

June 8th, 1921.

Mr. R. D. OLDHAM, F.R.S., President,
in the Chair.

The List of Donations to the Library was read.

Dr. WILLIAM FRASER HUME opened a discussion on the Relations of the Northern Red Sea and its Associated Gulf-Areas to the 'Rift' Theory, in the following words:—

(1) The areas specially considered are the northern portion of the Red Sea and a region to which the name of 'Clysmic Gulf' has been given. The Clysmic Gulf (from Clysmia, the Roman name for Suez) is defined as the district bordering the Gulf, and lying between the (largely) fault-bounded ranges of Egypt and Sinai on the west and the east respectively which dominate this depressed area. Within its borders Miocene deposits are of wide distribution; beyond them, these are notably absent. The folds within this region are from north-west to south-east, outside it their trend is frequently almost at right angles.

(2) A line prolonging the direction of the western coast of the Gulf of Akaba to the shores of Egypt divides the Clysmic Gulf from the Red Sea, the former being occupied by the shallow Gulf of Suez and disturbed lowlands, while south-east of the dividing-line is the Red Sea, with its great depths and its narrow coast-line.

(3) The Clysmic-Gulf area is one of complicated fold-and-fracture effects, while in that of the Red Sea only fold effects have been observed.

From a study of the facts known, it is concluded that:—

(4) The whole region under consideration underwent extremely slow submergence, the negative movements continuing from early Jurassic to late Cretaceous times.

(5) This was succeeded by one of a positive nature, the actual emergence of the new land taking place near the close of the Eocene Period. It is suggested that the area was occupied by an anticline or anticlinorium plunging northwards in the Clysmic-Gulf region, and that it was subject first to marine and then to subaërial erosion. This formed part of the continent on which grew the trees of the Petrified Forest, and on which wandered animals such as the *Arsinoitherium* and the earliest elephants. This continental period was most marked during late Eocene and early Miocene times, and the area dealt with here appears to have become one of very varied ridge and depression.

(6) The whole region thus dissected was invaded by the ancient Mediterranean; the slow advance southwards occupied the main portion of the Miocene Period, and probably extended well into the Pliocene. The pre-existing ridges became coral-reef centres; the intervening depressions were filled up, first by land-derived

deposits (such as conglomerates and clays), and then by lagoon formations (gypsum and salt). The earliest of these formations appear to have been of Schlier (Middle Miocene) age.

(7) The sequence of events from Middle Pliocene times onwards is difficult to unravel. The whole region of the Clysmic Gulf became folded and fractured to a remarkable extent, there being certain underlying elements of order discernible. There is strong faulting at the borders with the igneous hills, and fold-ranges are well marked, these being of asymmetrical anticline type. It is suggested that compression of the area, with uplift of portions of it, offers the best solution for the facts observed. It seems difficult to conceive that dislocation so marked, spread over so wide an area, could arise under rift formation as defined by Prof. J. W. Gregory. It seems equally difficult to ascribe the whole of the surface-differences to erosion alone. It will be readily understood that no simple solution of the problem can be offered on the evidence at present available, especially in view of the fact that no important faulting has been noted on the western borders of the Red Sea.

(8) The same reserve must be exercised with regard to the very interesting eroded trough-fault valleys, which the writer formerly regarded as of rift origin.

(9) A suggestion is made that the portion of the Nile Valley about lat. 26° N., where faulting is most conspicuous, may have been initiated by erosion of a sharp anticlinal fold due to the compression of almost horizontal strata. Sharp folds exist in the desert east of the Nile, but their origin is at present doubtful.

DISCUSSION.

The PRESIDENT said that it had been customary of late years to devote at least one meeting in the Session to a lecture on some subject of interest to geologists, or to a discussion of one of the larger and more speculative problems of geology. The subject selected for discussion that evening might be briefly defined: there was in Central Africa a well-known surface-feature, for which Prof. J. W. Gregory had popularized the name of the Great Rift Valley; there was also, in Southern Syria, a similar surface-feature, occupied in its northern part by the Jordan Valley, and continued as a surface-depression to the Gulf of Akaba. According to one school of thought, these two surface-features were not only of similar genesis, but formed the extremities of a continuous surface-feature, intimately related in origin to the tectonics of the surface-rocks, called the African Rift Valley, of which the Red Sea was regarded as an integral and important section. According to another school, no such continuity is recognized, and the origin of the Red Sea is attributed to causes other than those which gave rise to the rift-valleys of Africa proper and of Palestine. Dr. Hume had had a large personal experience of the geology of the Red-Sea region, and his presence in England afforded a useful opportunity of raising a discussion of this important and interesting problem.

Col. H. G. LYONS expressed his great interest in the information that Dr. Hume had laid before the Society, which made the structure of this part of North-Eastern Africa much clearer. He agreed that former assumptions of the rift character of the Nile Valley were not tenable, and that the Gulf of Suez, too, could not be strictly described as a rift-valley. For the Red Sea, he asked whether more information had been collected of late as to the structure of the eastern shore, to show whether it was as free from fracture-lines as the western was, according to Dr. Hume's account.

Prof. J. W. GREGORY, in a letter sent as a contribution to the discussion, remarked that the agreements between Dr. Hume's views and his own were more essential than the differences. The sequence of events stated by Dr. Hume for the Clysmic Gulf is similar to that which he had adopted for the Rift Valley as a whole—including Jurassic subsidences due to the Mesozoic deformation of the crust, an Eocene land over the Red Sea, subsidence of the Rift-Valley trough in the Oligocene, renewed and extended especially in the late Pliocene Period. The Gulf of Suez is not typical of the Rift Valley, as its lines there intersect those of the Levant, and as the rocks traversed are mostly young stratified deposits.

The main difference between the writer's interpretation and that stated by Dr. Hume is the relative importance of fold and fault. The importance of the faults is indicated by Dr. Hume's remark that

'the (largely) fault-bounded ranges dominate this depressed area,'

and by his statements (Geol. Mag. 1910) regarding the dome over the Clysmic Gulf:—

'I can conceive of no erosive agent which would break across this great earth-feature without the intervention of fracture,' [and that] 'faulting, and faulting alone, can explain the phenomena.'

These conclusions are supported by the recent statements in bulletins by the Geological Survey of Egypt that faulting was

'the controlling factor in the formation of the shore line of the Gulf' [and in] 'determining the present position of the Gulf of Suez.'

The attribution of the Red-Sea section of the Rift Valley to folds appears to be due to the use of the term 'fold' for movements which the writer regards as faults. The Geological Survey of Egypt has recently explained its use of the word 'fold' by a diagram¹ which identifies a steep, plane, slickensided surface as a fold. The writer regards the movement shown by this diagram as a fault, so that the difference is a question of terms. He found it impossible, in view of the post-Eocene faults with fault-breccias beside the Gulf of Aden and the maps of the Egyptian Geological Survey at

¹ Petrol. Res. Bull. No. 6, 1920, sketch before p. 1.

the other end of the Red Sea, to accept the view that on the Red Sea only fold-effects have been observed. He agreed that the Lower Nile Valley is not a Rift Valley, its structure being the antithesis to that of the Red-Sea trough.

With regard to the length of the Rift Valley, he referred to the explanation in his forthcoming book 'The Rift-Valleys & Geology of East Africa' (briefly stated in Geogr. Journ. vol. lvi, p. 38), representing it as due to worldwide mid-Kainozoic earth-movements, and to its position between the mountain-forming movements in Europe and Africa which were northward, and the simultaneous Asiatic movements which were southward. Its great length is due to the continental scale of the accompanying movements, and seems no more inconsistent with its formation by tension than the equal length of the contemporary fold-mountain system is inconsistent with their formation by compression.

Dr. J. W. EVANS thought that the structure of the Akaba and Clysmic gulfs would prove very different, the latter being probably the same as that of the Dead-Sea depression. He enquired whether the faults shown in Dr. Blanckenhorn's map near Suakim, parallel to the coast in that neighbourhood, and approximately parallel to the Gulf of Akaba (though not in the same line), were authentic, and, if so, whether they had a downthrow towards the sea. The deep depression in the north of the Red Sea was sharply defined, both on the north and on the south, and suggested a subsidence. The existence of a 'graben' seemed to point to a state of tension, when it was found, but did not imply the existence of a rift as wide as the sunken area. The speaker looked forward to the production by the Egyptian Survey of further evidence on this most important question.

Mr. G. W. LANPUGH remarked that the 'rift-valley' hypothesis raised the wider question as to the supposed prevalence in many parts of the world of large-scale surface-features produced directly by comparatively recent faulting. The geological record showed that the local development of troughs of depression had been frequent throughout the accumulation of the stratified rocks; and the resultant synclines were often faulted longitudinally at the margins, as well as within. But the field-evidence generally implied that the subsidences had been gradual, and the faults of slow growth. Secondary 'fault-controlled' features, due to selective denudation, were common enough both in valleys and on high ground, but new original fault-scarps were difficult to find: he had not yet himself seen a single convincing example, though he had seen several to which this origin was ascribed. He knew no case of the trunk-drainage of a land-area having been revolutionized by the uprise of a fault-block athwart it; and this seemed to imply that the surface-effects of faults for a long time past had never been rapid enough to overcome the ordinary course of weathering and erosion. The conception of the 'rift-valley' had always been attractively simple, and there may be features on the Earth to which the conception will apply absolutely; but the

researches of Dr. Hume and his colleagues have shown that we must now look elsewhere than in Egypt.

The PRESIDENT said that the interesting and instructive discussion had left two doubts in his mind still unsatisfied. One was whether two distinct problems, the origin of rift-valleys and the origin of the Red-Sea depression, had not been confused. The magnitude of the Red-Sea depression was of so different an order from that of the African rift-valleys, that any similar rifting, which may have taken place, would be of subsidiary importance in determining the position and form of the Red Sea. The other doubt was as to the existence of anything which could properly be called the Great Rift-Valley. There was in Africa a belt of country in which the surface-form known as a 'rift-valley' was of fairly frequent occurrence; but it seemed to him that there was insufficient evidence of continuity between them, or of the existence of one continuous rift-valley. It appeared more likely that further investigation would prove the independence of the individual depressions, which should rather be regarded as separate members of a continuous range or series.

Dr. W. F. HUME, in reply, thanked Col. Lyons for his remarks, and pointed out that Dr. Blanckenhorn had never himself visited the Red-Sea region, the faults inserted having no basis of observation. With regret it had to be stated that Dr. Blanckenhorn was frequently incorrect in regard to the existence of faults in Egypt. He had bordered the Fayûm with faults and then removed them, shown an important one at Moghara Oasis which could not be confirmed, and finally bordered the Red Sea with faults where proof of their existence was absolutely wanting.

Prof. Gregory was certainly justified in stating that the actual diagram exhibited was a true fault; but, if continued, it passed into a monoclinical fold. The point did not affect the main issue, as the section was within the area of admitted fracture.

Instead of assuming all the depressions discussed as part of a great rift system, each had to be considered on its merits. The parallelism of the Red-Sea borders could be explained as due to erosion of a broad fold, and, apart from the apparent absence of faulting on the large scale along its borders, the breadth of that sea was such as to make it most difficult to conceive it as a tension-crack. In the Clysmic-Gulf area, which was narrower, and lying between hill-masses of granite or limestones, folding and fracture were intensely marked, but might well be due to compression. The features on which special attention would have to be concentrated in connexion with rift questions were the relatively narrow valleys of the Jordan, the Dead-Sea depression, and those of South-Eastern Sinai, for which no simple erosion theory seemed satisfactory. They were undoubtedly, like the Clysmic Gulf, fault-guided or fault-controlled depressions.

The speaker, as a result of his own studies, agreed with Mr. Lamplugh that a dogmatic assertion of rifts at this stage

might give a bias to younger geologists which might cloud the truth, this being one of Dr. John Ball's objections to Prof. Gregory's original paper.

Dr. Hume also was glad to note the President's remarks, and thought that the idea of 'tension regions,' as advocated by Dr. Evans on this occasion, was one to be approached with great caution, as it required very full experimental evidence.

June 22nd, 1921.

Mr. R. D. OLDHAM, F.R.S., President,
in the Chair.

William Sawney Bisat, 1 Selwyn Avenue, North Ferriby, Hull; Arthur William Blanford, A.R.S.M., Kolar Goldfield Prospecting Department, c/o Grindlay & Co., Bombay; Charles John Philip Cave, J.P., M.A., F.R.A.S., Stoner Hill, Petersfield (Hampshire); and John Jerom Hartley, M.Eng., B.Sc., M.Inst.C.E., Church Walk, Ambleside (Westmorland), were elected Fellows of the Society.

The List of Donations to the Library was read.

The Names of certain Fellows of the Society were read out for the first time, in conformity with the Bye Laws, Sect. VI, Art. 5, in consequence of the Non-Payment of the arrears of their Annual Contributions.

The following communications were read:—

1. 'The Jurassic of New Zealand.' By Charles Taylor Trechmann, D.Sc., F.G.S. With an Appendix on Ammonites from New Zealand. By Leonard Frank Spath, M.Sc., F.G.S.

2. 'The Norite of Sierra Leone.' By Frank Dixey, M.Sc., F.G.S., Government Geologist of Sierra Leone.

Specimens and lantern-slides were exhibited in illustration of the papers by Dr. C. T. Trechmann and Mr. F. Dixey.