

DID THE WATERS OF THE JORDAN ORIGINALLY FLOW INTO THE GULF OF AKABAH?

A REJOINDER TO THE WRITER IN THE "SATURDAY REVIEW."

By PROFESSOR HULL, F.R.S.

THE mode of formation of the Jordan-Arabah Valley has been a subject of investigation, or of speculation, for a long period of time. The idea, first, I believe, suggested by Burkhardt, that the river Jordan originally flowed down the whole course of the depression from the Lebanon to the Gulf of Akabah, has been deliberately rejected by Lartet, and more recently by myself, after an examination of the line of depression from the Gulf of Akabah to the plains of Jericho and the Jordan Valley. This hypothesis has, however, been revived by a writer in the *Saturday Review*,¹ who it may be presumed has not had the same opportunities of personal examination of the ground, and who takes the author somewhat to task for presumably not giving this view sufficient examination in a recent memoir on the geology of this region.² The Reviewer objects that I leave unexplained "the peculiar and distinctive contours of the Jordan-Arabah Valley, especially the gradual descent on both sides to the greatest depth in the bed of the Dead Sea, as well as the singular flattened watershed in the Wâdy Arabah." The writer proceeds: "The physical features of the region appear to accord far better with the view that the valley as a whole marks the course (originated no doubt by a line of flexure and faults) of a river which once poured its waters into the sea on the site of the present Gulf of Akabah, and that this valley was afterwards affected by a new series of flexures running east and west, the result being to raise the parts to the north of the Gulf, and to lower the whole of the upper region, the maximum depression being now indicated by the Dead Sea. This hypothesis, the more natural, as it appears to us, does not appear to have been duly considered by Professor Hull."

It is perfectly true I have not devoted much space to the attempt to confute a hypothesis which I believed to have been universally abandoned, and which, as I hope to be able to show, the more it is examined in detail the less does it appear to be capable of support. The enormous difference of level between the floor of the Dead Sea and the summit of the Arabah watershed, amounting to over 3,270 feet, seems to me an insuperable objection to the view that the Jordan-Arabah Valley could ever have been a continuous river-valley.

There is undoubtedly, at first sight, a great temptation to infer the existence of a continuous river-valley, when one looks at a physical map

¹ *Saturday Review*, 17th April, 1886, p. 552.

² "The Survey of Western Palestine: Memoir on the Physical Geology and Geography of Arabia Petræa, Palestine, and Adjoining Districts." Published by the Palestine Exploration Fund (1886).

of the entire region. At the northern extremity, where are situated the sources of the Jordan, we behold the highlands of Syria; at the other an arm of the sea, and each connected by a nearly continuous valley. I say *nearly* continuous, because at the saddle (or watershed) near the centre of the Arabah, the valley is mainly represented by the highlands of Edom on the east side; while, on the west, it is divided into two by a very low ridge of limestone called Er Rishy. Indeed, at this critical point it is somewhat difficult to determine where the real valley lies, as the western arm opens out upon the great plain of Badiet-et-Tih, and the eastern forms a terrace covered by gravel stretching across from the limestone ridge to the base of the Hills of Edom.¹ It seems to me that any one who studies the features of the watershed, as they are represented on the topographical map of Major Kitchener and his assistant, Mr. J. Armstrong, will come to the conclusion that they are very unlike those to be expected in the case of a large river-valley near the termination of its course. In fact, the distinctive contours, which are so remarkable in the Jordan depression to the north, and also in the southern portion of the Arabah Valley, here almost disappear.

Now, I come to inquire, what are these "peculiar and distinctive contours" which are so much relied upon by the Reviewer for indications of a continuous river-valley? I presume they are only applicable to the western margin, because those of the eastern are clearly and undoubtedly due to the elevation of the strata along the line of the great Jordan-Arabah fault, which was traced by us from the shores of the Gulf of Akabah to those of the Dead Sea, a distance of about 120 miles. To the east of this fault the different rocks crop out, and the sedimentary strata, having a general dip towards the east, break off in cliffs and escarpments such as are generally observable in similar cases.

I must therefore assume that it is in the scarped cliffs of limestone along the western side of the Jordan-Arabah Valley that we have the supposed indications of a river-valley margin. These cliffs are undoubtedly often very imposing, lofty, and precipitous. Taking the portion of the valley called *The Ghôr*, in which lies the Dead Sea and the Lower Jordan, if I am asked how do I account for these cliffs on the one hand, and for the deep hollow of the lake basin on the other, I have to reply, that the cliffs were formed in the first instance by wave action along strata fissured and fractured by faults, and subsequently by meteoric abrasion. It must be recollected that, owing to the manner in which the stratification is concealed along the sides and bottom of the valley by lacustrine deposits, it is seldom possible to make observations on the Cretaceous limestones; but, judging from the manner in which the beds are in some places flexured and highly tilted towards the western margin of the Ghôr, it is a fair inference that there are, besides the main fault which generally runs at the eastern margin, numerous other faults or fissures, by which the beds have been dislocated and displaced. When referring to the line of the

¹ Geological Memoir, p. 20.

Jordan-Arabah fault as an axis of disturbance, I have observed, "it is sufficiently clear that this line was an axis of disturbance for the whole region now under consideration. Along this line the strata are either displaced by secondary faults, or contorted and tilted at various angles; while, as we recede from the line of the displacement, the beds generally begin to assume a position approaching the horizontal."¹

Again, as regards the deep hollow of the Dead Sea basin, I have stated that as the land area was gradually rising from beneath the Miocene ocean, and as the table-lands of Judæa and Arabia were being more and more elevated, the crust fell in along the western side of the Jordan-Arabah fault, and that the bed of the trough, owing to continued subsidence, became more deep over the area now occupied by the waters of the Salt Sea itself, and that into this gulf all the waters flowing from the bordering lands naturally emptied themselves. In a word, my explanation of the existence of the deep hollow of the Dead Sea is:—unequal subsidence along the line of the main fault, and the presence of parallel and transverse fractures along the western side of the Ghôr; and if we recollect that this valley was filled by the waters of an inland lake, 200 miles in length and 8 or 10 miles in breadth, we shall have no difficulty in accounting for the presence of an aqueous agent, powerful enough to undermine, and in undermining to shape the lofty cliffs which abound the valley in some places.

With reference to the fine cliffs, often in the form of a double scarp, which bound the western side of the Arabah Valley for about 30 miles to the north of the Gulf of Akabah, I may observe, that they are essentially similar in character to those along which the Cretaceo-Nummulitic limestone of the Plateau of the Tih terminates towards the south and west, where the idea of river action is out of the question. During the period when the land was rising out of the sea, and again during the period of subsequent depression, when the sea rose from 220 to 300 feet, these cliffs must have assumed *in the main* their present outline. This has subsequently been modified by rain, frost, and water action; but I can see no sufficient reason for inferring the action of a great river in the tract of the Arabah south of the Dead Sea, nor do we find the remains of river terraces in the Arabah Valley, such as we might have expected if that valley had been the bed of a large river, which had afterwards dried up owing to subsequent physical changes.

Lastly, turning to the hypothesis of the *Saturday Review*, that after the formation of the main line of depression along the great north and south fault there occurred transverse movements, producing east and west flexures, I am quite unable to accept such a proposition. The general displacements of the strata were produced during the Miocene epoch, and except the subsequent gentle lowering of the whole region in the succeeding Pliocene, to the extent of 200–300 feet, which was unaccompanied by flexing of the strata, I hold that all the great disturbances are referable to the one epoch, namely, the Miocene.

¹ Memoir, p. 107.

The lowering of the deep trough of the Ghôr to a depth of 3,000 feet along an east and west synclinal axis could not have taken place without affecting the levels of the table-land of Southern and Central Palestine to a very appreciable extent. But, as a matter of fact, the central table-land is as a rule quite as elevated, or somewhat more elevated, to the west of the Ghôr as it is either to the north or south of that position. Nor does the existence of the saddle or watershed of the Arabah, which is 700 feet above the sea, seem in the least to affect the general levels of the table-land of the Badiet-et-Tîh, for, as already stated, this saddle seems to merge into the general surface of the country along the west.

One other point remains. Had the streams on each side of the Arabah entered a river flowing southwards it may be assumed that their channels would have pointed, more or less, in the same direction, at least along that part lying north of the watershed. It is only necessary to refer to the map of the Arabah to see that such is not the case. The valleys of the Jeib and its tributaries, together with those on the Edomite side, will be seen in the great majority of cases to point more or less to the northwards, indicating an original northward flow.

Having thus given the hypothesis of the Reviewer as full a consideration as appears necessary, I trust I have made it sufficiently clear, from considerations based on the physical features and geological phenomena of the region in question, that this hypothesis cannot be sustained.

"THE VALLEY OF ZEPHATHAH AT MARESHAH."

CAPTAIN CONDER in his April notes on the *Quarterly Statements* of last January referred to my article of the above title, and said, "The ingenious suggestion of Mr. Flecker does not seem to me necessary." The reason he assigned for this opinion was that he had some time ago proposed what he thought to be a satisfactory identification, viz., Wady Safieh, which I confess I have neither seen nor heard of before. As, however, readers of his remarks might think that I had invented a pretty theory, and rushed into print to overthrow better suggestions for the sake of my own, I begin with—

I. Some explanations of my suggestion. It pretends to no ingenuity, for I have invented nothing. I have only given the reading which I found in the LXX. I may have been the first discoverer of the cause of the variation, for Schleusnor does not give it. But that discovery is so simple that it is merely for want of attention that others did not see it before me. The only thing that might be blamed or objected to in my suggestion is the proposing a Septuagint reading instead of the Masoretic Hebrew. To this I can say that I have not done it because I like to correct the Authorised Hebrew by the Greek Version, but because, in