IMPERIAL COLLEGE

OF SCIENCE & TECHNOLOGY

KENYA

1968

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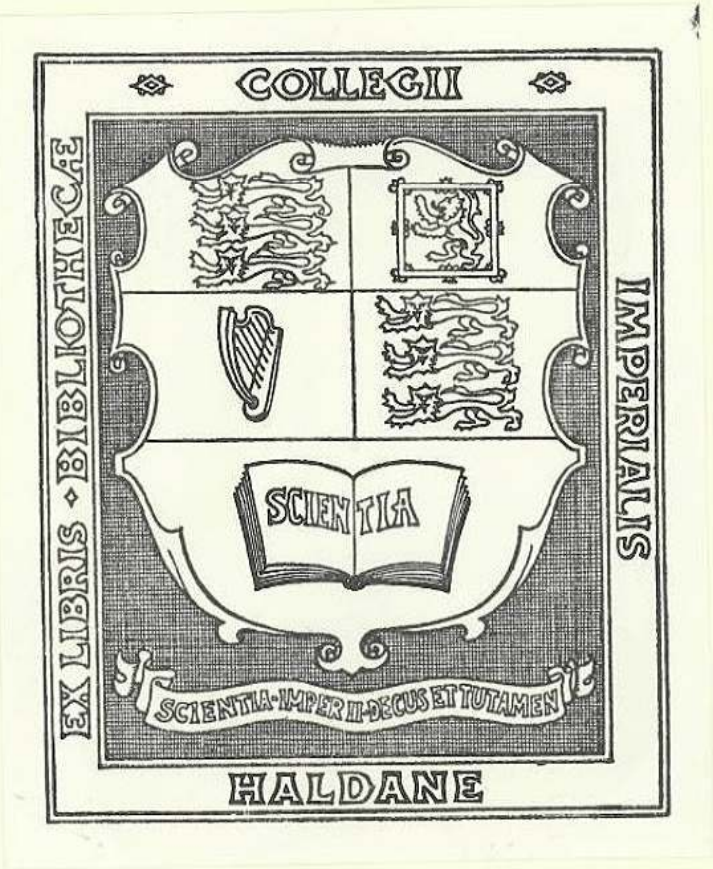
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IMPERIAL COLLEGE
KENYA EXPEDITION
1968

FINAL REPORT

EXPEDITION MEMBERS

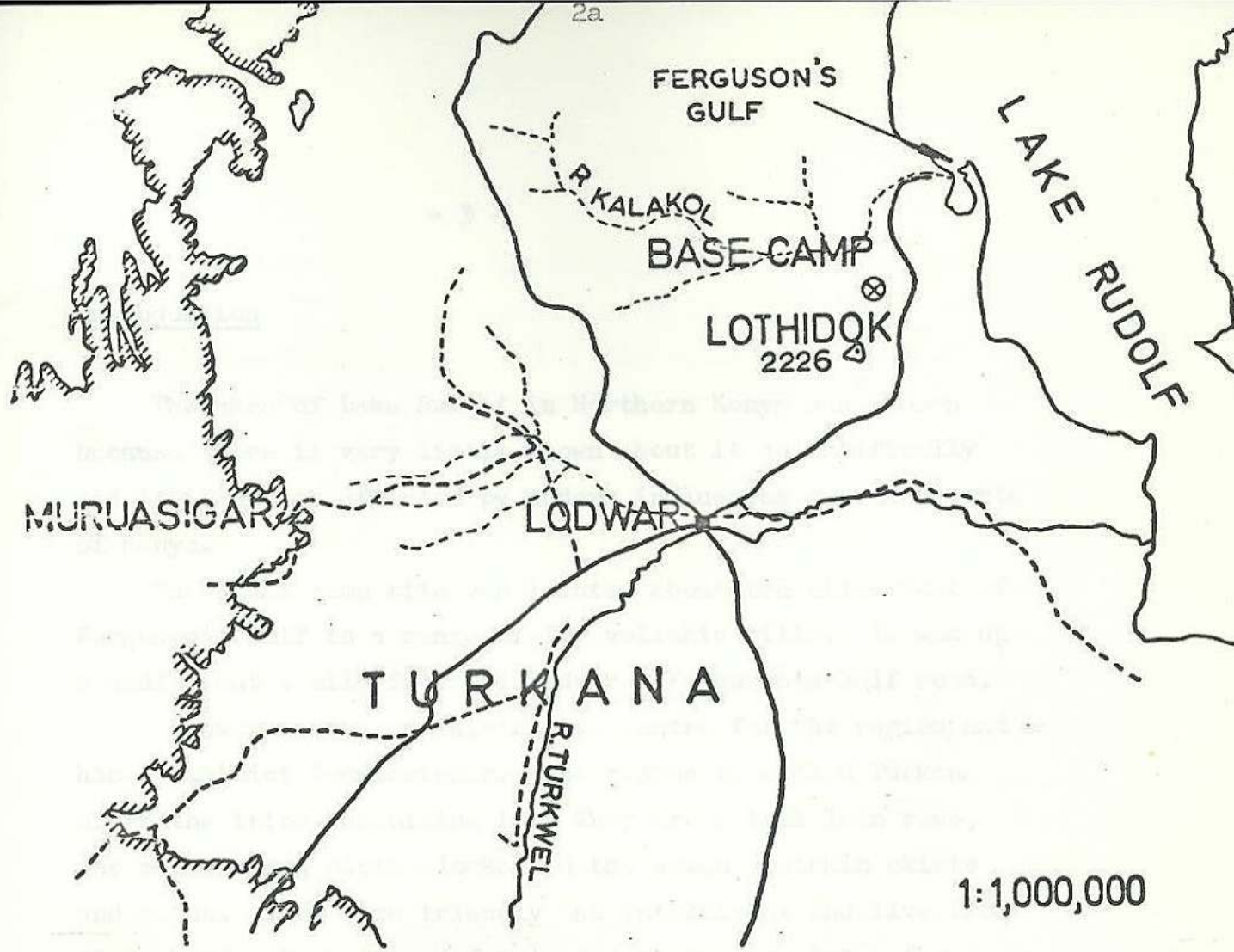
Kenneth Gales

Malcolm Lennox

John Noakes

Mark Stobeld

John Vessey


FERGUSON'S GULF
LAKE RUDOLF
R. KALAKOL
BASE CAMP
LOTHIDOK
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MURUASIGAR
LODWAR
TURKANA
R. TURKWEL
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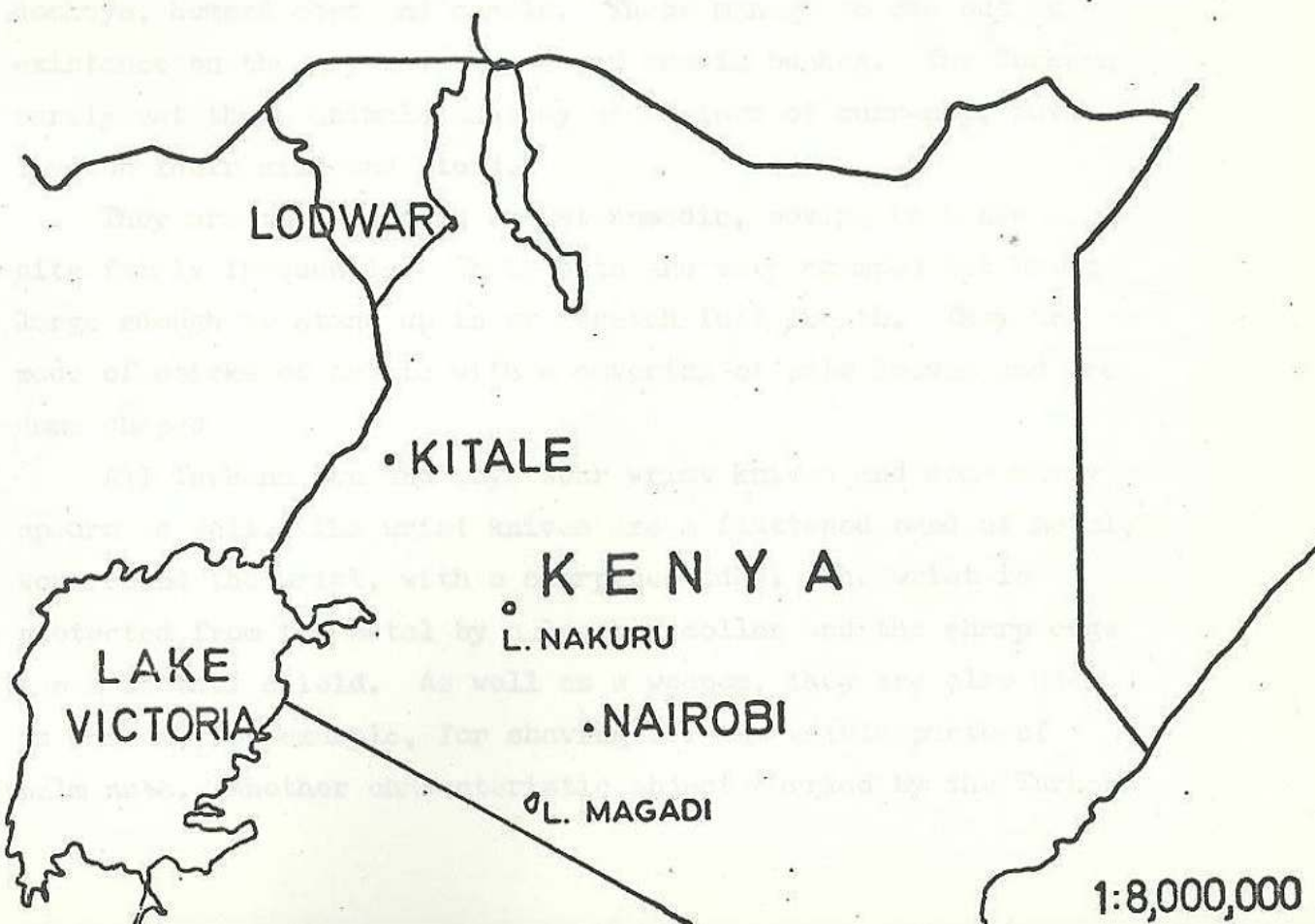
LODWAR
KITALE
KENYA
L. NAKURU
LAKE VICTORIA
NAIROBI
L. MAGADI
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Introduction

The area of Lake Rudolf in Northern Kenya was chosen because there is very little known about it scientifically and it is not as affected by modern influences as other parts of Kenya.

The final camp site was located about ten miles West of Ferguson's Gulf in a range of low volcanic hills. It was up a wadi about a mile from the Lodwar - Ferguson's Gulf road.

Lodwar is the administrative centre for the region and has a District Commissioner. The region is called Turkana after the tribe inhabiting it. They are a tall lean race, the men wearing cloth cloaks and the women goatskin skirts and beads. They were friendly and intelligent and live from their herds of goats and fat tailed sheep and also a few donkeys, humped cows and camels. These manage to eke out an existance on the dry wadi grass and acacia bushes. The Turkana rarely eat their animals as they are a form of currency, but live on their milk and blood.

They are to a certain extent nomadic, moving to a new site fairly frequently. Their huts are very cramped not being large enough to stand up in or stretch full length. They are made of sticks of acacia with a covering of palm leaves and are dome shaped

All Turkana men and boys wear wrist knives and some carry spears as well. The wrist knives are a flattened band of metal, worn round the wrist, with a sharpened edge. The wrist is protected from the metal by a leather collar and the sharp edge has a leather shield. As well as a weapon, they are also used as knives, for example, for shaving off the edible parts of palm nuts. Another characteristic object carried by the Turkana

is a stool. This is carved out of solid acacia trunks and is generally about fifteen inches high. It is "T" shaped with a flattened top for sitting on and a dome shaped base. We found them uncomfortable to sit on but they were light and could be used on any surface.

The Turkana living by the lake also fish with hemispherical cages about two feet six inches across at the bottom. They are made of sticks lashed together. A wide circle of men with these cages form in shallow water and slowly move inwards. Every few paces they push their cages out of the lake bed and occasionally they are fortunate to trap a fish. As can be imagined this form of fishing is inefficient and the government is trying to encourage them to use boats and nets, but with only limited success.

Information

The area is desert and vegetation very sparse though this is probably worsened by over-grazing. The rainfall decreases between Lodwar and Ferguson's Gulf and over the last twenty-eight years has averaged 5.7 inches in Lodwar. Temperatures are uniformly high and there is very little cooling at night. The mean daily maxima for the hottest and coolest months are 98.6°F and 92.1°F with the minima lying constantly at 74°F. The area is 2° North of the Equator and when we were there in the summer, the sun was very hot and virtually prevented work in the afternoon. However, the air is very dry and there was a constant breeze on the tops of the hills so that the effect of the heat was somewhat reduced.

The Kenya Government requires visitors to Turkana to obtain a permit. We obtained this before going but (it could be, if necessary, though not advisedly) obtained at short notice in Kenya.

We flew from London to Nairobi via Cairo by a chartered United Arab Airways comet. Considering the price, the flight was very good. Fortunately one of the expedition members had relatives living in Nairobi who kindly allowed us to camp in their garden, so we did not have to find accommodation.

The Land Rover agents in Nairobi are used to supplying vehicles to expeditions, but although they agreed to have a vehicle ready for us when we arrived, we had to wait several days before it was ready. When we did get it, it was in good condition apart from the tyres, one of which had to be replaced before the end of our stay.

The bus services in Nairobi are cheap but not used by Europeans (unless they are waiting for delivery of a Land Rover). The buses are old and driven fast so that they can get to the stops before their competitors.

We were lucky in being able to get a large secondhand ridge tent on our first day. This slept the five of us with a little room to spare and survived the expedition. We bought most of our requirements in Nairobi as we could not bring them on the plane. All goods are bartered for in the shops. With careful packing we got all our equipment and several weeks supply of food into our long wheel base Land Rover, as well as the five of us.

It took three days to drive from Nairobi to Lodwar. The road to Kitale is tarmac and of good quality. From Kitale to Lodwar, a distance of 230 miles the road is a dirt track with two dangerous escarpments and several steep wadi sides to negotiate. It is badly rutted and in places corrugated so that our speed had to be kept down. The track from Lodwar to Ferguson's Gulf is only motorable in the dry season and then only slowly. In the wet seasons the flash floods wash the road away. It is possible to drive up the wadis and beside the lake on the sand dunes using four wheel drive, though we had to get out and push a few times. After a few weeks in Turkana we kept on getting punctures from thorns picked up by the tyres and working their way in. Thereafter we inspected the tyres weekly and pulled out the thorns with tweezers and knife. This stopped the punctures. We also followed some of the tracks round Lodwar and found that we frequently had to get out and search for the track. Also they were not accurately plotted on the maps of the area.

Although we brought a large amount of supplies from Nairobi, our requirements could be bought in Lodwar at a reasonable price. Our food consisted of corned beef and rice with cabbage twice a week and fish from the lake once a week. We also had tea, milk, sugar and some flour and tried goat once. Occasionally we could buy oranges in Lodwar. There were petrol pumps in villages on the way to Lodwar and Lodwar had its own petrol pump. However, this runs dry on occasions so we bought a large drum of petrol to keep at camp.

When we first set up camp we had made insufficient allowance for the quantity of water we would need. Mr. McConell, the Fisheries Officer at Ferguson's Gulf kindly lent us an oil drum which we used to store our water in. Water in the area is obtained from wells and does not need purifying. Ferguson's Gulf and Lodwar were the two nearest. The lake water is too soda to drink.

We were advised to carry snake serum with us. We saw a few snakes including a spitting cobra, but did not need the serum.

All dead wood was eaten by termites but neither they nor ants attacked our food and tent. Scorpions were very common and some lived under our ground sheet, but gave us no trouble.

The Fisheries Officer obtained a Turkana as a camp boy for us. He spoke a little English and soon learnt to understand us and act as our interpreter. He did jobs round the camp and our washing, but his main purpose was to look after the camp while we were away working. He proved to be honest and intelligent and did his work well. We paid him at the rate of two shillings a day and provided him with the standard food of maize meal and beans. He also consumed our remaining rice and fish with much relish.

The botanical speciments were sent to Kew Gardens by the East African Herbarium for us. The geological specimens were crated and shipped back to London. A permit was needed for this.

We had to return to Nairobi two weeks before our plane was due to leave in order to be sure of escaping the rains.

From Nairobi we made several memorable trips. The first was to a volcano in the rift valley (Susua) which was very interesting geologically. We drove up a steep track over a lava flow into the crater. This had a flat bottom, apart from one place where it had sunk to form a deep gorge, and was surrounded by the crater walls. The lava flow contained some very impressive lava caves. We also made a trip to Lake Magadi to see the soda lake and how it was mined by the Magadi Soda Company. When we were there the water was below the level of the soda surface, so the lake was a white mass of soda crystals. Our trip to Nairobi Game Park was unforgettable. The park has a high concentration of game of all types which is unafraid of cars.

Finances

The budget below shows how the expeditions funds of £1,250 (20,507 East African shillings) were spent. The figures are in East African shillings. The Expedition had five members and lasted for ten weeks.

	E.A.S.
Return flight to Nairobi	9,550
Land Rover hire	5,000
Petrol and oil	1,949
Food	2,618
Tent	500
Other Camping equipment	612
Hire of camp boy	126
Additional transport	31
Vehicle repairs	35
Crate for rocks	35
Maps	27
Other expenses (including medical supplies, translator and other equipment)	24
	20,507

Botanical Report

Two of the five members of the expedition were botanists and they collected together. Fifty specimens were collected all with flowers. Where possible flowers of different ages, fruit and roots were also collected, together with notes on the plant, the date collected, altitude and the place collected from. Most specimens were collected from within walking distance of the camp. This area covered the volcanic hills and the plain between the hills and the lake. Specimens were also collected from the Eminit forest and the lake side, though at the time of year we visited it, most specimens had finished flowering.

Specimens were preserved by pressing and drying. The specimens collected are listed below under their families. Duplicate collections were made for the East African Herbarium and The Royal Botanical Gardens, Kew.

Acanthaceae

Blepharis persica (Burm.f.) Kunth
Justicia flava Vahl.
Peristrophe bicalyculata (Vahl.) Nees.

Aizoaceae

Sesuvium sesuvioides (Fenzl.) Verd

Amaranthaceae

Aerva persica (Burm.f.) Merrill
Celosia argentea L.
Dasysphaera prostrata (Volkens) Schinz
Digera muricata (L) Mart.

Apocynaceae

Adenium obesum R.&S.

Asclepiadaceae

Calotropis procera (L) Ait.
Leptadenia lastata (Pers.) Decne

Burseraceae

Commiphora sp.

Caesalpiniaceae

Cassia longiracemosa Vatke

Capparidaceae

Cadaba farinosa Forsk.
Cadaba rotundifolia Forsk.
Cleome scaposa DC
Maerua oblongifolia (Forsk.) A. Rich.

Cucurbitaceae

Cucumis dipsaceus Ehrenb. ex Spach.
Cucumis prophetarum L. ssp. dissectus (Naud) Jeffrey
Momordica trifoliolata Hook. f.

Cyperaceae

Cyperus laevigatus L.
Cyperus longus L. var. longus.

Euphorbiaceae

Euphorbia granulata Forsk. var. glabrata (Gay) Boiss
Euphorbia heterochroma Pax var. griscola (Pax) Bally
Euphorbia triaculeata Forsk.
Jatropha sp.

Graminae

Cenchrus ciliaris L.
Cenchrus setigerus Vahl.
Chloris virgata Sw.
Echinocloa colonum (L) Link
Elyonurus royleanus A. Rich.
Sporobolus marginatus A. Rich S.L.
Sporobolus consimilis Fresen
Sporobolus spicatus (Vahl) Kunth.

Labiatae

Plectanthrus igianius Schweinf.

Liliaceae

Aloe turkanensis Christian

Malvaceae

Abutilon sp.

Abutilon hirtum (Lam.) Sweet

Hibiscus sp.

Mimosaceae

Acacia etbaica Schweinf. Subsp. uncinata Brenan

Nyctaginaceae

Commicarpus stellatus (Wight.) Berhaut.

Papilionaceae

Crotalaria saltiana Audr.

Indigofera spinosa Forsk.

Pedaliaceae

Sesamum sp.

Polygalaceae

Polygala erioptera DC

Salvadoraceae

Salvadora persica L.

Solanaceae

Solanum dubium Fresen.

Zygophyllaceae

Fagonia bruguieri DC.

Tribulus terrestris L.

Geological Report

Introduction

Three of the expedition members were geologists. One geologist planned to map an area of the volcanics and the other two to work on the lake sediments. However, exposure of the sediments was not as good as had appeared from the aerial photographs beforehand so all three mapped a portion of the volcanics, then while a third continued with this work, the two sedimentologists mapped in some detail an area of suitable sediments. Also a short time was spent by the lake surveying beach ridges. Samples were taken of the lake water and from the areas mapped. These were shipped back to London where they were analysed in the Geology Department of Imperial College. The geologists each produced a report of their work, copies of which are in the library at Imperial College, Geology Department. These reports are too long and detailed to reproduce here, so a summary of the geology of the area and some information on the samples is given.

The Rift System in Kenya

The rift valley round Lake Rudolf differs from the rest of the East African System in that it is not bounded by faults on both sides. It has a large fault on the Western boundary (the Uganda escarpment) and a large monocline to the East. The rift system has a central dome and this can be traced by observing the elevations of lakes in the rift. Lake Magadi to the South of Nairobi has an elevation of 2,000 ft, Lake Rudolf in the North 1,230 ft, and Lake Nakuru on the dome, 6,000 ft. The rift is 180 miles wide in the Lake Rudolf area but has a range of mountains in the centre, just to the West of the lake.

The Geomorphology of the Area

The area mapped bears marks of the Lake itself. Between the volcanic hills and the lake is a broad belt of blown sand with numerous shallow wadis. Blown sand comes from the lake edge and forms a dune belt which is moving West. Old beach and lake levels (1,240 to 1,700 ft) form prominent lines round the lake on the aerial photographs. The volcanic hills are intensly weathered and dust bowls have formed in areas. In places exposure is nil as the weathering covers a complete hill. Good basalt mantles have developed in places producing a rook desert.

Drainage is a combination of superimposition and fault controlled. Water holes are few and where they occur are in wadi floors about two feet below the surface. They are dug opposite outcrops of rock which trap the water. Palm trees also grow here.

The main hills in the area have caps of olivine basalt. In some areas the basalt cover is broken and the tuffs exposed underneath have been quickly eroded to produce dust bowls with scarps all the way round. The most striking feature, though, is the flat-iron structure in which large slabs of basalt form hills with strike oriented crests and valleys.

Termite mounds are a feature of the area and indicate old soil horizons. They can be found on bare rock though, and this is thought to indicate that a soil horizon underlies the basalt layer and it is this which is utilised. This indicates time lapses between flows but, unfortunately, only the cap rocks are exposed well and no positive determination of soil horizons have been made.

The area is young geomorphologically as is exemplified by the sharp crests to the flat-irons.

The Basement

The basement rocks were not exposed in the area mapped. However, structural control of the volcanics does lie in the basement.

Essentially the basement was uplifted to form the Uganda escarpment which provided various sedimentary deposits in the Turkana region. The basement rocks are of a fairly high metamorphic grade and consist of:-

Horneblende schist
Horneblende garnet schist
Garnetiferous schist with much staurolite
White marbles

The age of the basement rocks is not precisely known although Fuchs has dated them as Archaean.

The Volcanics

The dips in the area are reasonably concordant, but differs in some instances. The main point though is the consistency of strike. Nowhere in the area, where it was measurable, did it differ by more than 10 degrees. Specimens were collected and examined by this section.

Walsh estimated the age of the volcanics to be 16.0 to 17.0 million years (Middle Miocene) using dating techniques.

Throughout the area the tuff beds seem to be disturbed by the overlaying basalts. In some cases brecciation of the tuff by the lava is seen. The tuffs are usually concealed because the lava above breaks off as a seree and blankets the underlying formation. If all the sequences are conformable then a general history of the rocks in this area can be outlined as below

1) Deposition of plateau type basalt.
2) Deposition from volcanic centres not delimited in the area.
3) Deposition of the West ridge plateau basalt.
4) Deposition of olivine basalt with some ponding as shown by columnar basalt.

Between (3) and (4) there could have been faulting as a small unconformity could be measured but the main faulting occurred afterwards.

The Recent Sediments

The Western shores of Lake Rudolf have an interesting sedimentological profile. A predominent on-shore wind direction provides a means of transporting sand from the lake edge inland. This, coupled with the braided river zone, hampered any serious study into the lake sediments themselves so two beach profiles were measured and samples taken.

The striking feature about this area is the long shore drift. This is quite considerable, forming sand bars across rivers running into the lake.

The Kalakol delta comes out at the Northern end of Ferguson's Gulf and a sand spit is forming accross the general area of the delta. The delta itself has moved round as shown by the extent of crossbedded sands underlying fine laminated muds. The sand bar itself has very good cross-bedding of the planar variety.

Also along the coast is a belt of aeolian sand dunes moving Westward over the land mass. These show small asymetric ripples moving up the face of the dune and megaripples in wind eroded channels. These channels are only found where the vegetation cover does not occur. An interesting feature of the ripples is that the minerals concentrate themselves on the crests and not in the troughs.

The dunes come down to lake level just before the lake. Typically at this position is a lagoon which lies just behind a beach ridge. The lagoons fill up in the early morning due to an increased wave action. This transports water and material over the beach ridge into the lagoon. By late afternoon the lagoons have almost completely evaporated leaving behind a muddy sand. The sand is bound together by algae and tough spiky grass which acts as a sediment trap. There is some disturbance of the bedding due to air entrapment. The water from waves percolates so quickly through the sand that air is trapped and released by bubbling up through the sand.

Pits were dug in the beach ridges and lagoons and bedding was found to be of the expected type. Heavy mineral bands dip towards the lake on the front of the beach ridge and away from the lake on the reverse side. The lagoonal areas have flat bedding. Samples were taken and the heavy mineral grains examined. These indicated a metamorphic source, the basement. A noticeable lack of volcanic minerals was found. This is probably due to the fact that the main sediment transport direction was landwards. The nearby Turkwell river drains a large area of basement round the Chemerong Hills.

The grain sizes of the sands, dune, lagoonal and beach were five on the Wentworth Scale, the dunes having some proportion of very fine. They all fall into the subangular-subrounded category indicating not a great deal of abrasion.

The sand spit at Ferguson's Gulf has been re-worked many times and as a result the garnets are concentrated as laminations in cross-bedding units. Present day ware action has sorted these out and the beaches on the spit have a layer of pure garnet sand.

The lack of invertebrates in the lake is noticeable considering the oysters and gasteropods found in older sediments.

In the last few years the lake level has risen several feet and is continuing to rise.

Analysis of the Samples taken of Lake Rudolf Water

	Mg.	Ca.	K	p.p.m.
Lagoon 1	1.82	6.96	35	
Lagoon 2	0.92	6.07	26	
Lake	3.15	6.07	20	
Ferguson's Gulf	2.52	8.57	18	

The Ancient Sediments

A plane table survey was carried out on an area of ancient lake deposits where they were faulted against the volcanic belt. Detailed stratigraphical sections were made and correlated.

Five distinct formations were mapped in the area and one bed formed a very useful marker horizon being four inches thick and traceable over most of the area mapped. A brief description of these formations is given below:-

1) This formation consisted of a series of calcareously cemented sandstones interbedded with loosely compacted sands. The cemented sandstones were medium to five grained with ripple laminations present in abundance, picked out clearly by haavy mineral bands which contained biotite, garnets and felspars. Some evident bioturbation was present, with the occasional development of channel like structures. Vertebrate remains were present.

2) This was again a hard sandstone band, medium to coarse grain, with less heavy mineral lamination than formation. 1) There was also evidence of trace fossils in the surface sandstone which took the form of criss-crossed burrows.

3) This was a well bedded unit about 18 inches thick. It had medium to fine grains with calcite cement and heavy minerals, though the laminations were not good. Occasional vertebrate bone fragments were found. Good trace fossils were found on the surface and it is possible that the bioturbation had destroyed some of the lamination. Few palaeocurrent indications could be found.

4) Again, fine and medium sandstone with very good current bedding, again picked out by heavy mineral bands. The current bedding was in the form of festoons and a number of accurate palaeocurrent readings were taken. The cemented sandstone is underlain directly by an uncemented sand which erodes away much more easily. Thus the harder cap rocks break up and drape the sides of the drainage channels.

5) This formation consists of a highly bioturbated limestone interbedded with muds of a calcareous nature and occurs just on the edge of the map. This formation probably underlies the previous four formations described above.

The sediments represent flow regimes from high velocity currents in the case of the boulder beds, to very quiet conditions in the case of the Dolomites. Thus each type of sediment represents a particular environment which, in some cases, may have been very localised. The sandstones and siltstones represent the norm. Analysis of both the heavy minerals and palaeocurrent data suggest that most of the clastic sediment was derived from the basement schists and moved northwards by longshore drifts.

Palaeontology shows that both vertebrates and nulluses were present, though not abundant, but that diatoms flourished. At some time the chemical conditions of the water were such that dolomite could be precipitated.

In conclusion the sediments were deposited in shoal water near the shore of a large freshwater lake.

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