north side the plantations occur only in clearings in the forests owing to fear of the Masai. On the south side the country is lower, the rainfall less, and the forests are replaced by woody scrub, most of which has been cleared.

The topography of the country is rendered extremely puzzling, as the surface is cut up by the most complex valley system I have ever seen; the origin of this I should have tried to work out had the natives been less unfriendly. It appears to have been due to some such sequence of events as follows. The main slope of the country was determined by the subsidence of the district now covered by the Kapté plains and the lava plains of the upper Tana; as Laikipia remained fixed, this movement gave the whole of Ukikúyu a south-eastern slope. The rainfall being very heavy, the rocks easily denuded, and very variable in hardness, the streams cut a series of deep and sinuous gorges. Another cause of irregularity was that numerous lakes occurred in hollows, and these have now been drained by the basal corrosion of the streams; these all flow into the Tana, either directly or by the Thikathika.

In the return march we crossed the country at almost its widest part, south of Ndoro, and through the previously unvisited districts of Kornu, Kithu-Uri, and Maranga.

VIII. THE RIFT-VALLEY.

The desire to study the physical and geological structure of this valley in its highest part was the main incentive to my visit to Naivasha and Baringo, and its topography may be considered in detail owing to its unique character and interest.

The mountains that form the eastern wall of the valley are first seen towards the end of the first march from Machakos. As we cross a broad turf-clad col, and wind down the picturesque valley that leads to the camping-ground of the "first Lanjoro," a line of irregular hills comes into view far on the west horizon. For two days the route lies across the broad undulating prairie of the lava-sheets of the Kapte plains. Two more marches are necessary to cross the woody uplands of Ukikúyu,

and one then rises from the forests on to somewhat bare turf-clad hills. Having attained the summit of these, there is seen to the west a type of scenery quite unlike anything that has been previously seen in Africa, or which can be seen in Europe; it is a type of scenery that can best be paralleled in the Great Basin of Colorado. One is standing on the summit of an almost vertical cliff 800 feet in height, at the foot of which is a perfectly level plain, which appears absolutely barren except for a thin scrub of flat-topped mimosas at the foot of the cliff, and a fringe of large acacias along the course of the Kedong, till that river loses itself in the desert to the south. Rising from the plain in the west can be seen the cliffs of the Mau fault-scarp—or, as it is usually called, escarpment—which corresponds to the Kikúyu fault-scarp. To the north the view is limited by the splendid volcanic crater of Longonót, and the ridge of lava between its base and the east fault-scarp at Kajabe. To the south the rift-valley curves slightly, while the sky-line is partially occupied by the breached crater of Doenyo Suswá. With the exception of the two extinct volcanoes, the whole of the scenery is characterized by straight lines. Instead of the valleys having the sinuous courses due to erosion, they are straight with parallel sides, while the slopes are steep and bare, not yet having been moulded into curves by the slow action of subaerial denudation.

There are in England certain cliffs which are due to faults, but they are scarce and insignificant compared to the fault-scarps of this rift-valley, which in its height and enormous length, and in the general character of the scenery, reminded me of the great fault-scarp of the Wahsatch mountains, which forms the eastern boundary of the basin of the great salt lake of Utah.

In attempting to give a brief sketch of the topography of the highest part of the great valley of subsidence, it will be best perhaps to treat the subject in the following order: (1) the walls of the valley; (2) the floor; (3) the lakes and rivers; (4) the mountains within the valley.

THE WALLS.—Throughout the part of the valley here considered, the walls are formed by two roughly parallel lines of cliffs. That on the west is known by the general name of the Mau escarpment, or Mau mountains (*Mau Kette* of Von Höhnel). This extends from Lake Natron on the south side of the Anglo-German frontier, to the west of Eldalat, near Lake Nakuro; here it forks, one branch trending slightly to the east to form the narrow plateau of Kamasia, while the western branch, separated from the other by the narrow valley of the Weiwei, forms the eastern face of Elgeyo.

The eastern margin of the rift-valley is formed by a similar cliff-line; the southernmost section of this is the west face of Ngongo Bagas. This is continued northward by the part called by the Railway Survey the Kikúyu escarpment; it is here 800 feet in height, but is broken by a terrace 300 feet from the base. Further to the north the terrace

thins out, but it soon reappears as the grazing plateau of Kinangóp. This is limited to the west by a low cliff face, which Gedge has called the Kinangóp escarpment. The much higher cliff which forms the eastern boundary of the plateau may be conveniently named after Settima, which rises just above it. North of the Maléwa (Murentát) the two cliffs unite, and are continued northward as the great Laikipia fault-scarp; this is broken in places into a series of parallel steps, as east of Njemps, but they appear to reunite when followed northward beyond the country of the Wasuk.

In many parts of the valley the walls are so precipitous that not even the most expert of cragsmen could scale them. This is, however, interrupted in two ways: in one the single fault-scarp is replaced by many smaller parallel ones, such as those which form the foothills of Kamasia and Laikipia, east and west of Njemps. In the second type the steep cliffs are replaced by a series of gentle slopes. The most striking case of the latter is that by which the middle road to Uganda ascends on to Mau; on the opposite side of the valley to this, is the track by which Thomson reached the plateau of Laikipia. The difference is entirely due to the geological disposition of the strata; the middle road simply follows a valley formed by a synclinal fold, which crosses the rift-valley in an approximately north-west to south-east direction. A similar synclinal appears to occur north of Baringo, and is probably continued to the west by Kimama (Lake Salisbury) and the Masange chain of lakes.

The two cliffs that bound the rift-valley were originally spoken of as mountain ranges, a term which has clung especially to the western line. It is, however, gradually being replaced by the term "escarpment," though in most German maps *kette* is still adopted. The use of the word "escarpment" is, however, not correct. At the Kedong and opposite Baringo the walls of the valley, though due to faults, may be regarded as escarpments, the rift-valley lying along the axis of an anticlinal. Elsewhere, however, they are decidedly not escarpments; thus opposite Nakuro the valley is a faulted synclinal, or, more strictly, a faulted centroclinal. The walls on each side are formed by a dip slope, interrupted by a series of cliffs formed by a parallel series of faults.

To apply the term "escarpment" to such a valley wall as this is a complete inversion of its exact meaning. The only correct term, as far as I am aware, which can be correctly applied is "fault-scarp;" but this ought to be restricted to the steep cliff portions of the valley wall, and not to the slopes between them. A new term is needed for the wall as a whole.

THE LAKE BASINS.—It has already been pointed out that the rift-valley is crossed by a series of transverse folds; it is, therefore, only natural to find that the floor of the valley has been cut up by these

into a series of distinct basins, each of which is or has been occupied by a lake.

In the area under consideration there are four main basins. The descent from the Kikuyu fault-scarp leads to one which is bounded to the north by Doenyo Longonót and the ridge from which it rises; its southern limit is as yet unknown. This basin is now occupied by a level sandy plain, through which flows the river Kedong. It was, however, once the site of a vast lake, the raised terraces of which may still be seen. I propose to name this lake after Professor Suess, who has helped so largely toward the better understanding of the geology of this region of Africa.

On the north side of the Longonót ridge is the basin of Naivasha,* which is the best known of all the lakes of this series, and has been repeatedly visited by Europeans. The basin is limited to the north by the great volcanic pile of Doenyo Buru and a line of lava cliffs that runs thence to the north-east. These form to the south the long drainage slope of the Gilgil river, while they face the north with the cliffs above Elmetaita. The Naivasha basin is, therefore, bounded to the south by a fold, and to the north by a fault river.

The next basin is that occupied by the lakes Elmetaita and Nakuro, which are separated by a ridge. The walls of this basin present a very different aspect to those of Naivasha, for the dip of the beds is here toward the valley, so that it is a synclinal, with the sides broken by meridional trough faults. Moreover, the main synclinal is here traversed by a secondary one at right angles to it, so that the basin is really a great centroclinal. The extensive volcanic action and faulting around Elmetaita rather obscures the arrangement, which is better shown around Nakuro.

An anticlinal ridge to the north of Elmetaita and Nakuro separates them from the great basin of Baringo, which has now been split up by faults into at least four sub-basins. The first of these occupies the south and south-western parts of the basin. It is occupied in the main by a series of swamps surrounded by terraces; some of the swamps lie in completely isolated depressions, while others discharge into the Miviruni or the Nyuki, which drain the western side of the Baringo basin. The usual caravan route to Baringo lies across this district.

Running almost due north from near the camp at Miviruni is a long ridge sloping to the west, and facing the east with a vertical fault face. As this ridge is of great importance in the structure and geology of the basin, it is advisable to give it a name; as I could learn of no native one, and the district is rarely inhabited, I propose to call it the Equator Ridge, and the peak at its south end the Equator Peak, as it is almost

* *Naivasha* is the Masai word for "lake," just as *Tana* in Kipokomo means "river;" hence to speak of Lake Naivasha or the Tana river is tautologous.

upon the line. The ridge cuts off the south-east corner of the Baringo basin, and is occupied by a small lake, which was visited and not named by Teleki and Von Höhnel; it is known to the natives as Kibibi, but this sounds much like a Swahili name.* The basin is broken upon the west side by a series of fault-scarps parallel to the Equator Ridge. This sub-basin is of considerable interest from the diagrammatic simplicity of its structure; it is really a secondary rift-valley within the major one.

The third sub-basin is occupied by the lake known to the natives as Lake Losugúta (or possibly to one tribe as Lake Gonionábur), and in Europe as Lake Hannington. This is bounded to the east by the highest and steepest cliff face in the district, from the summit of which we enjoyed the grandest and most beautiful view which I saw in Africa, and which fully atoned for the extra marches and hardships, and the scarcity of water, during our journey over the faulted ridges of this district. At our feet, at the base of a precipice over 1900 feet in height, lay the long river-like lake, reminding me somewhat of our own Windermere. As a rule the colour effects in Africa were disappointing, but here was certainly an exception. The colour of the water is an exquisite blue, rivalling that of an Alpine lake, and suggesting at once its great depth and the minuteness of its floating impurities; the blue was broken by the dark green of the flat-topped acacias that cover the numerous islets, by the lighter green of vast floating masses of algæ, and by a number of delicate pink patches. These puzzled me much as I watched them at a distance, but on closer examination they turned out to be vast flocks of flamingoes. In striking contrast to the colour of the lake is a series of low white cliffs on the western shore, which are probably composed of silicious sinter deposited by the hot springs. Above these cliffs the ground is cut up by a great number of parallel step faults, and terrace rises above terrace, and tier above tier, till the whole of the western shore looks like a great amphitheatre rising to the summit of Doenyo Lugurumut level with our camp. Still further to the west, across the valley in which lies the ordinary caravan route, rises the dark grey escarpment of the rich food-bearing plateau of Kamasia. This can be followed past the bold outline of Doenyo Lubukwe and across the green swampy steppes of Njemps, till far to the north it slowly sinks to the transverse synclinal, the southern limb of which forms the northern end of the basin of Baringo. To the north of this is the basin in which lie the vast salt steppes of Sukut, which is probably another centroclinal like that of Elmetaita and Nakuro.

The floor of the valley has thus a very complex structure, and it is only natural to find that the rocks of which it is composed, and

* If so it would mean "little lady," but it is difficult to see how it could be used in this connection, unless it were a reference to the mosquitoes that abound there.

consequently the scenery, are both very varied. The harder rocks are all volcanic, and consist either of more or less perfect craters, the remains of denuded cores, long ribs of rock thrown by faults across the valley, and lava streams retaining their original extent and character. The greatest extent, however, superficially is occupied by alluvial and pleistocene deposits, consisting of expanses of blown sand, alluvium, talus fans, and beaches around the existing and former lakes. Along the river-courses there are thick beds of gravel and brick-earth, with layers of fine porcelain clay, which is in places baked to porcelanite by the lava streams that have flowed across it.

THE LAKES OF THE RIFT-VALLEY.—Leaving the structure of the valley, let us turn to the lakes along its floor, of which there are six—Naivasha, Elmetaita, Nakuro, Kibibi, Losuguta (Hannington), and Baringo; but in addition to these there are four others, which are now dry. Of the first series Naivasha is by far the best known, though our knowledge of its fauna is very limited; it is generally reported that it contains neither fish nor crocodiles, a view which has doubtless helped the acceptance of the view of its formation being due to barriers of volcanic débris, having dammed back the waters of the two streams that enter its northern end.* Dr. Fischer, however, says † that some small fish are fairly common in it.

The lake is roughly lozenge-shaped in form, and covers an area of 70 square miles. Its altitude I calculate to be 6200 feet. It is given by Thomson at 6000 feet; by the Railway Survey at 6350 feet; and by Von Höhnel at 6100 feet. It receives the waters of two rivers, the Malewa or Murentat, and the Gilgil, which enters the northern end, and two streams on the east side. The southernmost of these flows through a somewhat deep cañon, but in its lower course it is above the level of the surrounding country. In spite of the fact that the lake has no visible outlet, the water is quite fresh.

The lake is well known, as it has been repeatedly visited since its discovery by Fischer; it has been mapped with care by Von Höhnel and the Railway Survey; while a large manuscript map, by Mr. Gedge, is in the possession of the British East African Company. As to the origin of the lake, there has been some difference of opinion. Thomson and Gibson regard it as due to the damming back of the waters of the Gilgil and Malewa, by the débris that fell during the eruptions of Longonót.‡ The Railway Survey, however, showed that it is not so shallow as was thought, but that in the centre there is a submerged crater, which I had independently suspected from a view from the summit of Longonót. The southern limit of the basin is unquestionably formed by the ridge

* Thomson, 'Masai-Land,' edit. 1887, p. 199.

† 'Mitth. Geogr. Gesell.,' Hamburg, 1882–3, p. 78.

‡ Thomson, *op. cit.*, p. 199; W. Gibson, Rep. Proc. Brit. Ass., 1893, p. 758.

crowned by the crater of Longonót; but this ridge is not a mere pile of volcanic ejectaments, but has been formed by "negative elevation," i.e. it remained fixed during the subsidence of the ground to the north and south.

Elmetaita (*syn. Angata Nairogua*) is now a small lake, only 6 miles in length and 2 miles in breadth. It is bounded to the east by a vertical fault-scarp of very recent date; its west shore is low, and the lake once extended far to the westward, over what is now a level, sandy, salt steppe. Its waters are very bitter, and it contains a good deal of carbonate of soda. Two streams flow into it, the Kariandusi at its south-east corner, and the Guaso Nagut at the north end; the former drains a valley between the fault-scarps of the Dondole mountains, and the latter the area to the south of the Menengai anticlinal. The western boundary of the basin is a fault-ridge, which separates it from that of Lake Nakuro.

The shore of the lake is covered with grasses and sedges, while its waters yield masses of a green alga, some small amphipods, and insect larvæ. The altitude is given by the Railway Survey as 6000 feet, and by Von Höhnel as 6037 feet; my boiling-point observations on the shore place it at 5880 feet.

Lake Nakuro, or Nakuro Sekelai. This is a close neighbour of Elmetaita, and was no doubt once connected with it. It occupies a centroclinal depression on the west side of the rift-valley, the drainage of which it receives by three small rivers. The lake is at present about 9 miles long and $4\frac{1}{2}$ broad. Its altitude may be estimated at 5860 feet; its water is said to be very salt. Nothing is known of its flora or fauna.

Lake Kibibi is the next of the series. It was discovered by Teleki and Von Höhnel, who visited it from their camp at Miviruni. They did not name it, and the only writer who appears to have referred to it is Professor Suess. Höhnel has only dotted its outline, and remarks that it is sometimes dry; but as it was approximately of the same size when I visited it at a very different season of the year, I should doubt if it is ever quite dry. It must at one time, however, have covered thrice its present area. Several valleys lead down to the lake, but, though it rained heavily every day while I was to the south of it, the stream-beds were all dry, and it is probably mainly supplied by springs upon its floor. It appears to be very shallow. We could not find any fish in it. The altitude is 4820 feet.

Lake Losuguta is the longest lake in the series, and by far the most beautiful and interesting. But, though near the great trade route to Njemps, it has been always missed until it was discovered by Teleki and Höhnel, who visited its northern end. It was correctly marked on Von Höhnel's map, but the Railway Survey have not only missed it, but in the index map runs two rivers across its site.

A lake is marked by Thomson and Ravenstein a little to the north

of this, which I thought must be intended for it ; but the total difference in size and shape, as well as in position and in the rivers that enter it, shows that this cannot be the case. Their lake really represents the swamp to the east-north-east of Njemps, which it does fairly accurately. The two rivers, however, that enter it from the south and east of "Donyo Lugurumut" have no existence, as they flow across the site of Lake Losuguta.

Von Höhnel's map well shows its general proportions, though the outline requires many alterations in detail. He does not mark any river as entering the lake, whereas one flows into the north end, which is second in volume amongst those of this part of the rift-valley only to the Malewa. It was so deep and rapid where we wanted to cross, that we were delayed till we could find a place sufficiently narrow to bridge. Until its correct name be discovered, it may be referred to as the Hannington river. It rises near the south end of the lake, on the great plateau on the eastern side, north of my fiftieth camp. It thence flows down a narrow valley for probably 7 miles to the north ; it then bends sharply back to the south, passes between the main escarpment and a group of foothills seen from the camp at "Maji Moto," and enters a swamp at the north end of the lake. In this its course is broken by some rapids and an 8-foot waterfall.

The water of the lake is said by Von Höhnel to be lukewarm, but at its south end it was slightly cooler than the air at eleven o'clock in the morning. Its waters are intensely disagreeable to the taste, with a putrid sulphurous flavour, and acted as a very prompt emetic upon the men who drank any. Both Höhnel and Thomson record hot springs in this locality, but though I saw what appeared to be such at the south end of the lake and on the east shore, I was not able to reach them.

The lake is about 10 miles long, and its breadth varies from 1 to $3\frac{1}{2}$ miles. The water is often of a bright green, owing to the number of algae that live in it, but I was not able to find any animal life within it.

The altitude of the lake, as determined by boiling-point observations, I calculate at 3050 feet. The water was standing at the time some feet above its normal level, as trunks of dead trees with the leaves still hanging stood out in the lake, while acres of yellow rotten grass were submerged along the shore. From this mass of decaying vegetation there arose a stench which, combined with the intense damp heat and the long march without drinking-water, told severely on the health of the men.

Lake Baringo is the most northern of this series, and is also the largest in extent. The first European who reached it was Mr. Joseph Thomson, who determined its true extent and the absence of the asserted connection with the Victoria Nyanza. It was subsequently visited by Teleki and Höhnel. Mr. Thomson went round the lake, but he was busy elephant-shooting, and was often some distance from its shores.

Teleki and Höhnel passed at a little distance from its western and eastern sides. The maps of these travellers showed such striking differences in the shape of the lake, the rivers that flow into it, the distribution of its islands, and the arrangement of the mountains on its eastern shore, that I resolved to follow its shore-line to settle these points in its topography. I had also intended to survey the passes that lead northward on to the steppes of the salt plains of Sukut, in order to determine the line of its probable outflow to the north. A scare of a Wasak raid, however, led to the mutiny of the ten men I had with me, and I was for a while left with only a Mkauchi guide. I could not venture, therefore, far from the lake.

Baringo is 15 miles long and 8 miles broad; it covers about 100 square miles. Its altitude, from my aneroid readings, taken at the same hour on following days so as to avoid diurnal variation, show it to be 120 feet lower than Njemps Ndogo. The elevation of this, my boiling-point observations determine as 3320 feet above the sea. Thomson gives the altitude of the lake at 3217 feet, Von Höhnel at 3660 feet, and the Railway Survey as 3300 feet, while I make it to be 3200 feet.

The river-system of Baringo has been very differently represented by previous cartographers. Thomson says that five rivers enter it; Von Höhnel and the Railway Survey reduce the number to three; Ravenstein retains five, but arranges them differently to Thomson. I could, however, only find two, the Guaso Tigirish and the Guaso Boli, which are as represented by Von Höhnel. Both this author and Thomson show a river entering the north-east corner of the lake. The former calls this the Mugutan, having as a tributary the Seremas, while Thomson names it the G. Mogodeni. It, however, never reaches the lake. At the point where they mark its mouth there is really an outlet, as when the lake is high the water drains into the porous lava sheet, which here runs down to the shore. The Mugutan is probably lost in the same lava sheet. The mistake, no doubt, arose from both explorers mistaking the fertile level lava plain for a tract of alluvium beside the mouth of a river.

The Guaso Nyuki does not reach the lake, but is lost in a swamp east of Njemps Mkuba. A little north of the Guaso Boli there is a dry stream-bed, which must be a powerful torrent after storms. It has not been marked on previous maps. Its name is the Guaso Duk.

The course of the Guaso Ndau has also been misunderstood. It is a tributary of the G. Tigirish, which it reaches in the swamp near its mouth. It was omitted from Von Höhnel's map, but where we crossed it was a rapid stream 3 feet deep and 12 yards wide, and flowing between banks raised above the level of the surrounding plain. It receives the drainage of the Mkuyuni valley and parts of the Kamasia foothills; but it must have a subterranean course, as for some distance its bed is dry. Its upper branches appear to have been called

the Kamnye and the Susien or Suseira; but from my guide and the people at Njemps Mkuba, I could only get the name Ndau.

The islands in the lake are of considerable interest, as the main series appear to be the remains of a volcanic crater broken up by faults as well as ordinary denudation. I was disappointed at not being able to get into communication with the Wakauvi, who inhabit them, and thus had to be content with a distant view. There are nine islands in all, of which six form a small archipelago near the southern end. The largest, highest, and central is named Langari; it is crescentic in shape, and has a steep inner and more gradual outer slope. Sections at its broken end show what are probably lava beds between layers of volcanic ash; the whole seems to have a quaquaversal dip. North of Langari are two small islands known as Loel Divis; to the east is a long narrow one named Mandadu; to the south-west is Lukrum.

The islands at the northern end are near the shore, and are merely bosses of lava that have been separated from the shore ridges by denudation. The two largest are named Somiten and Logobiti.

The last point on the topography that has to be noticed is the character of the east shore. Von Höhnel shows a mountain chain here running right down to the lake; but a tract of alluvium more than two miles wide separates it from the fault-scarp, which forms the western margin of Doenyo Lersubugo, which is here the lowest of the foothills of Laikipia. An island-like boss of lava rising from the plain forms a conspicuous feature on the eastern shore, and is known as Logwamara.

It has been remarked several times during the description of the present lakes, that these were once far more extensive than at present. Baringo especially must have had a much greater extent, and once had an outlet to the north.

There is evidence, moreover, of the former existence of a series of lakes which are now quite dry. The largest of these is south of Lake Naivasha, and it must have far exceeded in size all the existing ones put together. Its extent is shown by a series of lake terraces high up along the sides of the fault-scars of the rift-valley. The lake must have extended right across the valley; its southern limits are quite unknown, while that to the north is very uncertain. It may have been continuous with Naivasha, or have ended against the Longonót anticlinal. I propose to name it Lake Suess, after the distinguished geologist who has thrown so much light on the geology of East Africa.

Another dry lake basin exists near Miviruni, to the north of Nakuro and west of the Kibibi basin.

Summary of Classification of the Lake Basins—

Naivasha } transverse synclinals faulted in along the axis of a meridional
Baringo } anticlinal.

Elmeteita } Nakuro } together occupy a centroclinal.

Kibibi
 Losuguta } secondary rift-valleys on the floor of the major rift-valley.
 Miviruni }

THE MOUNTAINS OF THE RIFT-VALLEY.—Excluding fault-ridges and lava streams, the mountains of the rift-valley consist solely of volcanic craters, which are disposed in the main on a north and south line.

The southernmost is the vast mass of Doenyo Suswa, opposite the fault-scarp of Ngongo Bagas. It has a width at its base of 9 miles, and its height is estimated by Von Höhnel at about 7870 feet. Its north wall is breached, and a smaller crater has been developed within it.

North of this is a much older cone, composed of a red andesite and rhyolite, to the colour of which it owes its name of Doenyo Nyuki ("Red Mountain"). On the lower flanks are some beds of pumiceous volcanic ash and tuff, and on the south side a prettily wooded gorge has cut through a parasitic cone, giving a section of diagrammatic clearness. The mountain is now only about 640 feet in height above the valley floor, but it must once have been very much higher.

Three miles to the west of the foot of Doenyo Nyuki is the lowest and most recent of the lava flows from Doenyo Longonót, the largest and most perfect crater in this part of the rift-valley. It was visited by Thomson, who climbed to the rim of the crater, the height of which he estimates at 9000 feet. I succeeded in gaining the summit of the highest pinnacle; boiling-point determinations gave its height as 9350 feet, which is 2140 feet above the summit of the pass at the east foot of the mountain, and 3000 feet above that of the surrounding plain. The rim of the crater is not so sharp as it appears to have been at the time of Thomson's visit, for the zebras have worn a fine cinder track round its level part; the jagged north-western part of the crater is covered in scrub. The crater walls vary from 300 feet on the south, to 1000 feet on the north-west.

On the inner north wall of the crater is a powerful steam-jet, which may be on the same line of weakness as a remarkably perfect parasitic cone on the north slope.

The mountain is of some interest, not only from being probably the last of the series in age, but from the very high proportion of lava in its mass. Beds of volcanic ash play a very subordinate part in the structure of the cone.

North of Doenyo Longonót there is a considerable number of volcanic cones in the district of Ndabibi to the south-west of Naivasha. Hot springs are said to occur there by the Masai, and Mr. Martin tells me that he has seen "smoke" rising from some of the cones. This may indicate dust-coloured steam. The cones in this district are small.

Doenyo Buru is comparable in size to D. Suswa and D. Longonót.* It is situated to the north of Naivasha. Its height is estimated at 9000 feet by Thomson, and 7870 feet by Von Höhnel. It has been subjected to great denudation, and is certainly older than Longonót. On its north side are a series of steam vents, which must cover several acres in extent. The steam is attributed by the Swahili porters to Wanderobbo fires, but this is clearly incorrect.

At the south-west end of Elmeteita is a group of three faulted and denuded craters. The south-eastern one, which we may call A, consists of the crescentic north wall and a cone, which may be the remains of the central core. This crater must have risen 1800 feet above the level of the plain. The second member (B) is the most perfect of the group. It consists of a crater wall, which, though now broken up by faults and erosion, can be traced all along its former extent. A double cone rises in the centre of the crater floor.

North of Lake Baringo is yet another series of denuded basic cones, forming the Erri mountains. The cores of this group have been exposed by faults, but many of the lava streams are surprisingly fresh, and some of the craters of the steam vents on the flows are perfectly preserved. They seem to be later in age than the period when Baringo had an outlet to the north. They are older than the second set of meridional faults, which has had such a marked influence on the scenery and topography of the district.

(To be continued.)

EXPEDITION TO THE HADRAMUT.†

By J. THEODORE BENT.

IN the proper acceptation of the term, the Hadramut at the present time is not a district running along the south-east coast of Arabia between the sea and the central desert, as is generally supposed, but it is simply a broad valley running for 100 miles or more parallel to the coast, by which the valleys of the high Arabian plateau discharge their

* The synonymy of these three peaks is a little confused, as is shown in the following table:—

Thomson.	Von Höhnel.	Railway Survey.	Gregory.
Lolbotat. Longonót.	— Longonót or Lolbotat.	— Longonót.	Lolbotat. Longonót.
— Doenyo Nyuki.	— Ssusswa.	— Suswa.	Doenyo Nyuki. Suswa.

† Paper read at the Royal Geographical Society, May 21, 1894. Map, p. 384.









A MAP
illustrating a Journey to
MOUNT KENYA
AND
LAKE BARINGO.

By DR. J. W. GREGORY.

Scale—1 : 1,000,000

10 20 30

The Author's Routes.

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