

GEOLOGICAL REPORT ON THE SITE OF DR. KOHL-LARSEN'S
DISCOVERY OF A FOSSIL HUMAN SKULL, LAKE EYASI,
TANGANYIKA TERRITORY.

PART II.

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INTRODUCTION.

The object of the writer's visit to this region was to report upon the geological aspect of the site of Dr. Kohl-Larsen's discovery made in the period 1934-36.* The visit was paid in company with Dr. and Mrs. L. S. B. Leakey and camp was established at the northern end of the Mumba Hill range, a distance of three and a quarter miles from the actual point of discovery.

The accompanying sketch-map drawn from Geological Survey Map G.S. 91 (1 : 200,000) indicates the position of the site accurately only with reference to the highest (southern) peak of the Mumba Hills and to the position of the first cave excavated by Kohl-Larsen. It is 1.9 mile west of this cave and 1.25 mile on a bearing of eleven degrees† from the western base of the southern peak of Mumba Hills. The lack of triangulation points in this region rendered it impracticable to fix the position of the site more accurately. The directions given above are, however, quite sufficient to enable the site to be found.

Water for camp purposes, fresh and of good quality is obtainable from a small offshoot of the Mangola stream. The Mangola flows along the south-eastern flank of the Mumba Hills and is permanent.

GEOLOGY.

(a) *Stratigraphy*.—Apart from the exposures of gneissose granite and intruded basic schists in the tors of the Mumba Hills, an almost complete absence of natural sections in the lake deposits renders an accurate interpretation of the geology of the region somewhat difficult. Erosion gullies are to be found, but the average depth of these is seldom greater than one foot. One such gully about a hundred yards east-south-east of the discovery site exhibited a section of approximately three feet depth for a distance of two to three yards only.

*In the course of an expedition to Lake Eyasi in 1934-36, Dr. Kohl-Larsen discovered parts of three fossil human skulls in association with stone artefacts and fossil mammalian remains. Of the three skulls represented, the partial reconstruction of one only was possible but the reconstruction was sufficient to indicate that the skull represents a low type of human with markedly anthropoid characters, while in other ways it approximates more to the *Sinanthropus* type. In a preliminary report by the late Prof. Hans Reck and Dr. Kohl-Larsen, it is attributed to the genus *Paleoanthropus* (sp. *njarasensis*). (See "Erster Ueberlick ueber die Jungdiluvialen Tier- und Menschenfunde Dr. Kohl-Larsen's im nordöstlichen Teil des Njarasa-Grabens (Ostafrika)." Von H. Reck and L. Kohl-Larsen. *Geologische Rundschau*, Nov., 1936). The associated culture and fossil fauna strongly suggest an Upper Pleistocene (early or middle Gamblian) date.

†All bearings given are magnetic.

There is a gradual fall from the western base of the Mumba Hills to the edge of the present-day lake but the slope in the actual vicinity of the site is so slight as to be indiscernible. Gentle undulations are observable owing to the accumulations of drifted sand but the differences in height are small. There are two raised beaches between the base of the Mumba Hills near the first cave and the present lake edge. The height of the floor of the trough at the point where the fossil skull was found is, as accurately as can be calculated, 3,410 feet above mean sea-level.

It may be noted that nothing could be ascertained from Kohl-Larsen's own excavations which, at his request, were left untouched. This place had obviously been submerged beneath the waters of the lake during the previous rainy season and is now filled with dry, cracked mud.

Pits and trenches were dug nearby and finally a section of about twelve feet of the underlying beds was exposed.

The thickness of the wind-drifted sand varies from a few inches to a foot or more. Where it is at a minimum, or where it has been completely removed from the surface of the underlying beds, the ground is strewn with mammalian bone fragments.

In several places in the neighbourhood are exposed surface outcrops of a dark red rock with a cellular and laterized appearance. These outcrops are small and sporadically distributed; in one or two places, they form low bars or "reefs." At the ground surface the rock is hard and compact and, as will be shown later, for a depth of not more than ten inches, the rock is a laterite. Below this depth, it becomes much less well-consolidated, distinctly sandy and loses its red colour to some extent. A pit (No. 2) was dug through one of these outcrops, three or four yards west of the point where the skull fragments were found. This revealed one foot six inches of the red bed, hard and compact on top, becoming softer in depth, somewhat sandy and much less consolidated, and underlain by greyish-green marl which is sharply distinguished from the overlying sandy portion of the red bed. A similar section was observed in a trench twelve feet in length by two feet wide, dug about ten yards west of Kohl-Larsen's excavation and a few feet from pit No. 2. In the trench, however, a thin band of four inches thickness, of greyish-green sandy marl with fossil fish-scales lies immediately below the sandy base of the red bed, followed by the same greyish-green marl as in pit No. 2. The thin, sandy marl band with fish remains is undoubtedly Kohl-Larsen's "Unterer Fisch-mergel."

Twenty yards south of the site of the skull find, the main pit, No. 1, measuring ten feet by six feet, was sunk to a depth of nine feet and exposed the following section, "A" :—

11. Surface wind-borne sand	4-12 inches.
10. Reddish, ill-consolidated sandstone with mammalian remains. (Horizon in which skull fragments found by Kohl-Larsen)	±4 feet.
9. Thin layer of concretionary limestone	$\frac{1}{2}$ -1 inch.
8. Greyish-green sandy marl with fish scales. ("Unterer Fischmergel" of Kohl-Larsen)	8-10 inches.
7. Greenish-brown, sandy marl	±5 inches.
6. Greyish-green clayey marl with abundant limey concretions	18 inches.
5. Sandy marl, greenish	6 inches.
4. Green clay	2 $\frac{1}{2}$ inches.

3. Sandy clay, greenish	2½ inches.
2. Thin layer of beach sand	±1 inch.
1. Brown sand becoming earthy at depth, with abundant flakes of white mica. Ill-consolidated. Base not seen	+1 foot.

It is probable that beds 3 to 7 inclusive represent the "Hauptmergel" of Kohl-Larsen, the thickness of which he estimates at \pm two metres. Here it is clearly divisible into the sections shown, the changes from one band to another being unmistakably defined in a clean section in the pit. Bed 8 would appear to be the equivalent of Kohl-Larsen's "Unterer Fischmergel" and 10 his "Hauptsandstein mit fossiler Fauna." The latter is the bed in which, in Kohl-Larsen's own excavation, the fragments of the human skull were found and in pit No. 2, a laterite capping covers the eroded surface of this bed. No sign of an upper fish-bearing marl was seen in this or in any other section exposed.

Approximately a hundred yards to the east-south-east, an erosion gully exhibits on its north-western bank a small section of about three feet in depth for a distance of two or three yards (Plate V). A second trench was excavated across this gully until a depth of seven to eight feet from the overlying sand to the base of the trench was reached. The following section was then noted, "B":—

8. Thin covering of wind-borne sand	±3 inches.
7. Ill-consolidated sandstone with mammalian remains. (Bed 10 of section "A")	4-5 inches.
6. Thin layer of concretionary limestone. Not strongly defined	±½ inch.
5. Greyish-green sandy marl with fish scales	±5 inches.
4. Greenish, sandy marl	±5 inches.
3. Green, clayey marl with numerous limey concretions	16 inches.
2. Thin layer of beach sand	1 inch.
1. Brownish-red clayey sand with abundant flakes of white mica. Base not seen.	

On the eastern side of this gully, a deeper hole was dug in the same trench and this opened directly into bed 1, showing well-stratified, slightly reddened modern sands underlain by two feet of red, sandy clay with three to four feet of brownish-red clayey sand below it. This is a continuation in depth of bed 1, and the high mica content is again conspicuous.

The sections "A" and "B" therefore correspond, "B" exposing a greater thickness of the basal red, sandy material. In "B," the sandstone with mammalian remains has been eroded, only a few inches appearing here as against four feet in pit No. 1. Here, too, the surface sand is very thin, in some places completely removed and the bone fragments are strewn about over the ground surface.

In a private communication to Dr. L. S. B. Leakey, Dr. Kohl-Larsen says that when excavating his "fossil mansite" he had just reached the lower fish-bearing marl before being compelled to suspend operations on that occasion. Simple levelling measurements on the spot demonstrate that the top of the fish-marl in pit No. 1 (bed 8 of section "A") is at exactly the same level as the caked mud surface of the shallow depression marking the site excavated by Kohl-Larsen and which, according to his own words, is the upper surface of the lower fish-bearing marl. Similarly the lower fish-bearing marl in the erosion gully a hundred yards east-south-east of the first pit, is at the same level. *There is no suggestion of dip of the beds, nor are there the slightest indications of disturbance in the way of folding, faulting or shearing.*

The presence of the thin band of concretionary lime between the lower fish-bearing marl (bed 8 of section "A") and the reddish, partly consolidated sandstone with mammalian remains overlying it, points to the existence of a land surface after the deposition and consolidation of the marly beds, the uppermost of which is the lower fish-bearing marl. This is either altogether absent from pit No. 2 or indistinguishable from the greyish-green marl below the red, sandy bed with lateritic capping (see page 45). The failure to observe any fish scales in that marl is not necessarily a proof that the lower fish-bearing marl is not represented there as the fish remains, though plentiful, are sporadically distributed.

Again, the presence of a thin layer of beach sand overlying the brownish-red clayey sand at the base of the sections "A" and "B" is indicative of the existence of an old land surface. This basal bed with its high content of white mica and its earthy nature is quite distinct from the rest of the overlying strata and is thought to be the old land surface on the primitive rock foundation. This foundation is here composed of gneissose granite which has intruded still older schists and gneisses, as the rock of the Mumba Hills and numerous smaller *inselberge* on the floor of this part of the Eyasi trough show. If this is the case, the sedimentation on the floor of the trough cannot have assumed any great proportions, even allowing for the subsequent processes of erosion. From the very nature of the floor, erosive processes must have been slow and poorly effective since its formation.

In an endeavour to adduce further evidence for the age of the Eyasi sediments, a petrographical examination was made of the material of the several strata. This was compared with rock samples from the Pleistocene beds in the Oldoway (Olduvai) gorge, which the writer, in company with Dr. Leakey visited before leaving the district.

(b) *Petrography*.—Possibly one of the most significant results of this examination lies in the fact that the material of the upper part of the red bed observed in pit No. 2 proves to be lateritic. A partial analysis of this material revealed the presence of 37.64 per cent. of Al_2O_3 . It is therefore an aluminous laterite and represents a stage in the formation of bauxite. A comparative analysis of high grade bauxite from the Gold Coast gave 70.84 per cent. Al_2O_3 .

The lower portion of this red bed is not lateritic. It is not nearly so red as the laterite, is very ill-consolidated and though no mammalian bone fragments were actually found in pit No. 2, the writer considers that this portion (about eight inches in thickness) represents the eroded bone-bearing sandstone as found in pit No. 1.

Microsections of the laterite from pit No. 2 show that it contains only minute amounts of detrital material, principally quartz grains. Similar material from a point about half a mile to the east-north-east contains more detrital material, the most prominent minerals being quartz, orthoclase, microcline, oligoclase, bright green hornblende, colourless pyroxene, biotite and muscovite. Numerous small, partly rounded lava pebbles are also to be seen.

In general, the material from both places appears to be in the nature of a detrital or low-level laterite formed by the denudation, transportation and deposition of rock fragments and cementation by lateritic material. In pit No. 2, all the Eyasi beds observed, lie below the laterite. The upper fish-bearing marl of Kohl-Larsen was not seen but it is probable that this, too, was eroded before the laterite formed. The presence of lava pebbles in the laterite of the second locality is also significant in connection with the date of the laterisation.

The general opinion is that laterite is formed under humid conditions with a well-marked, well-distributed seasonal rainfall accompanied by high temperature, extended over a lengthy period of time. Its origin appears to depend more upon climatic conditions than on the nature of the underlying rock. Thus in India, it

is found on basalts of the Deccan⁽¹⁾ but is also derived from granites and other rocks ; in West Africa it is observed on granites, norites and meta-sediments⁽²⁾ and in East and South Africa, on granite, on gneisses and on volcanic rocks⁽³⁾. The main point is that in this Eyasi locality, the presence of laterite indicates climatic conditions for its formation vastly different from those that prevail at the present time. It is impossible for the laterite to have formed under present day conditions ; it is *not* forming at the present time.

These rocks were compared with the red bed 3 of Olduvai (Oldoway) but the differences are sufficiently striking to convince one that the beds are not the same. Bed 3 of Olduvai is not lateritic ; it contains far more limey material and includes calcite, epidote and apatite which are absent from the Eyasi red bed. Biotite, which occurs in some abundance in the latter, is rare or absent in Olduvai bed 3 ; muscovite is entirely absent. Bed 5 of Olduvai is very different both in colour and texture from any of the Eyasi strata but contains minerals that are common to the latter. In particular, biotite is abundant in long, narrow flakes, much less so as basal sections. The commonness of the long, narrow flakes is peculiar as the rock does not show any particular structure or directional features. Microcline and green hornblende are also common. Bed 5 of Olduvai and the Eyasi sands and marls all differ from Bed 3 of Olduvai in the relative abundance of the green hornblende and biotite which are common alike in Bed 5 of Olduvai and in the Eyasi beds.

(c) *Paleontology*.—Little can be said here concerning the fauna of the Eyasi beds examined on the occasion of this visit beyond the fact that all the remains obtained by us from the sandstone in which the skull fragments were found by Kohl-Larsen in his excavation, appeared to be those of existing species, including bones or teeth of hippopotamus, rhinoceros, pig and monkey.* In the lower fish-bearing marl, fish scales only were found. All the bone fragments were in an advanced state of mineralisation though this fact cannot be considered of great value in determining their age. The mineralisation of the bones is manganiferous as tests on the material have proved and this may, conceivably, be connected with the process of laterisation, manganese oxide being a constituent which, along with the oxides of iron, titanium and aluminium, tends to be concentrated by the process of laterisation.

(d) *Archæology*.—This side of the investigation is dealt with more fully by Dr. Leakey, but it is of interest to note here that an implement found by him in the neighbourhood of the site, and belonging to a stage of Levalloisian culture, proved to be made from a fragment of lava which is of a distinctive type. It is a basic phonolite containing leucite in some quantity. As there appears to be very little feldspar it is between a leucite-nepheline-tephrite and a leucite-nephelinite. The curious feature of this rock is its rarity in this part of East Africa. Only one other specimen of this type of lava has been observed by any member of the Geological Survey ; this was a leucite-bearing nephelinitoid phonolite from south-east of Meru

(1) Fox, C. S. The Bauxite and Aluminous Laterite Occurrences of India : *Mem. Geol. Surv. India*. Vol. 49, Pt. I, 1923.

(2) Cooper, W. G. G. The Bauxite Deposits of the Gold Coast : *Gold Coast Geol. Surv. Bulletin*. No. 7, 1936 ; also Government of Gold Coast : *Rept. Geol. Surv.* 1917, 1919, 1921.

(3) Mennell, F. P. Mineral Resources of Rhodesia : *South African Journ. Indust.* Oct., 1918.

*The collection of fossil fauna made by the Kohl-Larsen expedition in 1934-36 included very rolled bones and teeth of such extinct genera as *Hipparion* and *Simopithecus* which are derived fossils, and unrolled fauna (that is, contemporary with the skull) including *Bos bubalus* which is extinct and which, in Kenya, S. Africa and N. Africa, is typical of Upper Pleistocene. None of these faunal types was found, however, on the occasion of the visit which forms the subject of this report.

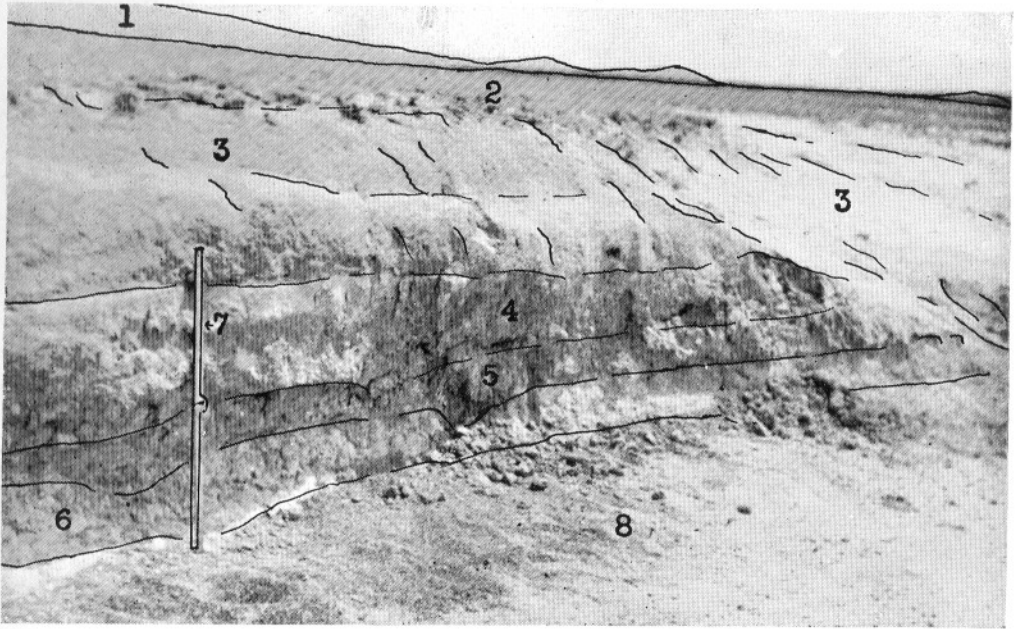


PLATE V.

1. Basement Complex hills fringing the Eyasi trough.
2. Surface, wind-borne sand.
3. Reddish, ill-consolidated sandstone with mammalian remains.
4. Greyish-green, sandy marl with fish-scales. (Kohl-Larsen's "Unterer Fisch-mergel").
5. Greenish-brown, sandy marl.
6. Greyish-green clayey marl with abundant limey concretions.
7. Two-foot rule.
8. Bed of erosion gully.

collected and described by F. Oates (⁴), and was the only leucite-bearing lava out of seventy specimens from the eastern rift zone. Leucite is typical of the volcanic rocks of Bufumbira, Uganda Protectorate, situated in the western section of the Great Rift Valley where probably the largest concentration of that mineral in the world occurs.

As no time was available for a study of the lavas of this region, it has not been possible to make any pronouncement regarding the significance of the use of this type of lava in modelling a tool of Levalloisian culture.

SUMMARY AND CONCLUSIONS.

Summarising, it may be said that the Eyasi strata contain some minerals common to either one or other of the Olduvai beds but mainly to bed 5. Previously (p. 46), it has been stated that they do not show the least signs of disturbance whereas the Olduvai beds 1 to 4 are certainly faulted. Bed 5 of Olduvai lies unconformably upon the lower strata and, like the Eyasi beds, is undisturbed. There is a strong suggestion, therefore, that the Eyasi beds are younger than beds 1 to 4 at Olduvai. Lying as they do in one of the principal zones of recent disturbance, with the Eyasi scarp rising up to the west, the Hohenlohe rift valley (or Yaida depression) and the western branch of the Gregory rift valley to the east, and the great volcanic highlands to the north (Oldeani, Lemagrut, Ngorongoro, Ololmoti, etc.), it is inconceivable that the Eyasi beds, were they as old as the Olduvai beds 1 to 4, could have escaped the effects of these tremendous disturbances.

The Eyasi trough and the Balbal depression form a tectonic unit, the continuity of which is broken by the projecting volcanic mass of Lemagrut. The earlier-formed part of Lemagrut has suffered dislocation along the line of the trough and is therefore older than the Eyasi-Balbal depression. Oldeani, on the other hand, is in no wise disturbed. Its lavas have flowed over the floor of the Eyasi trough in the north-east; it is therefore younger than the formation of the trough. So are the youngest lavas of Lemagrut.

The Balbal depression is bounded by the strata of Olduvai which are confirmed by stratigraphical, paleontological and archæological evidence to be of Lower to Middle Pleistocene age (beds 1 to 4), the faulting and formation of the depression being placed somewhere between the Middle and Upper Pleistocene. The formation of the Eyasi trough is accordingly fixed here and its sedimentation, being post-faulting, must be either of Upper Pleistocene or Recent age.

The nature of the sediments suggests that there was a change of climatic conditions during the period of deposition. The lower strata overlying what is thought to be the old gneissic land surface, are lacustrine and were probably laid down in fairly calm, fresh water as the fine grain of the marls and the fish remains prove. At the top of these lake beds is a layer of concretionary lime, which suggests that they were exposed for some time as a land surface before the formation of the sandy bed with mammalian remains overlying them. The latter bed, from which Kohl-Larsen obtained the fragments of human skull, indicates a terrestrial formation laid down fairly quickly and by rapid disintegration of the rock of the neighbourhood, for its marked feature is the coarseness and angularity of the constituent grains.

Kohl-Larsen reports an upper fish-bearing marl overlying the sandy bone-bed, which would indicate a recrudescence of pluvial conditions and deposition of the succeeding strata under water. No trace of this upper marl was observed on this occasion, nevertheless, the view is probably correct and the red, sandy bed indicates the climax of a dry period intervening in a predominantly pluvial period.

(⁴) Oates, F. Collection of Tertiary lavas from the Northern Province: *T. T. Geol. Surv. Ann. Rep.* 1933, pp. 27-28.

In a private communication to the writer, Dr. Leakey states that the layer of concretionary lime separating the marls from the sandy bed with fossil remains suggests to him the pause in wet conditions between the first and second peaks of the Gamblian Pluvial period. Kohl-Larsen's *upper* fish marl would then represent the renewal of wet conditions in the Gamblian Second phase. Following this, he suggests erosion of the upper fish marl and the underlying bone-bearing sandstone in the dry period between the Gamblian Second phase and the Makalian wet phase, and laterisation during the latter phase.

The above suggestions appear to fit in fairly well with the observed facts, but upon one point, the writer feels rather in doubt. That is in regard to the laterisation being Makalian, Leakey puts the Makalian wet phase at circa 8,000 years B.C., the wet conditions lasting for about 1,000 years. The conditions may have been climatically suitable, but did they obtain over a sufficiently lengthy period? Could a laterite formation of even so restricted a thickness and extent as the Eyasi laterite have formed in a period of the order of 1,000 years? If this question can be answered in the affirmative, then the skull is very probably pre-Makalian in age. It is considered by most authorities on the formation of laterite that a long period of time is necessary during which the topographical and climatic conditions are steady and conducive to its formation. This would seem to rule out the Recent epoch* and therefore, in view of the doubt that exists regarding the Makalian age of the laterisation it can only be stated that the skull appears to be post-Middle Pleistocene and pre-Recent. In other words, a date somewhere in the Upper Pleistocene is indicated. It is not possible to be more precise than this.

DODOMA,

8/1/1938.

*The presence of *Bos bubalus* in the fauna contemporary with the skull, collected by Kohl-Larsen confirms this statement. This is extinct and in Kenya, South and North Africa is typical of Upper Pleistocene.