THE RIVER VALLEYS OF THE HIMALAYAS.

By Mr. R. D. OLDHAM, F.G.S., of the Geological Survey of India.

Addressed to the Society, in the Memorial Hall, Wednesday, December 6th, 1893, at 7-30 p.m.

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IT has become one of the hackneyed paradoxes of the populariser of science, wishing to attract a little cheap astonishment at the cost of a small amount of originality, to maintain the inaccuracy of that old proverbial expression which regards the everlasting hills as a type of changeless antiquity. The design, however, no longer succeeds, for everyone now knows that the mountains, which impress man with their apparently immovable grandeur and changelessness, are in many cases affairs of but yesterday in the life of the globe, and that in the past there have been mighty mountain ranges which have now vanished or dwindled to insignificant hills. It is not, however, my purpose to expatiate on this hackneyed subject, or to justify, as might well be done, the old proverb, but to deal with what are often older than the hills, though not regarded as types of antiquity—the rivers that flow between and through them. Ever changing, at one time a raging torrent, at another a chain of sluggish pools, here cutting away its bank, there heaping up sediment, it can be no wonder that a river should never have been popularly accepted as a type of permanence. But just as man preserves his individuality though the substance of his body is ever being changed, and undergoes several complete renewals in the course of his lifetime, so rivers, though the water that flows in their channels is constantly changing and constantly being renewed, preserve their individuality and, born when the land first rose from the sea, have witnessed the gradual rise of the hills, through which they now flow in the valleys they have carved for themselves.

The antiquity of rivers has not, however, been one of uneventful changelessness; no sooner had different drainage systems been defined than the struggle between them began. Favoured or hindered by circumstances, by accidental differences of amount or distribution of rain, differences in the hardness of the rocks opposed to its attack, and by the manner in which

the gradual upheaval of the land affects the gradient of its bed, one river may invade the territory of another, forcing back the position of the watershed, and in some cases diverting whole tributaries from a rival drainage area to its own.

The study of the processes by which these changes take place, and of the consequences resulting from them, have been much less studied of late years by English geologists than by their rivals on the Continent and in America; yet the subject is one which possesses great interest and, when reduced to its elements, the effects are found to be entirely due to two fundamental principles which, in the ultimate resort, control the actions of a flowing stream. The one is that water will not stand on an uneven surface, but will flow off to the lowest levels, and in doing so will choose that course which is immediately easiest. Hence it comes that the bed of a stream will often make a long detour and return almost to its original position,* because at some previous stage of its history this happened to be the easiest outlet for the water, and having once established itself there is always a tendency to retain the old course, down which there is a continual descending gradient.

This may be called the law of permanence of river courses; the other may be called, but not quite so appropriately, the law of change. It is that—like anything else in nature—a flowing stream is always tending towards a condition of stability, which in this case means a state when it is neither compelled to attack its bed by the velocity to which the slope and shape of the channel impel it, nor is it prevented by the same circumstances from acquiring sufficient velocity to transport its solid burden. Until such a state of equilibrium is attained the stream will attack its bed whenever the velocity is in excess, and the vigour of this attack, and *cæteris paribus* the rate of erosion, will be proportionate to the excess. Now, the velocity of a stream is dependent on the gradient of the channel, and also to a great extent on the volume of the stream. A large stream will be able to acquire a given velocity on a gentler gradient than a small one, an effect which becomes important in the case of the very small streams at the heads of the valleys, and more especially in the rivulets which drain down the valley sides after rain.

A result of this influence, which volume has on the velocity of the current, is that where a stream is flowing at a considerable height above its final base level of equilibrium, we find that it flows in a narrow steep-sided valley, and that as the watershed is reached the slope rapidly increases. As the final condition of equilibrium is neared the deepening of the valley becomes less rapid; weathering and the action of the small rivulets of

* The windings of a river in an alluvial plain are not referred to, these being due to a different cause.

water on the hill side combine to open out and ease the slopes of the valley. But always a steepening of the gradient towards the watershed will be observed, and where this is wanting, it is clear proof that the head of the valley has been cut off, or robbed, by another stream cutting its valley backward.

Such cutting back of the head of the valley has repeatedly been observed and demonstrated, and in this way the whole course of a drainage has before now been altered. Sometimes where a river takes a long detour and returns to near its original position, some tributary stream, favoured by the more rapid gradient of its shorter course, may gradually obliterate the ridge which confines the river to its valley and divert the main current by a short cut down the course of what was once a tributary. More often, however, it will be one drainage area which encroaches on another and diverts part of the upper waters of the one into the channel of the other.

These are the general principles, so well established, so necessary, and supported by so many observations in different parts of the world, that there is no gainsaying them, and the following paper will be an attempt to apply them to the explanation of certain peculiarities shown by the drainage system of the Himalayas.

The maps of the Himalayas may be divided broadly into two classes, those that only show what is more or less known and those which, in addition, exhibit the ideas of the compiler regarding the orography of the unknown portions.

Of the latter, the production of Clements Markham, prefixed to his edition of the travels of Bogle and Manning, is a conspicuous example; three long, well-defined, and continuous ridges are depicted running along the length of the Himalayas in a more or less parallelism with each other. The idea embodied in the maps has a certain foundation in fact; the line of greatest elevation, as marked by the highest peaks, does not coincide with the main watershed between the southern drainage and that which only crosses the range after a longer or shorter course parallel to it. These constitute two of the supposed three ranges; the third runs parallel to and north of the Indus and Sanpo valleys. Here, too, it seems doubtful if there is any defined range, though the ground is of course more elevated than in the valleys of the two great rivers. The fact is that the structure of the Himalayas is a complex one; it cannot be regarded as a simple mountain range, or even as three parallel ranges, rather it is an aggregate of numerous smaller ranges of various sizes and degrees of pronouncedness.

Of the second class of maps a very favourable instance is the large map of India published by the Surveyor General. This, too, is in a way misleading, for all the southern slope of the

mountains, whose topography is more or less known, is fully drawn, while north of this in Thibet there are only a few outlines of rivers and lakes, and faintly sketched in hills, thus giving an appearance of much less relief. To a certain extent this is true. Thibet is a region of broad plains and open valleys, and the mountains, though high, are comparatively small, on account of the altitude of the bottoms of the valleys from which they rise. Still there is certainly not that absence of relief which a casual glance at the map might indicate.

Both classes, however, agree in their delineations of the broad features of the hydrography, for as regards this it is easier to obtain information, and one of the most striking points is the pair of great longitudinal valleys which run along the northern side of the main range, and finally break through it to escape on to the plains of India. In a north-westerly direction the Indus flows for about 600 miles through some of the loftiest mountains of the world till it turns south-westwards; while, not far from its source, the Sanpo river rises and flows at first east, and then east-south-east, till it too turns southwards, breaking through the eastern termination of the Himalayan range, to join and assume the name of, the Brahmaputra. The Sutlej too, rising in the immediate neighbourhood of the source of the Sanpo, flows to the north-west, and then, turning westwards near Shipki, flows by a deep valley through the snowy range to the plains.

But not less remarkable is the equally-known feature that the line of greatest elevation of the Himalayas does not coincide with the watershed between these longitudinal valleys and those of the numerous large rivers which flow more or less directly to the south, and sooner or later mingle their waters with those of the Indus or the Brahmaputra.

The Jehlam, Ravi, and Bias all break through high ranges, though in this terminal portion of the Himalayas there are higher peaks to the north and east of their drainage areas than those of the ridges they break through. Further east, in the median portion of the range, removed from the complications introduced by the junction of the Himalayas, Hindukush, and trans-Indus mountain systems, we find that the line of highest peaks lies to the south of the main watershed, and the rivers all drain, sometimes a larger, sometimes a smaller, area on the north of the line of maximum elevation. This has long been known, and various are the explanations that have been offered of the want of accordance that might be expected to exist between what appears to have been the axis of maximum elevation and what may be called the axis of the drainage system.

The earliest of these, that contained in the paper of General Strachey, written forty years ago,* is that the valleys cor-

* "Quart. Jour. Geol. Soc.," X., 249-253 (1854).

respond with great fissures or fractures, widened out by the rivers which flow through them. Though quite in accordance with the ideas prevailing at the time these papers were written, before the great power of rain and rivers was fully appreciated, the idea of attributing river gorges to fracture has become more or less discredited, as in instance after instance this explanation has been proved to be erroneous, and we may leave this explanation out of the question.

Another explanation that has been offered by von Richthofen* is, that the whole region north of the high peaks was once higher even than they are now, and that the line of greatest elevation originally corresponded with the present watershed; that the drainage system then originated, and that the present elevation of the peaks is due to their greater power of resisting denudation, while the softer rocks to the north were worn down. This explanation has been applied with great success to the explanation of the river valleys through the downs on either side of the Weald in the South of England, and in other places; but however true it is in these cases, there does not seem to be always such marked difference in the hardness of the rocks, composing the high peaks and those of the watershed range, as to account for the observed features, and it is difficult to believe that the highest peaks of the Himalayas were formerly overshadowed by a still higher range to the north.

A more probable explanation is that offered by the talented authors of the first edition of "The Manual of the Geology of India," that the features of the drainage were marked out long before the Himalayas attained anything like their present altitude, and that the rivers were able to maintain their courses transverse to the range by erosion of their beds *pari passu* with its elevation. The principal difficulty here is the comparatively small catchment area of many of the rivers to the north of the snowy range, and this was got over by supposing that they formerly extended further to the north, having been shortened by a gradual encroachment of the longitudinal valleys which, cutting back along the strike of the rocks, were able to divert the drainage into their courses. It must be remembered, however, that the gradients of these rivers, owing to their longer course, are lower than those of the rivers which have a more direct course to the southern margin of the range. This lesser gradient might be compensated by the existence of a zone of rocks much softer than are found to the south, and along part of the Indus valley in Ladakh such a band of soft tertiary rock does exist; but there does not seem to be any reason for supposing that there is such a general predominance of soft rocks along the whole course of the valleys, and it is difficult to see how the

* "Führer für Forschungsreisende," p. 175.

levels of these rivers, where they ultimately cross the axis of the range, could have been kept sufficiently lower than those of the other valleys to enable them to encroach and rob the drainage of the latter.

There is yet another hypothesis—that the original watershed did more or less accord with the line of maximum elevation as marked by the present line of highest peaks, but that the rivers which had a direct course to the plains have in many cases been able to cut back through it owing to their greater gradient. This is the explanation that I would propose; but, before entering into it more fully, it is necessary to sketch briefly what is known of the origin of the Himalayas.

There can be no doubt whatever that there was a time—and that not so very distant, geologically speaking—when the Himalayas were not. It is unnecessary to enter in detail into the grounds on which this conclusion is based, which are many, but the discovery of nummulites in the heart of the Himalayas, at an elevation of 20,000ft. and more, shows that, at the beginning of the tertiary era, the sea flowed where now these mountains stand, and that the very rocks of which they are composed were then only being formed. Yet, though the Himalayas did not exist in anything like their present form at the commencement of the tertiary era, there is ample evidence that, by the time its first half had elapsed, they stood up with much the same limits as at present, and with an elevation comparable—though probably not equal—to what they now have.

On the geological map of India a strip of tertiary rocks will be seen running along the outer or southern margin of the Himalayas, from one end to the other. To the north-west, where this strip expands in width, the lowest beds are of marine origin and nummulitic age; elsewhere these rocks are wanting, and only the miocene and pliocene periods are represented by beds of fresh-water and sub-aerial origin. The lower half, or thereabouts, of this fresh-water formation, known generally as the Siwalik series or system, consists of clays and fine grained standstones, probably formed sub-aerially by the action of flowing streams. In this lower portion of the Siwalik series no conglomerates, and not even a trace of a pebble, are known with certainty as yet; and even if subsequent, more detailed, researches should detect some occasional occurrences of coarser grained deposits, it will remain true that the general lithological type of the group is fine grained sandstone alternating with clay.

In the upper group we find a different state of affairs. Here, too, the lower beds are for the most part composed of sand with small pebbles; but, where the larger rivers debouch from the inner hills, these sands pass upwards into a great thickness of coarse conglomerates, composed of well-rounded fragments of

hard quartzites and other crystalline or metamorphic rocks, whose shape and composition show that they have travelled a long journey down a rapid stream from the interior of the Himalayan Mountains. In the intermediate stretches, away from the present positions of the rivers, where the streams now only reach a short distance into the outer hills, these coarse conglomerates of large and well-rounded crystalline rocks are replaced by clays, sands, and conglomerate beds, in which the fragments are imperfectly rounded and composed of such *debris* as is still being brought down by the local streams from the outer hills of the main mass of the Himalayas.

The particulars on which these general statements are based need not be detailed here, as they are given at length in the "Manual of the Geology of India" and in various other publications of the Indian Geological Survey.* The facts are well established and generally recognised, and from them we may conclude that at the commencement of the tertiary era the Himalayas did not exist in anything like their present form or proportions; that during the first half they grew in elevation, and that at the period when the conglomerates of the upper Siwalik series were being deposited and the great Siwalik fauna still lived—a time which is now regarded as corresponding to the pliocene period of European geology—the Himalayas existed as a mountain range with the main features of its hydrography already marked out. The drainage of the interior of the hills was even then carried off by the same great rivers, which issued at the same places as now; and these rivers were rapid torrents capable of carrying along large boulders, whose hardness and well-rounded forms speak for the distance they have travelled, and the wear they have undergone. The great thickness and coarse texture of these conglomerates argue a rapidity of current in the rivers which necessitates their having drained from lofty mountains; but we can derive no direct evidence from the conglomerates as to whether they were loftier or less lofty than at the present day. So, too, though we can fix the points at which the rivers left the hills, we can draw no conclusions as to the exact position of the watershed from these conglomerates alone, and if we would determine whether any or, if any, what changes have taken place in its position, we must take into consideration another line of argument, based on those fundamental principles which were referred to in the early part of this paper.

The question, then, is whether the longitudinal valleys of the Sutlej and the Sanpo have cut back their head waters and robbed the drainage areas of the transverse river valleys, or

* See in particular, H. B. Medlicott, "Memoirs Geol. Surv. Ind," III., pt. ii, 1-206 (1864). "Records Geol. Surv., Ind.," IX., 49-57, (1876). Also "Manual of the Geology of India," 1st Ed. 1879). 2nd Ed., pp. 468-470 (1893).

whether it is these transverse rivers which have given a more direct outlet to a portion of the drainage, which once flowed by a more circuitous route to the alluvial plains of the Indo-Gangetic rivers.

No observations have been made near the head waters of the two drainage systems with a view to settling the question. Such geologists as have visited the passes appear to have confined their attention to the solid geology, while the accounts of non-scientific travellers are too indefinite to yield any decisive facts, and in the whole range of the literature I have been able to find but one specific observation pointing to a change in the position of the watershed. According to General Strachey,* the sub-recent gravels of the upper Sutlej valley extend right up to the crest of the Niti Pass, and a detached portion is to be found some two miles south of the watershed. That these deposits should extend right up to the crest of the pass is in itself proof that the valley, down which they must have come, formerly extended south of the present watershed, and the detached portion of the gravels only gives a superfluous corroboration of the conclusion that there has been a northward recession of the divide, and a robbing of the Sutlej drainage by the Dhauli river.

From this we see that, in one case at least, there has been a movement of the divide towards the north, and apart from it the general features of the surface contour, north and south of the main watershed, point to the same conclusion. The approach to the passes from the south is in every case by deep cut valleys, on either side of which the mountains rise steeply for several thousand feet, and finally there is a long and steep ascent to the actual crest. On the northern side the descent is much less, and there may even be no perceptible descent at all, but the traveller arrives at once into a gently sloping river valley, whose size and gradient show that it must once have been occupied by a much larger body of water than the puny stream which now flows in it.

The best known, and probably the most conspicuous, instance of this is the Zoji La, on the road from Cashmere to Leh, separating the drainage area of Jhelum from that of the Indus. The ascent from the Sind valley on the south is steep and rapid, by a valley so deep cut and narrow that it is blocked by snow throughout the winter and well on into the summer, long after the crest of the pass is free. From the head of this ascent there opens out a valley, partially filled by talus fans and rain-wash from its sides, along which the road runs on what seems to be a level, and the first indication that the watershed has been passed is the appearance of a small stream flowing northwards. Here

* Journal of the Royal Geographical Society, xxi., 63 (1851).

the whole of the steeper slope at the head of the valley has been cut off by the gradual encroachment of the Sind river. I do not know that it is possible now to determine where the divide originally lay, but a considerable area, whose rainfall once fed the Indus, now drains into the Sind, thereby increasing the power of its attack on the divide, and diminishing that of the Gamber to deepen its channel and so resist this encroachment.

In the passes north of Kumaon and Garhwal the same thing may be observed. South of the divide there are deep cut valleys and gorges, with steep or precipitous slopes at their heads. North of the divide the valleys, on the contrary, have gentler slopes, are wider and more open, and generally show signs of

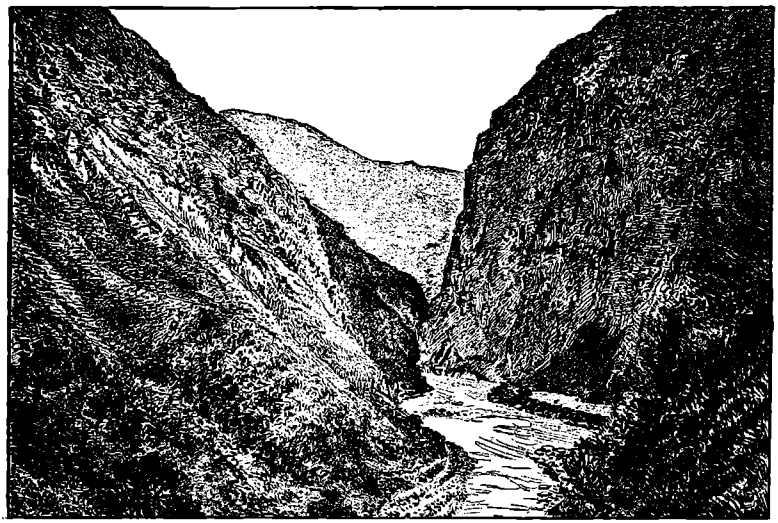

FIG. 1.—BIAS VALLEY NEAR LARJI KULU.
(From a photograph by Bourne and Shepherd.)

having been made by larger streams than now occupy them. The views that I throw on the screen of the scenery south of the passes are sufficient proof of the accuracy of my statements regarding the nature of the valleys, while the reproduction in Fig. 2 of the admirable sketch of my colleague, Mr. C. L. Griesbach, shows the great change of general features met with as soon as the passes are crossed. Moreover, the admirable maps of northern Kumaon, published by the Trigonometrical Survey of India, have enabled me to construct sections across some of the passes which show most strikingly the difference between the gradients on the northern and southern sides of the divide. This is very conspicuous in what may be called the Chitichun group of

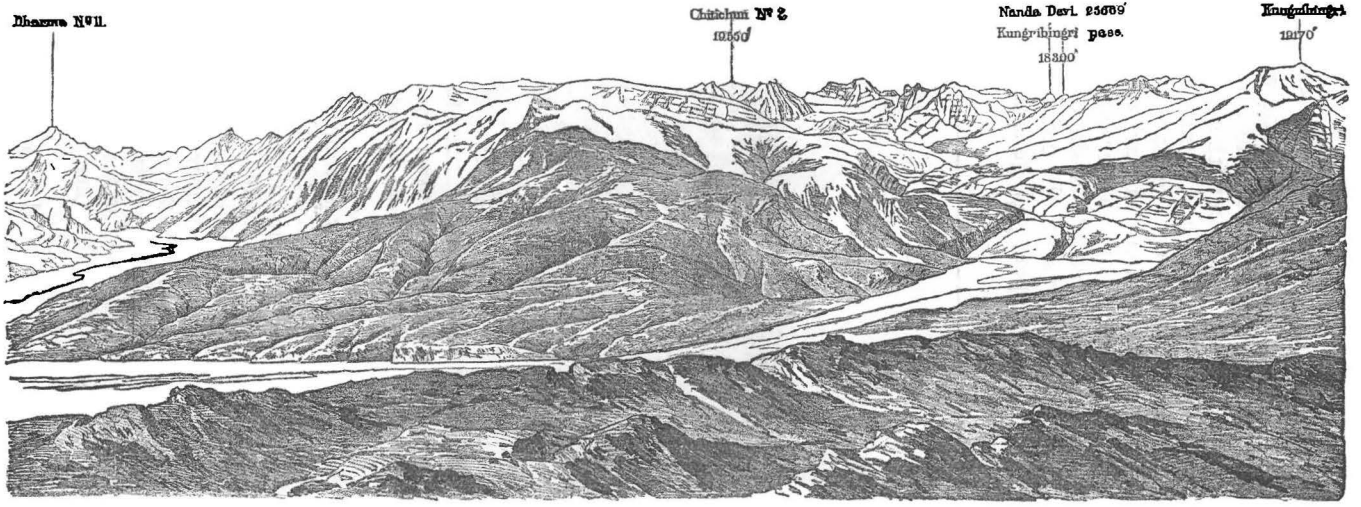

FIG. 2.—PROFILE OF THE KUNGRIBINGRI AND DHARMA PASSES FROM CHITICHUN No. 1 PEAK. After C. L Griesbach. *Records Geological Surv. Ind.*, XXVI., pt. 1 (1893).

passes. In figure 3 I have combined the sections on three passes at the head of the Kiogadh, in each case the section starts and ends at the same point, and the actual horizontal distance is so nearly the identical that no appreciable error is introduced by making it the same, as has been done for convenience. The great steepness on the southern face is very conspicuous, and the diagrammatic indication of the heights of the mountains bounding the valley shows clearly how the watershed does not coincide with the line of greatest elevation. Here there is obviously a much more active erosion going on on the south than on the north, and the original position of the divide probably lay ten miles to the south of the present. This Chitichun group of passes may be regarded as a typical one, where all the features generally recognisable are exceptionally emphasized; but in a lesser degree they may be recognised everywhere, and the section be regarded as a somewhat exaggerated or diagramatic form of the normal or average nature of the section across the Kumaon passes.

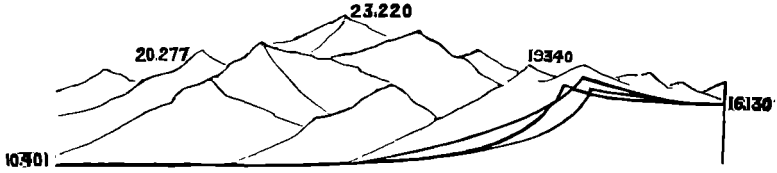

FIG. 3.—SECTIONS ACROSS THE CHITICHUN AND OTHER PASSES AT THE HEAD OF THE KIOGUDH IN KUMAON.

Horizontal scale 8 miles = 1 inch. Vertical scale = horizontal × 2½.

Everywhere the greater steepness on the south is very noticeable, and from it we may conclude that a recession of the watershed, which is geologically speaking rapid, is in progress. In the geologically recent past this must have been even more rapid, for not only does every increase in the length of the southward flowing streams diminish their gradient, and so lessen their power of erosion, but it seems probable that the latest stage in the history of the northerly flowing streams has witnessed some increase in their power of erosion and of resistance to the recession of the divide.

The upper Sutlej valley is occupied by a great accumulation of sub-recent deposits which have been cut into by river gorges to a depth of some 2,000ft. Whether these deposits are mainly lacustrine or alluvial is as yet unknown, but, however this may be, it must be obvious that while they were still intact the gradient of the northward flowing streams must have been less than is now the case, when they find their outlet into the Sutlej at a depth of 2,000ft. below the old surface, and it may be that the increase of gradient so obtained has been sufficient to enable

the streams to erode the upper portions of their channels and to assist the passive resistance of the mountains themselves to a change in the position of the watershed.

The whole range of the Himalayas east of Kumaon is not only unexplored, but inaccessible, except in Sikkim; we may, however, conclude that the features so universally seen in the accessible portion of the range are not confined to it, but that everywhere there has been in the past, and is still in the present, an encroachment of the southern on the northern drainage area.

The question then naturally arises, of where was the original position of the watershed, and the equally natural answer is that it may be looked for in that region, which the altitudes of the peaks and the antiquity of the rocks alike indicate as the one in which the elevatory forces reached their maximum intensity. It is probable that along this line the future mountain range first began to rise, and that in the earlier stages the streams flowed off north and south from a central divide. The northern drainage collected in rivers, which ultimately flowed across what subsequently became the mountain system of the Himalayas; and these rivers, owing to the size and power they possessed, in virtue of their extensive catchment area, were able to maintain their course through the rising mountains, by cutting away the barrier as it gradually rose across their channels.

The struggle, however, was not without its vicissitudes; at times and in places the elevation was more rapid than the rivers could altogether master, and extensive alluvial deposits or even lakes have been formed. In the latter stages of the struggle movements of elevation have probably been more rapid than at first, and the rivers have been put at a further disadvantage by a cause which has not yet been referred to.

While the Himalayas had still but a moderate elevation there is no reason to suppose that there was any marked difference between the rainfall on the northern and the southern slopes, but as the crest of the range rose, a larger and larger proportion of the moisture was cut off, till at the present day nearly the whole of the summer rainfall is taken by the southern slopes. In this way the power of the streams flowing directly southwards has been much increased at the expense of those which drain the northern slopes. The effect of this has been most marked. Over the greater part of Thibet the rivers have been completely mastered, and are no longer able to maintain their course to the sea. The Indus river has lost one long and important branch which formerly flowed from east of Rudok down the valley now occupied by the Pangong lakes to join the Shyok river, while in the main valley the extensive spreads of alluvial, and frequent occurrence of lacustrine, deposits show clearly enough how its gradient has been checked by a rising of

the river bed, which could not be immediately met and conquered by the erosive power of the stream.

In the Sutlej valley there is an especially striking instance of the struggle that has gone on between the forces which have uplifted the range on the one hand, and those which have cut out the valleys on the other. Here the former had for a long time the mastery, and the whole of the upper Sutlej valley in Hundes is now occupied by the great accumulation of sub-recent deposits, reaching a thickness of 2,000ft., which has already been referred to. At a later period the river again acquired a mastery, and cutting down its gorge through the Himalayas has been able to re-excavate the deposits of an earlier date.

We find, then, ample indications of the difficulty that the Sutlej and the Indus have had in preserving their course across the Himalayan range, and though we have no detailed information regarding the other rivers further east, which similarly collect the drainage of the northern slopes and carry it through the range, it is natural to suppose that the conditions are much the same. The opposition which the rivers have met with in maintaining their course across the range has rendered it impossible for them to encroach on the southern drainage, and we may conclude that there has nowhere been a cutting off of the head waters of streams which once flowed from the north across the range, by a growth of the longitudinal valleys running parallel to the range north of the zone of highest peaks; on the other hand, whatever shifting of the watershed there may have been was in a northerly direction, and where one river has captured part of the drainage of another, it is the one which flows directly southward which has encroached upon the one which gathers the drainage of the northern slopes, before breaking through the range. This robbery has been due to the decreasing power of the northern drainage, owing to the lesser average gradient of the stream-beds and the diminished water supply; while not only did the gradient of those streams whose course is more directly to the south increase in greater ratio as the mountain range grew in height, but the volume of water flowing in them increased as a larger and larger proportion of moisture was extracted from the monsoon winds by the rising mountain range.

But though this explanation holds good in many cases where there is a comparatively small catchment area up stream of the gaps through the line of highest peaks, it can hardly apply in the case of those rivers which drain large areas in the high lands to the north.

The Indus and the Sanpo or Brahmaputra, each of which runs parallel to the range for half its length,* before turning to cross

* It is probable that the original form of their drainage area was less peculiar than the existing one; doubtless both had several large tributaries flowing from the north, which have been cut off by the drying up of the country—or may exist but have not been explored.

it on their way to the plains of India, are doubtless instances of what is known as antecedent drainage—that is, the rivers are older than the mountain range; so, too, the Sutlej, Gogra, Kosi, and the Subansiri, which have large catchment areas north of the line of highest peaks, are probably older than the range, and have been powerful enough to maintain their courses across it. But the numerous cases, similar to those which have been specifically referred to, where the catchment area is not sufficiently large to allow of this explanation, seem to be due to the cutting back of the heads of the valleys by the more vigorous erosive action of the streams that occupy them.

I cannot leave this subject without pointing out how similar are the features presented by the Himalayan to those, on a smaller scale, by the Alpine passes. The features of the Zoji La are repeated in the Maloya Pass at the head of the Inn valley; in both cases the pass is the lowest in the range, and this lowness is due to the complete obliteration of the steeper slopes at the head of the northern drainage. The other passes show the same contrast between the southern and the northern slopes as the Himalayan ones, and the explanation is the same—a more rapid erosion of the southern valleys owing to the greater gradient and heavier rainfall; and finally, to this recession of the heads of the southern valleys is due the fact that the highest peaks are not found along the line of the watershed, but frequently on spurs projecting from it into the southern drainage area.

The conditions in the two regions are in many ways very similar, but the features are developed on a much grander scale in the Himalayas; and now that mountaineering in the Himalayas is growing in popularity, we may hope that some of those who devote themselves to the pursuit may be induced to pay a little attention to the very interesting subject I have attempted to deal with, and to fill up the gaps in the present state of our knowledge with those accurate observations, on which a satisfactory theory can alone be founded.

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