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ARTICLE VII.

TRACES OF GLACIAL ACTION
ON THE FLANK OF MT. LEBANON.

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NEAR the bottom of the great valley of the river Damûr,* and about five miles above its entrance into the sea, are some remarkable fissures, or clefts, on the north side of the river, which are well worth visiting. Indeed, the entire ride from the village of 'Abeîh down to the Fazûr (as the principal cleft is called) is interesting, particularly to geological students of Lebanon. Passing on the west side of Kefr Metta (half an hour south of 'Abeîh), and descending by a steep rough path for half a mile, you come upon an immense formation of amorphous trap and globular basalt. This formation passes northward under the limestone ridges upon which are situated Kefr Metta, 'Abeîh, 'Ain Ksûr, 'Ainnab, Shemelan, Sûk el Gharb, and other villages, being cut through and exposed to view by the ravines of the rivers and mountain torrents. It is some two hundred feet thick; above it is limestone, and below it generally sandstone, which again rests upon limestone. Through this lower limestone, which is very hard and compact, the Damûr has cut its way to the sea, and in the cliffs on the north side are the fissures of the Fazûr. The immediate neighborhood, consisting of only two or three houses and a mill, is called *Muaffakeh*, 'the fortunate.' Being well watered by the canal which drives the mill, and the climate in this sheltered nook being almost tropical, everything planted there grows with surprising luxuriance.

The Fazûr itself is an immense rift, running down southwestward through the cliff. At the top, or upper end, the perpendicular sides are twenty-five feet apart; but they gradually approach each other in the descent, until at the lower end they

* The Tamyras, or Damuras, of classic geographers, which falls into the Mediterranean midway between Beirût and Sidon.

are only five feet asunder. The fissure is about three hundred feet long, and at the bottom the perpendicular sides are nearly one hundred feet high. The descent is at an angle of thirty or forty degrees, and down it straggles the path, cork-screw fashion, to the mill, which may be some two hundred feet above the bed of the river. The water is brought to the mill by a canal which winds picturesquely along the perpendicular cliffs for half a mile. To the appearance of some of these cliffs reference will be made hereafter.

A little to the south of this main cleft is another parallel to it, but, though of unknown depth, it is nowhere more than six feet wide. Unlike the other, also, it narrows upward, and the sides meet above, leaving no outlet in that direction. Rocks have fallen into it, making a sort of flooring, upon which one can enter between the walls of the chasm some thirty or forty feet, and a stone thrown into the abyss from this point is heard rolling away below for some seconds. Besides these two fissures, there are others running transversely, and descending directly south towards the river.

But although this wild wilderness of rocks and clefts is interesting in itself, yet it would not on that account be entitled to the special notice of scientific students. It is for what certain portions of the Fazûr indicate and suggest, that I venture to call attention to it. The sides of the main chasm throughout its entire length, and from top to bottom, have been beautifully polished, by the action, as I believe, of an ancient glacier. In this process, the polishing body in its passage through the cleft has drawn lines and scratches and fine *striae*, with surprising regularity, descending in accordance with the descent of the chasm itself. As the chasm narrows downward (being twenty-five feet wide at the upper end, and five or six at the lower, where it opens out on to the river bed), the glacier would necessarily assume the form of a huge wedge. This would render its movement through the chasm very slow and regular, which accounts for the beauty of the polish and the regularity of the *striae*. The rock being intensely hard and unstratified, received a uniform polish; and being protected by a remarkable curve of the cliff on the upper side (like the concave moulding of an immense cornice), by which the chasm is over-arched, and shielded from the sun, wind, and rain, this polish remains just as the glacier left it, and will so continue, apparently, as long as the mountain itself abides. In certain places below this natural cornice, water has trickled down on the upper side, in some past age, coating the surface with a stalagmitic incrustation, whose lines are nearly perpendicular to the *striae* of the polished surface. Where this old incrustation has peeled off, the *striae* are shown in unbroken continuity.

Scientific gentlemen have repeatedly inquired whether during my rambles over Lebanon and anti-Lebanon I had discovered any indications of the action of glaciers, and my answer has always been that there were none which appeared to me distinct and unmistakable. I had not yet seen this Fazûr, with its vast polished surfaces, which are far more perfect and extensive than any I have seen either in Europe or America. It is this which imparts to the locality special importance. The perfect preservation of the polish is owing to several circumstances. Thus, first, to the intensely compact character of the rock. I have examined numerous chasms and fissures in these mountains, but if their sides were ever smoothed by glacier action, all trace of it has been obliterated by the crumbling and splitting off of the surfaces under the combined agency of rain, frost, wind, and earthquake. The polished surfaces of Fazûr have been protected from all these agencies by the natural cornice already mentioned. Owing to the peculiar wedge-shape of the glacier, its passage through the chasm must have been extremely slow; and hence, all the roughness and irregularities of the sides when first torn asunder were perfectly eliminated, and nothing left but the smooth polish which has been able to resist all exterior action.

That this work has been accomplished by a glacier is corroborated by the condition of the parallel fissure. This is widest at the bottom, and runs out above, where it is also so covered by rock that no glacier could possibly enter it. Hence the sides are as rough as when first torn apart. The same is true in all the neighboring fissures, where glacier action was equally impossible. Again, a moment's inspection of the locality will convince any one that this Fazûr could never have been polished by running water; and there is no other agency known to me, by which the work could have been done, except that of the glacier.

Now, if we have here adequate proof that in some former era in the earth's history this chasm was filled with a glacier, the conclusion is irresistible that, at that time, the greater part, if not the whole of Lebanon down to the sea itself, was buried under enormous accumulations of snow and ice. This Fazûr is in the warm, secluded gorge of the river, and not five hundred feet above the shore, from which it is only about four miles distant. In the present condition of our earth, neither frost nor snow ever invades this spot, and the orange and the taro plant flourish all the year in the open air. Again, if these mountains have been clad in thick-ribbed ice since the cliffs of Fazûr were rent asunder, the geological features and phenomena of Lebanon, as well its natural history and productions, constitute a most interesting and complicated problem, which I recommend

to the savants of science. It has required a vast extent of time, and any number of physical convulsions, to bring the fertile valleys, vine-clad hills, and terraced ridges of Lebanon to their present condition. During those countless ages, the forces of nature have accomplished an amount of excavation, degradation, and abrasion which confounds the imagination.

The polishing of this Fazûr, by whatever agency done, has been accomplished since the surrounding hills and valleys, and even the fissures in the rocks, received their present forms and dimensions. There has been no appreciable deepening even of the river bed since they received their present shape.

I would by no means venture to assert that a searching inquiry by a practised eye would not discover other indications of the action of glaciers in these mountains. But, from the nature of the rock, they will be found only in places protected from the sun, rain, snow, and frost. The gigantic cliffs of Lebanon are continually adding to the enormous accumulations along their bases, by the splitting off of huge masses of rock and rubbish. All marks of glacier action are thus obliterated from the sides, and buried deep by the *talus* at the base. In the same way terminal moraines formed by dissolving glaciers would generally be covered up and disappear. There is also another agency continually operating in this country to obliterate all traces of glaciers. The mysterious cloud-bursts, called by the Arabs *sales*, sweep away everything that opposes their terrific floods. I have often examined the tracks of these *sales*, and stood appalled at the wild havoc made by them. I have seen thousands of tons of rock and rubbish precipitated from the mountains above upon lower levels in an hour, burying large tracts many feet deep in hopeless ruin. And as scarcely a season passes without some part of the mountains being struck by them, they would, in the long lapse of ages since glaciers disappeared from Lebanon, have either washed away or buried up all terminal moraines. So also these *sales* transport such masses of rock to great distances that we cannot safely argue from such examples to prove the agency of glaciers. These, however, are questions and speculations quite too extensive to be discussed here, and I close by recommending to those who may visit this country a closer scrutiny into them than travellers have hitherto attempted.