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GLACIAL PHENOMENA ON THE YUN-NAN–TIBET FRONTIER.

F. Kingdon Ward, B.A.

Read at the Afternoon Meeting of the Society, 16 *March* 1916.

IN the following paper I shall endeavour to show that the ice is retreating progressively from east to west on the parallel ranges separating the southward-flowing rivers Yang-tze, Mekong, and Salween, on the Yun-nan–Tibet frontier, and that glaciation was once much more extensive on the easternmost of the ranges than it is at present; furthermore that this retreat is due, not to the rhythm of glacial and interglacial epochs, but to a diminution of rainfall, either regional or local.

Our first journeys then will be on the Mekong–Yang-tze divide, that is the parallel range separating the Mekong from the Yang-tze where those rivers flow due south close to one another. The range is very narrow, and from a commanding position to the west one can easily look right over it across the gorge of the Yang-tze beyond, and to the mountains beyond that again. South of latitude 28° the range is of moderate elevation, but about latitude 28°, longitude 99° occurs a nucleus of snowy peaks known as Pei-ma Shan in Chinese, the highest of which is probably between 19,000 and 20,000 feet. From the Mekong valley itself this group is invisible, but from the next range to the west (the Mekong–Salween divide) or from the road which connects the Mekong and Yang-tze valleys, passing east of the snowy peaks, it can be viewed in its entirety.

Viewed from the east the glaciers on what seems to be the highest peak are well seen, and are evidently shrunken glaciers, the biggest no longer reaching the valley it once occupied but clinging amœba-fashion to the mountain side and sending icy pseudopodia creeping down the cliffs. The surface is crevassed in a peculiar criss-cross fashion, as I saw through the glasses, but I did not actually reach the glacier (Fig. 1). Immediately below the peak at an altitude of about 15,000 feet is a flat grassy valley filled with glacier mud, which leads up to the pass on the extreme right of the figure over vast piles of angular boulders; and on either side of it open "hanging" valleys, one of which is seen in the foreground. At the head of this "hanging" valley nestles a tiny turquoise lake, and there is a second lake in the main valley below the small glacier on the right, from which the water pours in a cascade between stone portals and over the boulders into the valley below, where meandering through the meadow it soon reaches the fir trees and disappears in the forest.

Just above this lake is a broad flat sandy plain surrounded on three sides by steep mounds of large angular boulders, across which several small streams flow to the lake; the flat itself appears to be a silted-up basin.

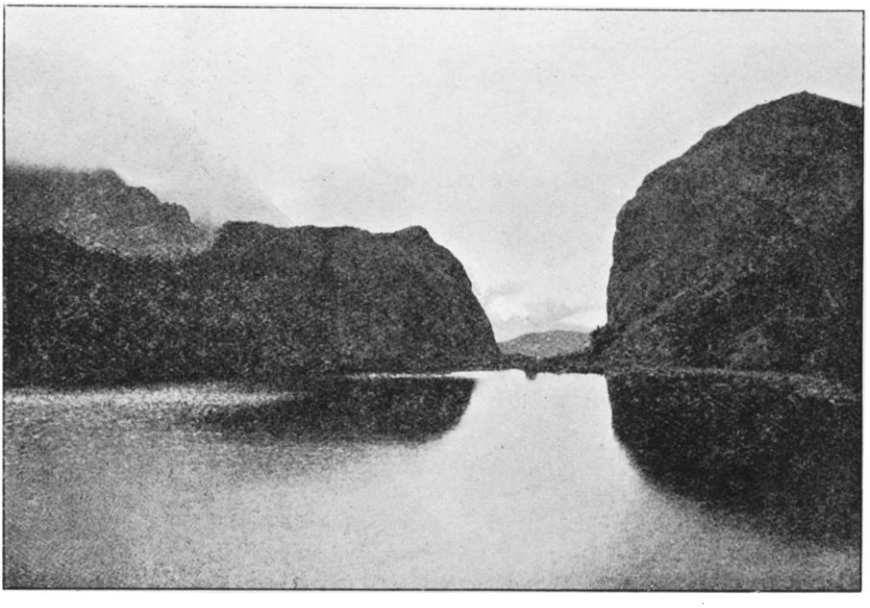
Climbing over the boulders, some of very large size, we found ourselves

on the small glacier which sweeps down from the high peak on the left, and has thrown a moraine (seen on the right) across the valley; the glacier, however, no longer reaches the moraine, which stretches down the valley as far as the little lake. It was here only a few score yards broad and at its termination almost concealed by rubbish. Keeping as close to the lateral moraine as possible, where there were few crevasses, we crossed it, and a sharp climb over confused piles of big boulders brought us to the pass at 17,000 feet.

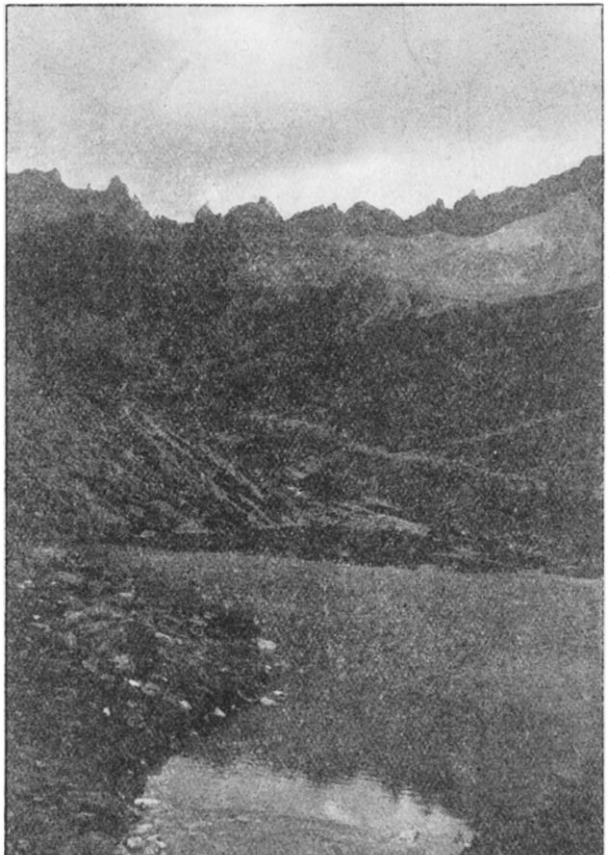
The descent on the west side was different, for there was no glacier in the valley nor even visible on the mountain above. We descended over the same confusion of boulders, amongst which we came upon small flat pockets of sand enclosed by steep slopes and shallow gullies dividing the boulders into vast mounds, till finally the valley fell away abruptly beneath us, and we were compelled to leave it and traverse along the side of the spur.

Northwards of the Pei-ma Shan snowy group these features continually

1. PEI-MA SHAN, FROM RIDGE TO THE NORTH, ABOUT 17,000 feet. THE PASS IS SEEN ON THE RIGHT.



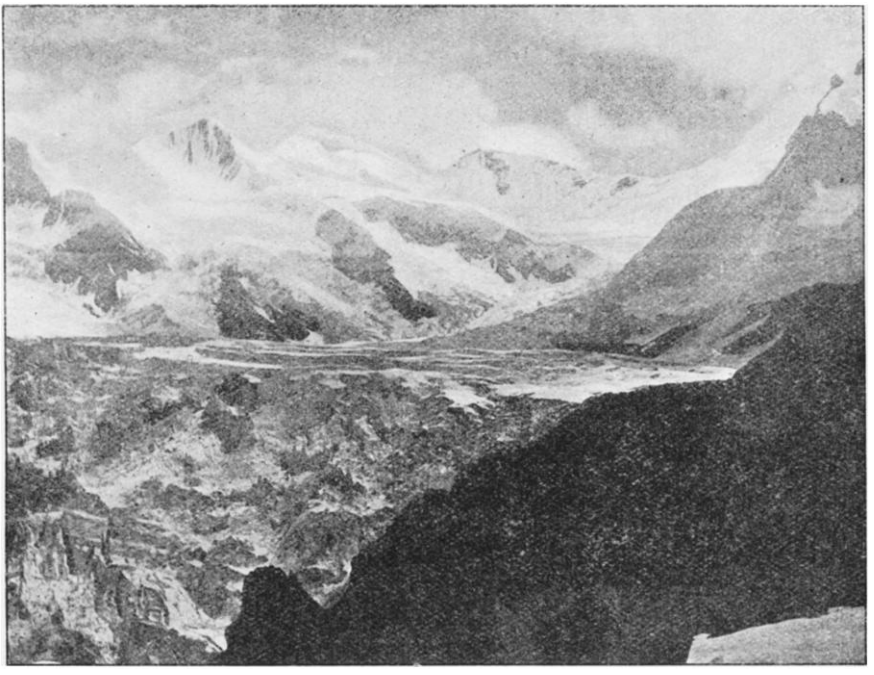
2. ROCK-BASIN ON THE MEKONG—YANG-TZE DIVIDE, 16,000 feet, LOOKING DOWN VALLEY. THE STREAM FROM THE LAKE FLOWS THROUGH THE GAP IN THE BASIN.



3. CREST OF THE MEKONG—YANG-TZE DIVIDE, WITH THE RUN-TSI LA (17,900 feet) TO THE LEFT. GLACIATED VALLEY WITH LAKE IN FOREGROUND.

4. ICE CATARACT AND NORTHERN PRECIPICE KA-GUR-PU GLACIER.

5. KA-GUR-PU GLACIER FROM CAMP AT 15,000 feet. NORTHERNMOST PEAK OF KA-GUR-PU RANGE.



6. KA-GUR-PU GLACIER AND SNOWFIELDS ABOVE THE ICEFALL, FROM THE HIGHEST POINT REACHED ON THE RIDGE, ABOUT 16,000 feet.

7. DOKER LA VALLEY, MEKONG—SALWEEN DIVIDE, 15,000 feet, LOOKING UP VALLEY. GRANITE WALL FROM BELOW CUT THROUGH BY STREAM FROM GLACIER.

reappear, though there are no more glaciers south of Adong (see sketch-map) and then only remnants. The side valleys, divided from one another by sharp ridges, the flanks of which present steep screes, always overhang the main valleys, and rise by a series of long steps—tread and riser—to the crest of the divide, the well-defined cirques being piled with great mounds of angular rock fragments. At the foot of the cirques and on the successive flats of the upper valleys are small lakes or pools, but these are not infrequently silted up. Some of them, such as that shown in Fig. 2, are of considerable depth, shelving rapidly. A peculiar feature about the uppermost of these lakelets is that they generally occur at the summit of a cliff which has been cut through, so that the stream at its exit from the lake is flanked by portals and then tumbles over boulders into the valley below (see Fig. 2 and compare Fig. 7). These scarped valleys are characteristic of this region; we shall find other instances when we come to the Mekong–Salween divide. Such breaches in the wall were—probably at least—started by the glacier, for it does not appear that the stream starting from rest in the lake would possess much erosive power.

In one side valley above Atun-tzu I found a very well preserved lateral moraine flanked on one side by boulders. Below in the main valley was a gigantic pile of big boulders shelving steeply down to a triangular lake; above, the moraine ended at the usual sandy flat—a silted-up lakelet, enclosed on two sides by gravel screes. Just above was the pass.

Roches moutonnées were conspicuous in the main valley at one point, and the valley also shows a typical **U**-shape without spurs in section. Besides the scarp shown in Fig. 2 this valley is again broken across by a cliff just above the village of Atun-tzu; over this cliff the stream pours, but there is no definite evidence that the glacier ever reached the village below. Supposing, however, that it reached the top of the cliff, as it must have done—for there is a lake occupying a valley below and to the north which has been ponded back by a moraine from this glacier—it must have been at least 5 miles in length.

Two other phenomena frequently noted on this range are (1) a peculiar tesselated arrangement of the stones, laid down like tiles in the level parts of the upper valleys, over which the stream, surrounded by boulder slopes, spreads out; (2) the frequency with which towers and pinnacles, generally of limestone, rise abruptly from the screes of gravel and earth crowning the highest spurs of the main divide. Frequently these wall-sided sharp-edged limestone rocks are of a most fantastic and striking form, and their isolation on the ridge of a gravel scree commands immediate attention.

We will now leave the Mekong–Yang-tze divide and investigate the snowy range of Ka-gur-pu on the Mekong–Salween divide to the west. Standing on the Mekong–Yang-tze divide and looking west we see the Ka-gur-pu range in its entirety, and are at once struck by two things: (1) The much greater amount of snow, and the consequent greater length of the glaciers which seem to come right down into the Mekong valley

after a very steep descent; (2) The different appearance of the peaks compared with those, snow clad and otherwise, on the Mekong–Yang-tze divide; for whereas the latter are mostly square-faced towers and buttresses, with abrupt **V**-shaped depressions between them so as to give a saw-edged outline against the sky (see Fig. 3), the former are all rounded or needle-pointed pyramids separated by more gently inclined **U**-shaped depressions. This latter difference may be ascribed partly to the difference of rainfall on the two divides, whereby the most westerly shows the curve of water-erosion while the Mekong–Yang-tze divide has for a long time been fashioned largely by dry denuding agents, particularly the action of a great range of temperature, both daily and seasonal; and partly to the effect of the different composition of the rocks themselves, the Mekong–Yang-tze divide being capped largely by limestone (though Pei-ma Shan itself is igneous), the Mekong–Salween divide by granite and metamorphosed igneous rock. Fig. 5 shows the northernmost peak of the Ka-gur-pu massif, and Fig. 3 the crest of the Mekong - Yang-tze divide and the Run-tsi La. When we come to examine the glaciers closer we find that they all, at least on the eastern flank, flow in deep gorges, and that they are all broken at one point by an icefall (see Fig. 4). Thus there is little room for lateral moraines (see Fig. 5) which often do not exist, and it may be necessary to fall back on other evidence as to whether the ice once filled the gorge to a higher level or not; also, if it did so, whether its subsidence is due to an actual diminution of the ice or to a continuous ploughing out of its bed.

But below the lowest glacier there existed unmistakable evidence of the previous extension of the ice. The snout of the glacier itself sloped gradually down in a long pointed tongue marked by a few lateral crevasses pointing down-stream. Here the surface of the glacier was smooth and undulating, convex from side to side, sloping gradually down from above, and presented no difficulties. There was very little moraine stuff on its surface but sections near the snout presented a curious honey-comb structure, the walls between the pit-marks being defined by dirt lines. Not far above the snout the cliff, seen on the right in Fig. 4, rises sheer from the glacier and is traversed at some height above the glacier by a path. The smooth undulating surface at the snout does not extend far up the valley; big longitudinal crevasses soon appear, and the sound of stones falling into the chasms both from the cliff on the right and from the surface of the ice, mingled with the splash of water, is continually heard. A little higher up we find a stormy sea of ice at the foot of the fall. The sound of the séracs falling over this precipice from above in the silence of the night is most awesome. During the winter a regular army of ice pillars seem to rise up and crowd to the brink of the precipice, and towards the end of June they begin to fall, so that by the end of August the ice cataract presents quite a different appearance, the dirtier surface ice being streaked and powdered with the frozen spume of the shattered séracs which leave long trails in their wake.

It is to be noted in Fig. 4 that the north flank of the gorge, *i.e.* the side facing south, is a more or less sheer precipice, while the north-facing side is less steep. But this is not always the case for in Fig. 5 it is just the reverse. All the streams flowing to the glacier (Fig. 4) from the precipice side leap 100 feet or more over the cliff—that is, the valleys are "hanging" valleys just as they are on the Mekong–Yang-tze divide. On the other less precipitous side, facing north and therefore less exposed to sunshine, these "hanging" valleys may be seen in process of formation as the ice-level drops.

At this present time the glacier ends at an altitude of roughly 9000 feet above sea-level (by aneroid). In the valley below the icefoot are great mounds of stones, some of them scratched, which have been spread out by the streams, and lower down the valley terraces have been cut out of the rubble. From the glacier foot to the Mekong is a distance of about 2 miles as the torrent flows, and whether the glacier ever reached the Mekong or not and actually flowed in that gorge is an interesting question; but there can be no doubt that it once reached at least a mile further down the valley and that it is still retreating.

I have already said that the cliff seen on the right in Fig. 4 begins a little above the glacier snout. From the end of this cliff, and stretching down the glacier valley for half a mile beyond the snout is a lateral moraine, its summit and far side covered with trees, while the flank facing the glazier is almost bare below or dotted with plants trying to establish themselves. The summit of the moraine is 350 feet above the glacier-level and shows a sort of step structure, as though there had been periodic fluctuations in the retreat of the ice. The lower step is not very clearly defined and may be due to local causes, but the upper one is conspicuous and marks the lower limit of trees on the moraine, including *Ailanthus*, willow, poplar, maple, oak, *Hippophæ*, etc. This part of the moraine is composed of big boulders, while below the step or ledge the material is finer—gravel with small scratched stones. Here small bushes of *Hippophæ*, with species of *Rubus*, *Senecio*, and one or two grasses were noted.

This very well preserved moraine extends, as I have said, about half a mile beyond the present icefoot, after which come terraces and cliffs of gravel; but there are rocks below this which have been smoothed and scored by the ice, as well as marks on the cliff where the path is now cut above the moraine which must be due to the same agency. When I asked the Tibetans if the ice had not retreated they said that forty or fifty years ago it extended further down the valley.

Across the valley, on the north-facing flank, are indications of a subsidence in the ice-level, a bare wall of rock or earth not yet occupied by plants intervening between the ice and the forest above. This is all there is in the way of a lateral moraine, most of the rubbish which falls from the cliffs on either side being engulfed in the longitudinal crevasses,

or in the chasm between the ice and the containing wall (see Fig. 5 in text).

One more point in connection with this glacier. At an altitude of about 10,000 feet we came upon an open more or less level bay in the cliff, and here, on the very brink of the precipice, was another portion of moraine, also covered with trees. Though not more than 50 yards long, its extraordinary position on the edge of the cliff 150 or 200 feet above the glacier made it a very conspicuous object. It was wedged in between two lengths of vertical cliff, much as the short stretch of moraine

SECTION ACROSS GLACIER FOOT, KA-GUR-PU.

(MEKONG-SALWEEN DIVIDE.)

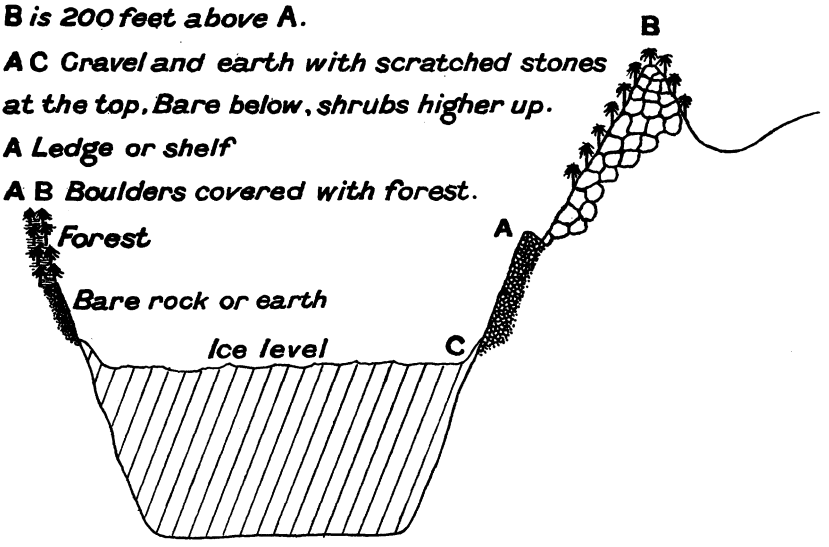
The section is not drawn to scale and the slopes are exaggerated.

A B C Ancient moraine, A is 150 feet above the ice level at C and B is 200 feet above A.

A C Gravel and earth with scratched stones at the top. Bare below, shrubs higher up.

A Ledge or shelf

A B Boulders covered with forest.



seen in Fig. 5 is, only instead of being down by the ice it was a long way above it.

This settles the question of whether the ice-level in the gorge has subsided owing to a diminution in volume or to the ploughing out of its bed. We have seen that the ice-level must have sunk between 200 and 300 feet in the gorge, for the summit of the moraine previously described is 300 feet above the glacier. But this moraine also extends half a mile down the valley beyond the present icefoot, and there are smoothed and scratched rocks half a mile beyond that. Evidently, then, the glacier itself has shrunk and it has all the appearance of a glacier in retreat.

Coming now to the glacier shown in Fig. 5. The foot of this glacier was inaccessible, but from the ridge whence the photograph was taken I

reached the moraine seen on the right. It is only a few hundred yards in length and of inconsiderable height. The ice no longer reaches it and a second moraine is being formed below.

The precipitous part of the ice-fall is well shown in the left-hand corner of the photograph, where two exposures of rock in the bed of the glacier are shown, though the whole visible length is steep. This glacier is not so long as the one previously described and ends about 10,000 feet above sea-level.

Fig. 6 is a view of the same glacier just above the beginning of the fall, taken from further up the ridge. Long transverse crevasses begin to appear as the ice approaches the brink.

We will now go to the other end of the Ka-gur-pu group and examine a valley from which the ice has retreated much further. Here at the southern end of the range is a valley—the Doker La valley, which instead of running steeply down from the crest of the watershed at right angles to the Mekong gorge, has been cut for some distance more or less parallel to the latter and to the divide itself before breaking through it at right angles.

Near what at first sight appears to be the head of the valley it opens out from a narrow gorge through which the stream tumbles and roars over large boulders to a comparatively broad meadow where the now divided stream rattles over a sandy bed. In this meadow are three colossal blocks of stone possibly not inferior in size to the olivine boulder above the Mattmark Lake in the Saas valley. Two of them are of granite and might possibly have fallen from the granite cliffs immediately above, though this is very unlikely. The third, an older block than the others—for its angular corners are worn smooth by weathering and it is completely overgrown with vegetation instead of only its summit being covered—is not of granite, and cannot therefore have fallen from the cliffs above; indeed, it cannot have been carried down the valley for less than a mile, which was as far as I explored in that direction, finding it hemmed in by granite cliffs thus far. Above this meadow over which hangs the lateral valley leading to the pass (Doker La), the main valley again narrows down and apparently comes to an end about a mile beyond in a granite wall (see Fig. 7) just below which is another enormous granite boulder. Over this granite wall a stream pours from the valley above, a continuation of the main valley, at the head of which is a small glacier, the southernmost glacier of the Ka-gur-pu range. But the stream has also cut through the cliff, as seen on the right of Fig. 7, and at the top of the cliff one might expect to find a small lake, only it is as a matter of fact silted up.

Looking down valley from this cliff (which I surmounted by means of the gulley on the right) to the meadow we see a broadly **U**-shaped valley walled in by sheer granite precipices, slit in turn by narrow gullies and dotted with these enormous boulders. The meadow is a sandy plain, another silted-up lake, and it is evident that the glacier the snout of

which at present reaches to within about a quarter of a mile of the cliff, once stretched down beyond the meadow; it has in fact retreated a couple of miles.

To what height it may have filled the valley we have the height of the cliff and also the height of the "hanging" valley above the meadow to show, presuming that the ice was once level with the floor of the latter valley; there are also visible on the granite precipices in some places deeply scored marks which may have been caused by ice-action. The height of the granite wall in Fig. 7 is about 400 feet, and the height of the "hanging" valley above the meadow is not less than twice that amount; and since it is evident that this valley presents very much the appearance that would be presented by the valley in Fig. 3 were the ice to disappear, we may fairly conjecture that the ice in the Doker La valley was not less than 200 feet deep, a depth which would barely cover the precipice. Some allowance must be made for the subsequent erosion of the valley by water after the retreat of the ice, and perhaps the ice never filled the lower part of the valley to a height level with the top of the wall; but we have already referred to a moraine 350 feet above the present ice-level, so that 200 feet in this case is likely to be a conservative estimate.

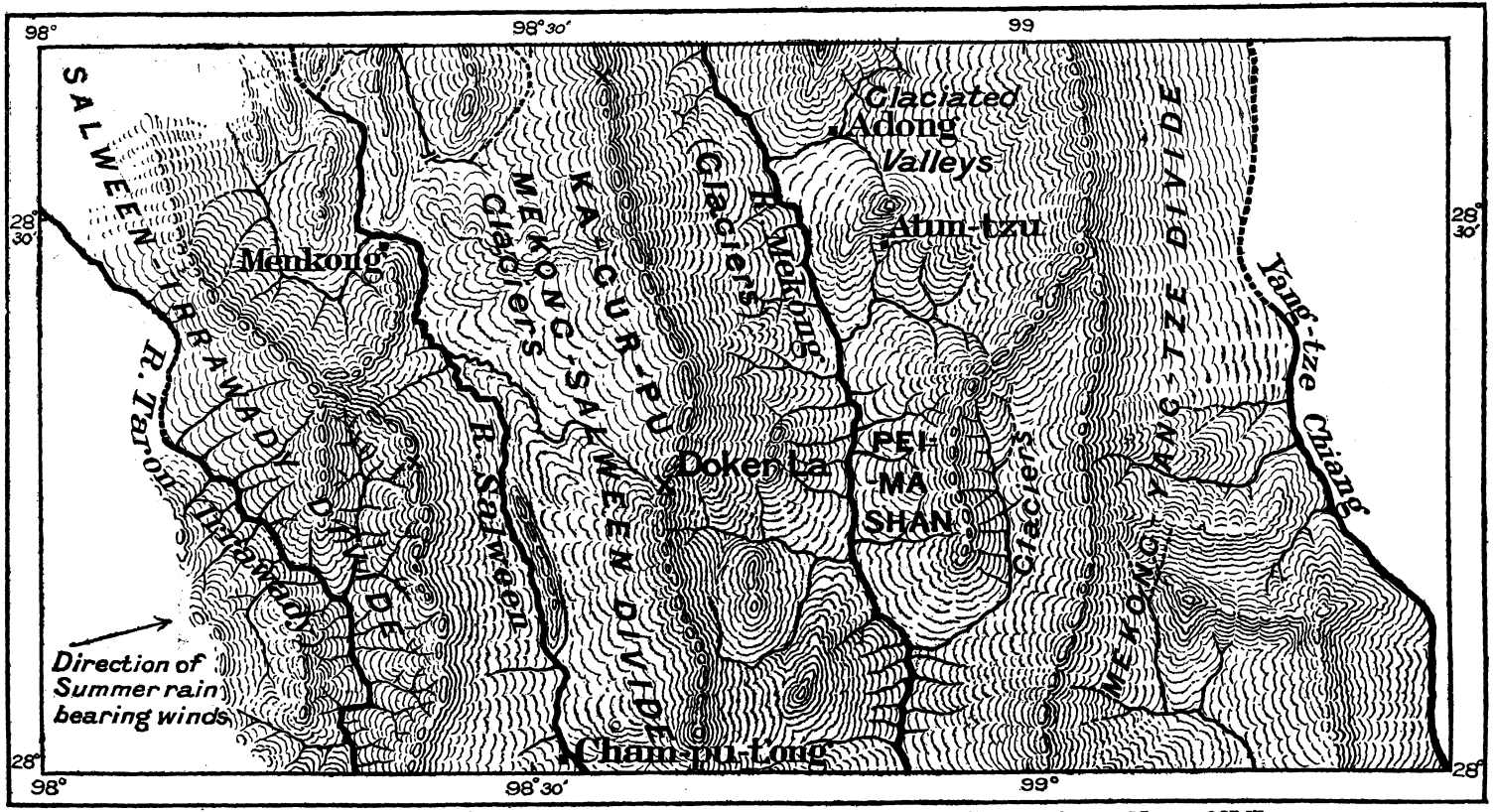
Comparing Fig. 7 with Fig. 2 it is to be noted that we have exactly the same structure on both divides, namely the valley broken by a cliff which has been cut through. We see the same thing again in Figs. 4 and 5, the cliffs in these cases being under ice. Fig. 2, of course, is taken from above and shows the rock basin filled with water; from below it looks exactly like Fig. 7 except that the water nowhere pours over the cliff, though as the lake gets gradually silted up it will no doubt do so in the future.

How these broken valleys were formed in the first instance one can only conjecture at present, and it is perhaps beside the present inquiry.

Thus the evidence for the previous extension of the glaciers on the Mekong–Yang-tze and Mekong–Salween divides is conclusive, and there is very good reason to believe, both directly from the evidence and indirectly from the lower snow-line and heavier rainfall on the Mekong–Salween divide, that the glaciers of the former range have retreated furthest. I saw no unmistakably glaciated valley on the Mekong–Salween divide which was not still occupied, at least at its head, by a glacier, and of the three glaciers visited no one had retreated more than 2 miles, or at least had left definite proofs of having done so.

It is otherwise in the case of the Mekong–Yang-tze divide. The main valley above the village of Atun-tzu must have been occupied by a glacier quite 5 miles in length, of which not a trace now remains even in the five lateral valleys or on a peak 19,000 feet high at its head. On Pei-ma Shan there are indications of ice-action in valleys no longer occupied by glaciers, while the smaller glacier shown on the right in Fig. 1 has retreated at least 3 miles. Moreover the Pei-ma Shan glaciers do not

SKETCH MAP SHOWING DISTRIBUTION OF GLACIERS ON THE YÜN-NAN TIBET FRONTIER



Scale 1:750.000 or 1 Inch=11·84 Statute Miles 5 0 5 10 15 20 Miles

descend below 16,000 feet, whereas those of the Ka-gur-pu descend to at least 10,000 feet, though there can be no appreciable difference in the altitudes of the two ranges.

Coming now to the Salween–Irrawady divide, I can judge only by analogy and by indirect evidence, not having climbed the range in this latitude. I have, however, climbed it on the north-eastern frontier, at Hpimaw (lat. 26°), and conclude from the alpine flora discovered at 12,000 feet (which is very similar to that found in the Mekong–Salween divide 2000 feet higher and 100 miles to the north), from the amount of snow still unmelted at 12,000–13,000 feet in July, and from the low altitude (7000 feet) to which snow descends in winter, that the glaciers have not retreated and are not in process of doing so. The same conclusion is certainly strengthened by the views of the snow-peaks on the Salween–Irrawady divide I have obtained from the Mekong–Salween divide in December and June, as well as by the rainfall throughout the Burmese hinterland, and the altitude to which snow descends in the upper Salween Valley in winter—about 10,000 feet.

I must confess the final proof is wanting, and I shall not feel happy on the subject till I have examined the glaciers on the Salween–Irrawady divide between the villages of Cham-pu-t'ong and Menkong in the Salween Valley. Nevertheless I have shown reason to believe, and am myself morally convinced, that the glaciers on these three parallel ranges have retreated progressively from east to west on a scale that might be expressed by the numbers 2, 1, 0. Furthermore, it is significant that north of the Ka-gur-pu range the glaciers have retreated to a greater extent, and the Mekong–Salween divide resembles the Mekong–Yang-tze divide in all respects. Of one thing there can be no doubt. The Salween Valley here is a climatic barrier or dividing line of first-class importance. West of the Salween are the rain-sodden, largely evergreen jungles of the Burmese hinterland, including many species common to southern Burma, where are found the tiger, elephant, rhinoceros, sambhur, and barking deer, besides hornbills. East of the Salween are the north temperate, deciduous, and coniferous forests of Western China, with the Himalayan bear, leopard, wolf, etc.* Were a comprehensive comparison of the fauna on the two sides of the dividing line to be drawn up it would be found that amongst the lower orders (*e.g.* insects) many species were confined to one side or the other.

Now this retreat of the glaciers must be due either to a general increase of temperature or to a diminution of rainfall. If it were due to the former there is no reason why the glaciers of the Mekong–Yang-tze divide should have retreated further than those of the Mekong–Salween divide, or,

* Gill mentions tigers in Western Szechuan, and it is a well-known fact that tigers are common in certain cold countries, *e.g.* Manchuria. The Himalayan bear and the leopard certainly occur in the Burmese hinterland ; the few animals mentioned must be taken rather as typical of the two regions.

presumably, those of the Mekong–Salween divide further than those of the Salween–Irrawaddy divide, which perhaps are not in a condition of retreat at all. It is therefore evident that there has been a diminishing rainfall on these mountains which may be regional or local in each case.

Now the climate throughout the Burmese hinterland, at least as far east as the Salween Valley, is a modified monsoon climate. The dry season is shortened by the winter rains, but the heavy summer rainfall is dependent on the south-west winds which continue to blow till after January. It would be necessary, then, to postulate a diminution of the monsoon itself if we are to account for the retreat of the ice by a regional diminution of rainfall.

Much more natural is it to suspect a local diminution of rainfall on each range, the greatest diminution occurring on the easternmost range, which is furthest from the source of supply owing to the intervention of rain-screens in the west. For the strength and humidity of the monsoon is dependent on forces which cannot have been materially altered within recent geological time, at any rate on the main distribution of continental land and water, the heat of the sun, and the rotation of the Earth, for example.

We are therefore justified in believing (1) that the Mekong–Yang-tze divide once had a heavier rainfall than it has at present and was correspondingly glacial; (2) that the rainfall has been cut off from the west by the intervention of rain-screens, namely, the Mekong–Salween and Salween–Irrawady divides (this conclusion is supported by botanical evidence based on the distribution of alpines on these ranges, and perhaps by the parallel ranges west of them again), and the same is the case, though to a lesser degree, with the Mekong–Salween divide, screened by the Salween–Irrawady divide.

From these considerations it follows that the oldest range is furthest east, the newer in the west, and hence that the pressure, if pressure and not a tension-strain ruckled up these parallel folds, acted from the west.

Before the paper the PRESIDENT said: The author of this afternoon's paper, "Glacial Phenomena on the Yun-nan–Tibet Frontier," is well known to us for his previous contributions to the geography of the interesting regions on the borders of Burma and China. He cannot be here this afternoon to read his paper in person, for he is at present on military service in Burma. In his absence I will ask the Secretary to read the paper.

(*The foregoing paper was then read and a discussion followed.*)

Dr. J. W. EVANS: I must congratulate Mr. Ward on a brilliant piece of work in a difficult country and on an interesting account of the glacial phenomena in the area, illustrated by many typical photographs. The retreat in the glaciers must be due to variation in the rainfall; but we should adopt an attitude of reserve as to the explanation that this is to be attributed to a rise of the mountain ranges between the river valleys. Glaciers adapt themselves rapidly to variations in the precipitation. The effects are visible in a few years, and

at the utmost thirty or forty years will show the full effect of any change of climate. We cannot accept the supposition that these mountain ranges have risen appreciably in the course of the last half-century until the rise is confirmed by actual survey. There must, I imagine, be another explanation of the change of climate. Perhaps the south-west monsoon winds have become feebler, or there were formerly winds from the north-east which brought the moisture from that direction. Such variations are apt to occur in cycles. There is no doubt that many regions of the Earth would be highly glaciated if there were a comparatively small increase of snowfall; for example, the northern part of Ontario. Any one who descends a mine in that region is struck by the extreme cold at moderate depths below the surface, and frequently icicles may be found hanging from the roofs or walls of the workings. If there were enough snowfall the whole country would be glaciated.

One of the chief interests of the present paper is that it describes important glaciers in Eastern Asia. North of this region there are mountain ranges having no apparent glaciation, past or present. Some indeed have said that the extensive glaciation of the Pleistocene never extended to Eastern Asia. If this were so, it was probably because the snowfall was insufficient.

The author doubts whether the notches he describes on the tops of cliffs have been initiated by the streams that flow through them, because these had already traversed lakes, so that they contained no material to assist erosion; but in the Andes, at altitudes where it freezes hard at night and thaws by day, every stream is marked by the shattering of rock by frost, and erosion is consequently very active.

The PRESIDENT: About twenty-five years ago our Alpine Club started a Committee of Investigation which developed into the International Commission on Glaciers. This Commission has already published much material, and will doubtless welcome Mr. Ward's contribution. I think there are several points of importance in his paper. First, there is the geographical fact that such large glaciers exist so far east in Asia. It will certainly be news to many of us. Secondly, there is the suggestion that the diminution of snow and ice on the eastern of the three ranges investigated is due to the uprising of the western range. On this point I confess a profound scepticism. I do not see any proof of a local retreat of glaciers in excess of that which has taken place in historical times over the whole of Europe and the old world, or of oscillations exceeding those recorded in the last few centuries. There is abundant evidence that about 1855 there was a maximum of glacial extension in Europe, and since then there has been a marked retreat of the ice. The Lower Grindelwald Glacier has now retreated high up its valley and left bare an old quarry with cut blocks of marble. The same marble is found in old houses of the seventeenth century in Bern, and its origin had been a mystery until the present retreat of the glacier. Hence it is clear that the advance of the last century in Europe had been preceded by similar oscillations, and it seems reasonable to account for the diminution in the Tibetan glaciers by causes affecting generally the northern hemisphere.

We can find in the Italian Alps, in the Adamello district, most of the features which Mr. Ward so well describes in these distant ranges—the alternating steps and flats, each step in the valleys causing an icefall or a waterfall, and each flat being occupied either by a tarn in the process of being filled up by the pounded stuff borne down by the glacier stream, or presenting the level floor left when that process has been completed. With regard to the clean-cut narrow clefts by which the streams cut into the ice-smoothed and furrowed

barriers which often contain the flats, I have a theory which is, I believe, capable of illustration by well-known features in the Bernese Alps. The examples I refer to are the clefts below the Eiger and Lower Grindewald Glaciers, and that by which the Aar penetrates the Kirchet above Meiringen. These sharp gorges were probably made by streams flowing under the glacier at a time of its greater extension, and these streams, being laden to an excessive degree with grit, were able to cut very narrow clean clefts through the rock. The walls of these clefts, protected from sub-aerial denudation by the glacier itself, have remained sharp and perpendicular.

We may hope that these mountains may in time become a place of resort for Englishmen stationed in Upper Burma. The scenery obviously is of great beauty, and the botanist as well as the geologist should find abundant interest. We shall send our thanks to Mr. Ward for his paper, and express the hope that he will continue his explorations.

Prof. J. W. GREGORY sent the following notes for the discussion :—

Mr. Kingdon Ward's account of the glaciation of Western Yun-nan is a very valuable contribution to the geography of the district, and three of his conclusions are of wide general interest. Firstly, he adds another to the cases in which the variation of glaciers is a local effect, for he has given conclusive evidence of glacial recession on the eastern mountains of this region while the western glaciers have remained undiminished. It is unfortunate that Mr. Ward's evidence is least definite regarding the non-diminution of the glaciers on the Salween–Irrawady divide ; for in many cases in which it has been claimed that there has been no recession of tropical or sub-tropical glaciers the claim has subsequently been disproved. Mr. Ward's negative conclusion is adopted for the region with which his acquaintance is least.

A second interesting contribution is his account of the striking biological differences on the two sides of the Salween valley. All fresh evidence of such differences in adjacent parts of a continuous land are useful, for they help to remove some of the inconsistencies between the biological and geological evidence as to the history of the Malay Archipelago and the isolation of Australia.

Mr. Ward's interesting suggestion that the diminution of the eastern glaciers of this district is due to an increased elevation of the mountains to the west would require very clear evidence in its support. There has probably been much more recent movement, both of elevation and depression, of the Earth's surface than many English geographers are disposed to admit. I have no *a priori* objection to his conclusion ; and if Mr. Ward regards this change as one which has been slowly progressing since prehistoric times his suggestion may be valid. For there probably have been important earth-movements to the east of the Bay of Bengal in Pleistocene times ; and, as Mr. Ward refers to the moraines as tree-covered, he may regard them as of considerable age. Moreover, his description of the Sierra-like crest of the Yang-tze–Mekong divide indicates either that the summits were not ice-covered or that the glaciation was so remote that the limestones have since been weathered into pinnacles. If, however, Mr. Ward considers that the retreat of the glaciers during the past fifty years is due to earth-movements during that time or even during the immediately preceding centuries, he will want stronger evidence in support of his conclusion than is likely to be forthcoming from a district of which our knowledge is so limited.

The advance and retreat of glaciers is very variable owing to local changes in precipitation, the exact cause of which may be indeterminable even in well-

known districts. One Alpine glacier may advance while its neighbours are receding; and this difference must be due to some local accident in precipitation and not to the formation of wind screens by earth-movements in the Alps.

Mr. Ward's evidence seems to me conclusive that the different behaviour between the eastern and western glaciers of his district is due to a local variation in precipitation, but the explanation may be meteorological and not tectonic. His paper is very suggestive and a useful contribution to the physical geography of Yun-nan.

THE RETURN OF SIR ERNEST SHACKLETON.

Hugh Robert Mill, D.Sc.

NEWS has been received of the safe return of Sir Ernest Shackleton to the Falkland Islands on May 31, after the most adventurous journey in the records of Antarctic exploration. The *Daily Chronicle* of June 2 published a long account of the expedition forwarded by wireless telegraphy from Port Stanley, and to this we are indebted for the following condensed summary.

The *Endurance*, with Sir Ernest Shackleton and the party who hoped to cross the Antarctic continent, left South Georgia on 6 December 1914, and met heavy pack-ice two days later off the Sandwich group, entering the pack in 58° 40′ S., 18° W. The ship pushed her way southwards through the ice for about 1000 miles, sighting Coats Land on 10 January 1915. Very heavy ice was encountered, and 200 miles of new coast-line was discovered and named the Caird Coast. Great glaciers were observed discharging from this land. The season proved abnormally cold, summer conditions not occurring. In the middle of February the ship was beset and never got free again. It was impossible either to land or to return, and the party prepared to winter in the ship. The winter was comparatively mild for the latitude, the lowest temperature being 35° below zero Fahr.; but the usual blizzards were experienced in full force. The *Endurance* first drifted to the south-west, her extreme southerly position being 77° S. in 35° W. She remained immovably locked in the pack, and then drifted in a zigzag course through the Weddell Sea in a generally north-westerly direction. The menace of ice-pressure became serious in June, the mid-winter month, and increased in July, when all preparations were made for leaving the ship in case of need. On one occasion in a terrific pressure the ship was hove bodily out on the ice, but stood the strain; but in September she was badly nipped, and this happened again more than once early in October, causing much damage to the hull. At this time she was drifting over the position assigned to Morrell's New South Greenland, and got a sounding in 1900 fathoms. On 27 October 1915, in 69° 5′ S., 51° 32′ W., a very intense "screwing" of the pack under pressure burst the ship's sides in and tore out her stern-post and rudder-post, while water entered and extinguished the fires. The boats,

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A THIRD JOURNEY OF EXPLORATION IN CENTRAL ASIA, 1913–16.

Sir Aurel Stein, K.C.I.E., D.Sc., D.Litt.

Read at the Meeting of the Society, 5 June 1916.

ABUNDANT as were the results brought back from the journey which during the years 1906–08 had carried me through the whole length of Eastern Turkestan and portions of westernmost China and Tibet, they could not keep my eyes long from turning towards plans of another Central-Asian expedition. It was not the mere "call of the desert"—strongly as I have felt it at times—but the combined fascination of geographical problems and interesting archæological tasks which drew me back to the regions where ruined sites long ago abandoned to the desert have preserved for us relics of an ancient civilization developed under the joint influences of Buddhist India, China, and the Hellenized Near East. I well remembered the openings for fruitful exploratory work which, on my previous travels, disproportion between the available time and the vast extent of the ground had obliged me to pass by, and I was anxious to secure these chances afresh while I could still hope to retain the health and vigour needed successfully to face the inevitable difficulties and hardships.

The arrangement of the large collection of antiques which I had brought to the British Museum from my former expedition, and the multifarious efforts which I had to organize and direct for their elucidation, helped by a staff of assistants and numerous expert collaborators, kept me busy in England until the very end of 1911. Work on the big publication which was to record the scientific results of that journey still continued to claim most of my time after I had returned to duty on the Archæological Survey of India, on the familiar ground of the North-West Frontier and Kashmir. That heavy task was not yet completed when in the autumn of 1912 a variety of considerations induced me to submit to the Indian Government my formal proposals for the long-planned expedition, by which I wished to resume my geographical and archæological explorations in Central Asia. Among these considerations regard for the favourable political conditions then actually prevailing in respect of the regions to be visited played an important part. In this connection I have reason to remember gratefully the shrewd advice by which two kind friends, Sir

Henry McMahon, then Foreign Secretary to the Government of India, and Sir George Macartney, H.B.M.'s Consul-General at Kashgar, helped me to decide for an early start.

The kind interest shown by H.E. Lord Hardinge, then Viceroy of India, in my past labours and in my new plans had from the first been a most encouraging augury. My gratitude for this help will be life-long. With it accorded the generous support which the Government of India in the Education Department, then under the enlightened direction of Sir Harcourt Butler, extended to my proposals. This included the payment in three successive years of a total grant of £3000 to cover the cost of the intended explorations, the Indian Government reserving to themselves in return an exclusive claim to whatever "archæological proceeds" my expedition might yield. It was understood that the new Museum of Indian Art and Ethnography planned at Delhi would be the first to benefit by prospective "finds."

For the geographical tasks, which formed a large and essential part of my programme, the ready assistance secured from the Indian Survey Department was of the utmost value. To Colonel Sir Sidney Burrard, Surveyor-General of India, I owed already a heavy debt of gratitude for the very effective help he had rendered towards securing and publishing the survey results brought back from my former journeys. He now kindly agreed to send with me my experienced old travel companion, Rai Bahadur Lal Singh, Sub-Assistant Superintendent of the Survey of India, and to make available also the services of a second surveyor of his department, Muhammad Yakub Khan, along with all necessary equipment and a grant to cover their travelling expenses. Thus the wide extension of our proposed fresh topographical labours was assured from the outset. For my geographical work I found also an asset of the greatest value in the moral support which the Royal Geographical Society generously extended to me, besides granting the loan of some surveying instruments. During the weary months of preparation, with all their strain of work and anxiety, and afterwards into whatever solitudes of mountains and deserts my travels took me, I never ceased to derive true encouragement from the generous recognition which the Society had accorded to my former efforts to serve the aims of geographical science. Nor can I omit to record here my deep sense of gratitude for the unfailing sympathy and friendly interest with which in their ever-welcome letters Dr. Keltie and Mr. Hinks, the Society's Secretaries, helped to cheer and guide me.

After having passed a Kashmir winter and spring over incessant work on *Serindia*, the detailed report on the scientific results of my second journey, there arrived by the middle of May the Secretary of State's eagerly awaited sanction for my expedition. Relying on the kind consideration which my plans had so often received before at the India Office I had ventured to anticipate, as far as I safely could, a favourable decision, and the lists of orders, etc., for the multifarious equipment needed were ready. Yet it

cost no small efforts to assure the completion of all the varied preparations within the short time available, considering how far away I was from bases of supply and friends who could help me. A careful survey of all the climatic and topographical factors determining the programme of my movements had convinced me that I could not safely delay my start across the mountains northwards beyond the very beginning of August. So the weeks which remained to me in the peaceful seclusion of my beloved Kashmir mountain camp, Mohand Marg, 11,000 feet above the sea, saw me hard at work from sunrise till evening. By July 23 I moved down from its Alpine coolness to the summer heat of the Kashmir Valley in order to complete our final mobilization at Srinagar in the spacious quarters which the kindness of my old friend, Mr. W. S. Talbot, had conveniently placed at my disposal for those last busy days in civilization.

There I had the satisfaction to find Rai Bahadur Lal Singh, my trusted old companion, duly arrived with all the surveying equipment, which included this time two 6-inch theodolites, a Zeiss levelling set, a Reeves telescopic alidade and two mercurial mountain barometers, besides an ample supply of aneroids, hypsometers, plane-tables, prismatic compasses, etc. With him had come the second surveyor, a young Pathan of good birth, with manners to match, and that excellent Dogra Rajput, Mian Jasvant Singh, who had accompanied every survey party taken by me to Central Asia. In spite of advancing years he had agreed to act once more as the Rai Sahib's cook, and to face all the familiar hardships of wintry deserts and wind-swept high mountains. At Srinagar I was joined also by two other Indian assistants, who, though new to Central-Asian travel, proved both excellent selections for their respective spheres of work. In Naik Shams Din, a corporal of the First (King George's Own) Sappers and Miners, whom Colonel Tylden-Pattenson, commanding that distinguished corps, had chosen for me after careful testing, I found a very useful and capable "handy man" for all work requiring technical skill. A Punjabi Muhammadan of Kashmiri descent, he proved in every way a worthy successor to Naik Ram Singh, whose devoted help on my second journey I owed to the same regiment, and whose tragic end I have recorded in *Desert Cathay*.

The other assistant, Mian Afrazgul Khan, a Pathan of the saintly Kaka-khel clan, and a Sepoy from the Khyber Rifles, was my own choice, and experience soon showed how much reason I had to be pleased with it. Originally a schoolmaster on the Peshawar border, with a sound vernacular education, he had soon after his enlistment in that famous Frontier Militia Corps been noticed for his topographical sense and superior intelligence. After a year's training in the Military Surveyors' Class at Roorkee, where he greatly distinguished himself, he was permitted by Sir George Roos-Keppel, Chief Commissioner, N.-W. Frontier Province, and Honorary Colonel of the Regiment, to join me as temporary draftsman and surveyor in connection with the excavations I was carrying on in the

spring, 1912, as Superintendent of the Frontier Circle, Archæological Survey. There I was soon impressed by his marked and varied ability, and when in addition I became aware of his energy and genuine love of adventure I did not hesitate to engage him as an assistant surveyor for the journey. Our small party was completed by two Indian servants; one of them, Yusuf, a man of somewhat "sporting" instincts, was to act as my cook, and the other, Pir Bakhsh, a worthy elderly person from the mountains north of Kashmir, as his substitute in case of illness—or some temporary outbreak of bad temper. The experience of previous journeys had warned me as to the necessity of this double string, and I owe it probably to its restraining influence that I was able to retain the services of both men in spite of all trials and bring them back to their homes in the end safely and in a state of contentment.

Ever since the plan of my journey was first formed I had been exercised in my mind by the difficulty of finding a practicable route which would take me across the great mountain barriers northward to the border of Chinese Turkestan on the Pamirs, and which was still new to me. By the initial portions of my previous journeys I had exhausted the only apparent alternatives of the Chitral and Hunza valleys leading to practicable crossings of the main Hindukush range. Even the devious route over the Karakoram passes I had seen on my return journey of 1908. But fortune seemed to favour me at the start, and unexpectedly to open for me the eagerly desired new approach to my goal.

For long years I had wished to explore the important valleys of Darel and Tangir which descend to the Indus from the north some distance below Chilas. Darel (*Ta-li-lo*) is prominently mentioned in the accounts of old Chinese Buddhist pilgrims, partly because there passed through it a route which some of them followed on their descent from the uppermost Oxus to the Indus and the sacred sites of the Indian north-west frontier, and partly by reason of a famous Buddhist sanctuary it once contained. No Europeans had ever been able to visit these territories, as the disturbed political conditions of the local tribal communities, coupled with their fanatical spirit, effectively closed access to them. But in recent years Raja Pakhtun Wali, of the Khushwaqt family, once ruling Yasin and Mastuj, had, after an adventurous career, succeeded in founding and gradually extending a chiefship of his own among these small Dard republics. The desire of consolidating his rule and securing support for his children's eventual succession had led him a short time before to seek friendly relations with the Gilgit Political Agency. When I learned of the opportune chance thus offering I decided to use it for a new route to the Pamirs. The matter needed diplomatic handling. But finally the effective help given by my kind friend the Hon. Mr. Stuart Fraser, Resident in Kashmir, with the assent of the Indian Foreign Department, secured for me the chief's permission to visit his territories. The conditions he thought fit to attach to it were obviously meant to safeguard

his political interests—and incidentally also my safety among his newly won subjects.

On 31 July 1913 I started from Srinagar, and proceeding by boat down the Jhelam, reached next day the little port of Bandipur on the Wular Lake. From there the bulk of our baggage was sent ahead with the second surveyor by the Gilgit military road to await us in Hunza. I myself with Lal Singh and Afrazgul left Kashmir through the side valley of the Lolab and struck north-westwards for the route which leads through the deep-cut gorges of the Kishanganga and its tributaries to the snowy passes of Barai and Fasat and then down to Chilas on the Indus. Bad weather pursued us from the time we entered the mountains, and even on the first eight days the tracks followed proved in many places impracticable for laden animals. But it seemed appropriate Alpine training for the ground ahead, and there was an antiquarian interest to compensate me for the fatigues encountered; for various topographical considerations indicate that it was by this direct route to the Indus and thence to Gilgit that the Chinese received those annual supplies from Kashmir which alone, according to an interesting historical document preserved in the Annals of the T'ang dynasty, enabled them about the middle of the eighth century A.D. to maintain for some years imperial garrisons in Gilgit and Yasin. Thereby they prevented the junction between their great adversaries who then threatened Chinese hold on Turkestan—the Arabs in the west and the Tibetans in the south. It was, of course, the human beast of burden which alone made the use of such a route possible, and we have historical evidence to show how abundant its supply was in ancient Kashmir.

By August 10 we had descended from the snowy range which culminates eastwards in the huge ice-clad pyramid of Nanga-parbat (26,620 feet above the sea) to Chilas on the Indus, the last British post towards the independent territory of Dard tribes, known as the Indus Kohistan. The *Pax Britannica*, brought some twenty years before to what was once the most turbulent and fanatical of these petty hill republics, had worked curious changes in the position of the cultivated areas, etc., which without definite records a future antiquarian or geographer would find most difficult to interpret correctly. The heat of the summer is great in the deep-cut rock defiles of the Indus, and the banks forbiddingly barren. So I was glad when our descent in the Indus gorge next day could be effected on a skin raft which the tossing current of the mighty river carried down at the rate of some 14 miles an hour. Though the snowy weather prevailing on the high ranges had caused the river to fall to some 24 feet below high-water level, yet the flood volume was still large enough to allow us to sweep down securely over what at other times is a succession of impassable rock ledges and rapids.

At the mouth of the Hodur stream we left the Indus behind and entered ground which offered ample scope for exploring work. Passing up the unsurveyed valley northward we found plentiful ruins of small

fortified villages clearly dating back to pre-Muhammadan times and a great deal of abandoned cultivation terraces for which the supply of irrigation water now available would manifestly no longer suffice. Pushing up to the Unutai Pass we crossed the range which overlooks the Khanbari River and there reached the eastern border of Pakhtun Wali's latest conquests. As we descended westwards through the Datsoi Nullah by a track almost impassable for load-carrying men we were met by Pakhtun Wali's capable nephew, Mehtarjao Shah Alim, with a large and well-armed escort. It had been stipulated beforehand that not a single man from the territory under control of the British Agency of Gilgit was to accompany us. The careful watch kept over us from the start by Pakhtun Wali's select men-at-arms, wherever we moved or halted, seemed to afford adequate protection from any fanatical attempt on the part of less trustworthy elements among his new subjects who might have liked to embroil him by an attack upon us. But I confess that it also at first caused me serious misgivings as to the freedom which might be left to us for useful topographical work.

It was quite as much regard for such work as the wish to avoid the excessive summer heat of the Indus gorges which had caused me to ask that we might be taken to Darel by the mountains at the heads of the Khanbari and Dudishal Valleys instead of the usual route, which leads through the former. It proved a difficult line of progress, even with such hardy porters for our baggage as Shah Alim had brought from the main Darel Valley. But its advantages for surveying operations were great, and fortunately I soon found that we were left full freedom to use them. The great spurs descending from the Indus-Gilgit watershed northward had to be crossed by a succession of high passes, between 13,000 and 14,000 feet, and these furnished excellent plane-table stations. The extensive views there obtained towards the great snowy ranges across the Indus and westwards on the headwaters of the Swat River permitted our positions to be fixed with accuracy from previously triangulated peaks. At the expense of much hard climbing we secured equally favourable conditions further on, and a protracted spell of fine weather made it easy to use them. R. B. Lal Singh, in spite of his fifty-one years, an age which Indians usually are apt to count as advanced, showed that he had lost none of his old zeal and vigour. Through his devoted exertions a fortnight's hard travel sufficed to map some 1200 square miles, on the scale of 2 miles to the inch, on ground which had never been surveyed or even seen by European eyes.

It was a pleasant surprise to find our tasks soon facilitated by the excellent relations we were able to establish with Mehtarjao Shah Alim and the band of Pakhtun Wali's trusted supporters who formed our ever-watchful guard. They were a strangely mixed crew, of distinctly shady antecedents, but all "handy" and pleasant to deal with. Most of these alert fellows were outlaws from Swat, Chitral, and the independent Dard republics on the Indus, who, with hands already blood-stained, had joined

Pakhtun Wali's fortunes at one time or other of his adventurous career. Their burly fair-haired commander Shahid, whose look of jovial ruffian curiously contrasted with his name, meaning "martyr," had from the beginning played a prominent part in all the mixed feuds and intrigues by which their capable chief had raised himself from the position of a hapless refugee in Tangir to that of absolute master of that once turbulent valley. The means and methods by which Pakhtun Wali, in true Condottiere fashion, had subsequently extended his sway over the neighbouring hill republics of Darel and Sazin, had been equally unscrupulous, and recalled times long gone by elsewhere. His was the most recent kingdom carved out in the Hindukush, a region probably less touched by historical changes than any other in the north-west of India, and to glean first-hand information about the process employed was for me a very instructive and fascinating occupation. Nor did quick-witted Shah Alim and his band of intelligent henchmen fail me when it came to collecting exact data about local resources, population, etc., or raising or managing needful transport. Fully familiar with the ground, as their employment had made them, they yet kept a mental detachment from the local interests, regard for which would have induced reticence among more settled subjects.

The Khanbari River was found to drain an unexpectedly large mountain area, and in all the valleys splendid forests of pines and firs, quite untouched by the axe, were found to clothe the higher slopes. In the wider portions below old cultivation terraces, now abandoned, could be traced for miles. Judging from the size of the trees, the forest which has overrun them in most places dates back for centuries. There is an abundant supply of water for irrigation from snowbeds and springs, and re-occupation of these fertile lands is retarded only by the great scantiness of population. Before Pakhtun Wali's conquest the Darelis had contented themselves with using the extensive grazing-grounds at the very head of the valleys, and only since the advent of more peaceful conditions has the slow immigration of Gujar settlers commenced. Whatever the cause of the original abandonment of these valleys may have been, it soon became obvious that they, like Darel and Tangir, enjoyed climatic conditions far more favourable in the matter of adequate rainfall than those prevailing higher up on the Indus or elsewhere between the Indus and the Hindukush. This abundant moisture may well be due to some feature in the orography of the Indus Valley, permitting the monsoon rains to advance here far beyond the line where their effect is stopped elsewhere by the high mountain chains southward.

The contrast with those denuded barren mountains to the north and east, which I remembered so well from my previous routes through Gilgit and Chitral, became even more striking as we descended from the Ishkobar Pass (*circ.* 13,650 feet) to the head of the main Darel valley. When encamped there at Nyachut, on rich Alpine meadowland and surrounded by mountain sides which magnificent forests of deodars and firs clothe for

thousands of feet in height (Fig. 1), I felt as if transported to the Sind or some other big side valley of Kashmir. Unfortunately there was little chance left to enjoy the delights of this glorious Alpine scenery while being constantly attacked by swarms of the particularly fierce mosquitoes which infest all Darel and Tangir. We met them first when approaching the Khanbari watershed from the east, and the trouble they gave steadily increased as we progressed. Even high up in the mountains we suffered severely from this plague which is apt to cause bad sores, as my surveyors and myself soon found by experience. There was little consolation in the fact that the local people suffer almost as much from the infliction, as their pock-covered skin showed, and that during the winter these tormentors descend to seek warmer quarters by the Indus. I often wondered whether their presence would not be an adequate defence of Darel against any permanent invasion by people concerned for their comfort.

When I moved down to the vicinity of Manikyal, the northern of the two extant walled townships of Darel, there revealed itself strikingly the remarkable openness of the main valley and the great extent of arable land on the wide plateaus flanking the middle course of the Darel River. The sight of this fertile area, all easy to irrigate, revealed at a glance the importance which Darel must have possessed in ancient times, and which with an adequate population and under a firm rule it could attain once more. But much of the land had passed out of cultivation long ago, and the great number of ruined sites gave striking confirmation of the observation The survey of these ruins, all known as *kots* (forts), kept me busy for several days, and showed that most of them were remains of fortified settlements dating back to pre-Muhammadan times. Rapid excavation near one of them, Bojo-kot, brought to light unmistakable relics of a Buddhist burial-ground in the shape of cinerary urns, metal ornaments, etc. These ruins always occupy naturally strong rocky ridges bearing elaborately built terraces, and by their position and constructive features curiously recalled to my mind the extensive ruined settlements of the Buddhist period with which my explorations in the Swat Valley and on the Peshawar border had rendered me familiar. Archæological evidence thus seemed to bear out the tradition preserved in the Chinese pilgrims' records as to the early historical connection between the ruling families of Darel and Swat.

All antiquarian observations pointed to the territory having been occupied in Buddhist times by a much denser population than the present and one possessed of far greater material resources. Yet even now Darel contains a number of large crowded villages, some, like Manikyal and Samagial, well deserving to be called towns. Again and again I was struck by lingering traces of an inherited civilization a good deal more developed than that to be found now in the neighbouring hill tracts. Thus the alignment of the irrigation canals and the carefully preserved solid stonework of the terraces and embankments over which they are

FIG. 1.—FOREST NEAR NYACHUT, HEAD OF MAIN DAREL VALLEY, LOOKING N.W.

FIG. 2.—DARELI GREYBEARDS ON CARVED SITTING PLATFORM, MANIKYAL.

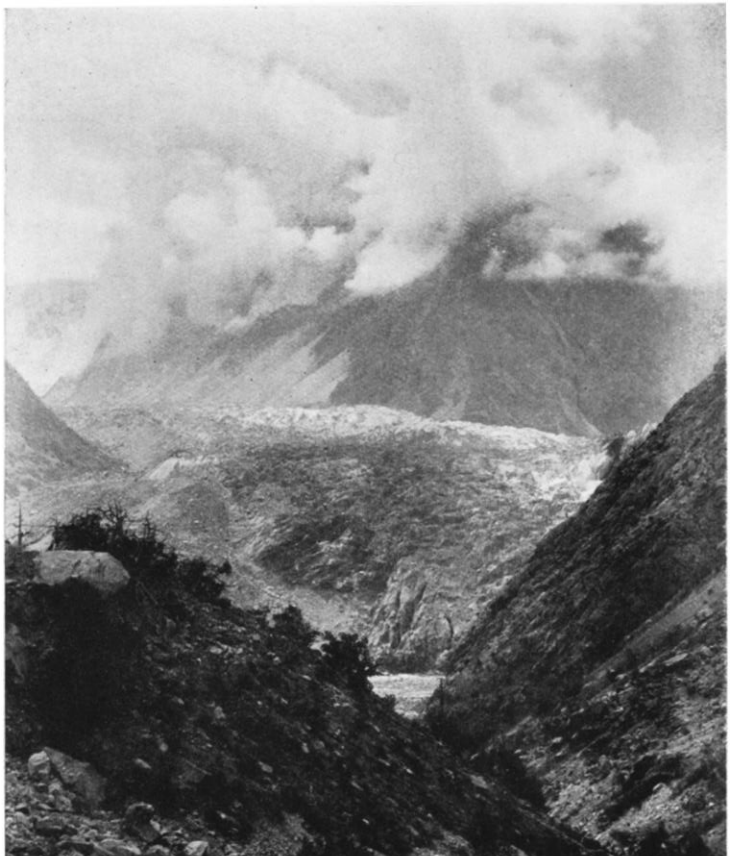


FIG. 3.—LOWEST PORTION OF CHILLINJI GLACIER, SEEN FROM WEST ACROSS ASHKUMAN RIVER.

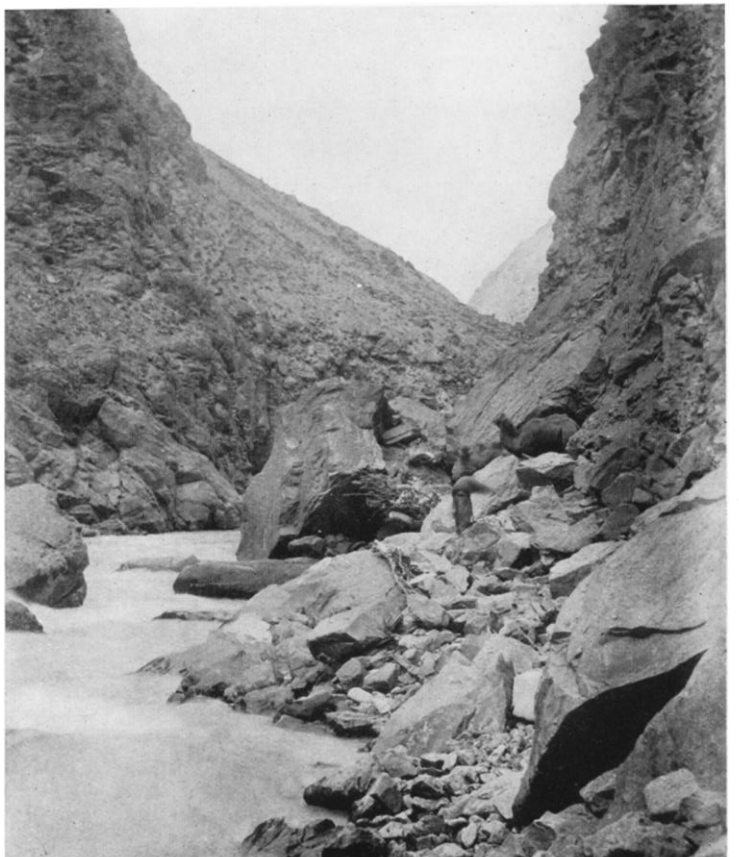


FIG. 4.—CAMELS DESCENDING KARA-TASH RIVER GORGE NEAR ARA-SUNDE.

carried showed unusual skill. Another very significant feature was the abundance in houses, mosques, and graves of fine wood-carving retaining decorative motifs which are directly derived from Græco-Buddhist art as known to us from the ancient relievos of Gandhara, and which occur frequently also in the ornamental wood carvings excavated by me at sand-buried old sites of Chinese Turkestan.

The racial type of the Darelis (Fig. 2), as far as I could judge without anthropometric observations, for the collection of which there was no time, seemed to me unmistakably akin to that of the other Dard tribes which occupy the adjoining mountain territories. This close relationship is also borne out by their Shina dialect. But there was something in the often refined features of the men, and their less heavily built frame, which vaguely suggested inheritance from generations weakened by a decadent civilization and a long period of internal disorder. They struck me distinctly as a race possessing the instincts of quasi-town-bred folk and needing a strong ruler.

On the evening of August 16 I was received by Raja Pakhtun Wali in full state at the castle of Gumare-kot, which he was building in the centre of his recently annexed territory and as a stronghold to safeguard its possession against possible risings. The steep ridge which rises above it is occupied by the ruins of the large fort of Raji-kot, marking the ancient capital of Darel. It was a very interesting experience to meet the man who, after a career as chequered as befitted the son of Mir Wali, Hayward's murderer, had succeeded in building up a new kingdom for himself, the last, perhaps, which India has seen raised on the old adventurous lines. His human environment, in which Darelis are still kept much in the background, and the methods by which he maintains his rule seemed to call up times long gone by. There was much to claim my interest in what I heard from the shrewd and energetic Khushwaqt chief that evening, and during the long visit he paid me next morning with his two young sons; but this is not the place to record it. He had spared no care nor trouble to facilitate my safe journey through his territory and to make it as profitable as the limitations of my time permitted. I shall always look back with gratitude to the friendly welcome accorded, and with genuine interest and sympathy to the ruler.

It was a special satisfaction to me that on my way down Darel I was able to identify at Poguch the site of an ancient Buddhist sanctuary which the Chinese pilgrims specially mention on account of its miracle-working colossal image of Maitreya Buddha in wood. The tomb of Shahakhel Baba, a Muhammadan saint renowned for his miraculous powers and attracting pilgrims from many distant parts of the Hindukush region as well as Swat and the Indus Valley, attests here the continuity of local worship. Lower down we passed interesting ruins of castles once closing access to Darel. Then we ascended westwards by a precipitous track, difficult for load-carrying men, to the rugged high spur which divides

Darel from Tangir. On reaching its top we were rewarded for a trying climb over bare rock slopes by the grand vistas which opened before us. Owing to its isolation the Shardai Pass commands wide views of Darel, Tangir, the Indus Valley, and the ranges beyond, and proved a truly ideal survey station. To the west there showed clearly the gap between precipitous snow-capped spurs, where the Indus makes its sharp bend to the south. Access to this famous defile, where the bed of the mighty river is reported to contract into an exceedingly narrow rift, is closed by independent tribal territory. Even from afar European eyes saw it now for the first time. How I wished that Pakhtun Wali's expansionist policy might open the route some day for exploring those Indus gorges, where the old Chinese pilgrims made their way south by dreaded rock ledges and "iron chains suspended across chasms"!

The descent to the Tangir River over cliffs and vast slopes of rock débris was a trying experience; but the valley itself proved remarkably open and fertile. Fruit trees and vines were more plentiful than in Darel, and the mosquitoes a little less fierce. The population is scattered in clusters of hamlets, and showed a manly bearing. Of those fortified villages in which the Darel people seem to have always sought shelter since early times I could trace no ruins here. I had a very pleasant reception at Jaglot, where Pakhtun Wali had established his original stronghold, and where his family ordinarily resides. The original modest structure which he occupied as a refugee from Chitral had witnessed a memorable siege by the powerful Gabar-khel tribesmen who hold the upper portion of Tangir, and who then vainly tried to rid themselves of their ambitious exile-guest. Their defeat marked the first stage in Pakhtun Wali's rise to power. The old animosities seemed to be still smouldering here, and as we moved up the valley our ever-watchful escort took special care to safeguard us from any attempt of Pakhtun Wali's old foes, or the fanatical *talib-ilms*, or religious students, gathered in numbers round a famous Mullah at the mosque of Kami.

In the great forest belt at the head of the Satil branch of the valley hundreds of Pathans from Upper Swat and the independent tracts lower down the Indus were engaged in cutting the magnificent timber, an important source of revenue to Raja Pakhtun Wali. The timber is made to float down the Indus under arrangements with Kaka-khel traders, who, owing to the sanctity enjoyed by their clan, are able to exploit this business in tracts otherwise far too risky. Here we were joined by Mian Shahzada, the uncle of Afrazgul, my Kaka-khel surveyor, who for years had been in charge of these operations, and whose opportune intercession had helped to overcome the Raja's original scruples about our passage. Shahzada had charged himself with the responsibility of keeping all fanatical characters in these woodcutters' camps out of mischief, and by his effective help amply earned the recommendation I could give him to the district authorities of his far-off home on the Peshawar border.

All arrangements worked smoothly to the end, and when on August 21 we safely reached the Sheobat Pass, over 14,000 feet in height, on the range which forms the watershed between the Indus and the Gilgit River drainage, it was with regret that I left behind Pakhtun Wali's fascinating dominion, from which we had just "lifted the Purdah." I was sorry to bid farewell to our hardy escort of outlaws, after meeting the large *posse* of respectable Gilgit levies which had waited on the other side of the pass to take charge of us. It was amusing to watch the ill-disguised expression of distrust with which the latter viewed our quondam protectors, some of them well remembered, no doubt, from their old raids and similar exploits. The ample and richly deserved rewards I gave to Pakhtun Wali's men, however, sufficed to efface any unpleasant reciprocal feelings.

In order to reach the big Yasin Valley through which our northward route was to lead, we had first to gain the Gupis post on the Gilgit River. The mountains to the south of the latter have not yet been adequately surveyed. So it was scarcely surprising that the unexplored pass above Gafarbodo, which I chose as a short cut, proved nearly impossible for our load-carrying men. It took fully eight hours' scrambling over huge masses of rock débris left behind by ancient glaciers, the worst I ever encountered in this region, to reach the pass at an elevation of close on 16,000 feet.

Then I pushed up rapidly in the open and relatively fertile valley of Yasin. It leads due north, flanked by mighty spurs which descend from the glacier-crowned main Hindukush range, and has always been an important route, as it forms the nearest connection between Oxus and Indus. I found myself thus on ground claiming distinct historical interest, and there was a good deal even in things of the present to attest the strong Central-Asian influence to which it has been subject since early times. In addition to much fine old wood-carving in dwellings and mosques, I was able to trace a ruined Stupa with relics of Buddhist times and the remains of several old forts, which tradition significantly enough connects with early Chinese invasions.

It was owing to an early and historically well-attested Chinese conquest of these valleys from the uppermost Oxus that I felt a special interest in the glacier pass of the Darkot by which we crossed on August 29 to the headwaters of the Yarkhun or Mastuj River. It had been the scene of that remarkable exploit by which a Chinese force, despatched in 747 A.D. from Kashgar against the Tibetans, had effected its entry into Yasin and Gilgit. Already in May 1906, on my way up from Chitral, I had been able to ascertain how closely the topographical features of the Darkot Pass agreed with the exact account which the Chinese Annals of the T'ang dynasty have preserved for us of General Kao Hsien-chih's famous expedition. I had then succeeded in reaching the top of the pass, 15,400 feet above the sea, from the Mastuj side; but no examination of the southern approach, which also figures in that account, had been possible.

In view of the very serious natural obstacles presented by the glaciers

of the Darkot, Kao Hsien-chih's passage deserves to rank as a great military achievement, like his successful march across the whole width of the Pamirs, with a relatively large Chinese army, which preceded it, and to which I shall have occasion to refer further on. So it was a particularly gratifying find when I discovered an old Tibetan inscription scratched into a large boulder on the track where it ascends by the side of a steep moraine flanking the southern glacier of the Darkot. It is very probable that it is a relic of that short-lived Tibetan advance on the uppermost Oxus which the T'ang Annals record towards the close of the second quarter of the eighth century, and which Kao Hsien-chih's adventurous expedition successfully stopped.

On the top of the Darkot I was met by Captain H. F. D. Stirling, of the 57th (Wilde's) Rifles, then commanding the Chitral Scouts, with fresh transport from the Mastuj side. Thus the descent over the big and much-crevassed northern glacier could be effected without undue risk to men or baggage. I have special reason to feel grateful for the most effective arrangements made by Captain Stirling as I pushed on eastwards after crossing the Darkot. Our easiest route to the Chinese border would have led over the Baroghil saddle to Sarhad on the Oxus and thence across the Afghan Pamirs along the line I had followed in 1906. But apart from the fact that its use would have required the special permission of H.M. the King of Afghanistan, I was anxious to see new ground, and was therefore glad to move now by a parallel but far more difficult route by which westernmost Hunza could be gained from the headwaters of the Yarkhun and Karambar (or Ashkuman) Rivers. This route allowed me to sight the Showarshur branch of the Darkot Glacier, now completely closed by an impassable ice-fall, and to examine more closely the interesting instance of bifurcation by which the glacier above the Karambar saddle discharges its drainage partly towards the Yarkhun or Chitral River and partly into the lake forming the head of the Karambar River (Fig. 5). On its south side the route skirts an almost unexplored region of high ice-clad peaks and big glaciers, and the snouts which the latter have pushed across the gorge of the Karambar River (Fig. 8) together with the huge old moraines encountered in the main valley lower down constituted serious obstacles. They made all the more welcome the friendly help given by Captain Stirling, who, as an expert mountaineer, took pleasure in accompanying me on those four days of hard marching and climbing.

Beyond the Ashkuman River we were met by fresh porters, collected from the settlement of hardy Wakhi immigrants lower down that much-confined valley. The ascent made with them on September 2 to the Chillinji Pass (*circ.* 17,400 feet high) proved a difficult task (Fig. 3). The snowy weather prevailing all through August had rendered the very steep snow slopes to be climbed still more trying, and had added greatly to avalanche risks. The pass had not been traversed by any one for a long number of years, and only one old man sent with us had ever been across. So it

was a great relief when after eight hours' toil we safely reached the col, nearly 5000 feet above camp. It offered a grand view over the extensive glaciers which meet at the head of the Chapursan Valley, but the icy gale sweeping it made even a short rest difficult. Fortunately the great glacier below us proved less trying, owing to the fresh snow which had adequately covered up most of the crevasses, and after a descent of five hours more we found a dry spot by its side where we could bivouac in safety under the shelter of a moraine. Some of our coolies did not turn up till next morning, but they had wisely kept moving all through the bitterly cold night. Their safe arrival caused me great relief; and so also did the assurance that my feet, in spite of the loss of toes and the impaired circulation which resulted from my frost-bite accident at the close of the former journey, could stand well thirteen hours' struggle over snow and ice. The snout of the Chillinji Glacier was not passed until after a descent of another four miles in the morning, and a short distance beyond I had the satisfaction to find fresh transport from Hunza awaiting us. The arrangements made weeks ahead through my old acquaintance Humayun Beg, the Wazir of Hunza, had not failed me.

After this experience our progress through Hunza seemed easy. The Chapursan Valley, in spite of the huge moraines which the glaciers south have pushed down into it, contains more stretches of level ground than probably all the rest of Hunza. It was hence a feature of special interest to note the extensive areas of old cultivation which we passed on the 25 miles' march between Baba-ghundi and Spandrinj. Neither want of water for irrigation nor present climatic conditions at this elevation from *circ.* 11,000 to 10,300 feet seem to furnish an adequate explanation for their abandonment. Re-occupation is recent and proceeding slowly.

By September 5 we had reached the head of the main Hunza Valley over the Kermin or Rich Pass. Crossing two days later the border of Chinese Turkestan on the Mintaka Pass (15,430 feet) I found myself restored to ground familiar from my two former journeys. But how easy the previously followed routes seemed by comparison with our recent tracks! Since leaving the Kashmir Valley we had crossed altogether fifteen passes between 10,000 and 17,400 feet in height. The total marching distance covered during these five weeks was over 500 miles, and of this nearly four-fifths had needs to be done on foot.

Rapid as was my descent down the Taghdumbash Valley to Tash-kurghan, I could use it for fresh surveys of antiquarian interest. It must suffice here to mention an ancient canal of large size, famous in local lore but abandoned for long centuries, which had once brought fertility to extensive areas along the right river-bank, now almost wholly desert. We could trace its remains, in places remarkably well preserved, for a distance of over 40 miles, from Dafdar to below Toghlan-shahr. There, opposite to Tash-kurghan, still as in ancient times the chief place of Sarikol, I found also ruins of Buddhist shrines which had previously escaped me.

On leaving Sarikol for Kashgar I followed for a couple of days the main caravan route through the mountains. I was here on the track of Hsüan-tsang, the great Chinese Buddhist pilgrim whom ever since my first journey I claim as my patron saint. So it was a special satisfaction when on crossing the high plateau of the Chichiklik Maidan, already under fresh snow, I found conclusive evidence that a badly decayed enclosure, now worshipped as a sacred site by Muhammadans and used as a burial-place for unfortunate wayfarers, represents, as I had previously conjectured, the remains of an ancient hospice which Hsüan-tsang described as a place connected with a sacred Buddhist legend.

Beyond this our routes divided. Lal Singh moved off by rapid marches in order to reach, *viâ* Yarkand and Khotan, that portion of the main Kun-lun range along which I was anxious to have our triangulation of 1906 extended as far as possible eastwards. My heavy baggage was despatched to Kashgar by the usual route *viâ* Ighizyar under Afrazgul and Shams Din. I myself set out due north with the second surveyor in order to reach the same goal by a new route, across the Merki Pass and down the valley of the Kara-tash or Beshkan River which receives most of the eastern drainage of the great glacier-clad range of Muztagh-ata. Owing to special difficulties this important valley had never been explored in its whole length. In the spring and summer the narrow gorges of the Kara-tash River are rendered quite impassable by the big floods of the melting glaciers. By the time these floods subside in the autumn, heavy snow on the Merki Pass equally closes the route to traffic. In the spring of 1906 I had sent my late surveyor, plucky Rai Ram Singh, to descend the valley, but his attempt was completely baffled. Chance showed more favour to me now. An exceptional succession of early snowfalls had stopped the melting of the glacier ice just in time to allow of my passage while the Merki Pass (14,500 feet), though deep under snow, could still be traversed with laden yaks. But even thus the descent through the river gorge for two long marches proved a very difficult and in places risky business. The constant crossings of the river tossing between sheer rock walls could not have been safely effected without opportunely secured Kirghiz camels, and none but such hardy local camels accustomed to the ground could have negotiated the boulder-strewn narrow tracks leading elsewhere along the foot of these precipices (Fig. 4).

By September 19 we had safely emerged from the last of these gloomy defiles, and two days later a 40 miles' ride through fertile plains carried me back to Kashgar. There I had the great joy of being received once again, after seven years' absence, by my old and ever-helpful friend, Sir George Macartney, under the hospitable roof of Chini-bagh, now much enlarged and rebuilt as befitted its new dignity as a British Consulate-General. The two busy weeks passed in those familiar cheerful surroundings would certainly not have sufficed for all the heavy work which the organization of my caravan demanded, had not the watchful

care and often proved prevision of my kind host aided me in every direction.

In due course there arrived twelve fine camels from Keriya, accustomed to desert work and selected by Hassan Akhun, my experienced old camel factotum who was now about to embark on the third of our long expeditions into the "sea of sand." Other faithful old Turki followers, too, were glad to take their place again in my caravan. I had been delighted to see again at Kashgar my devoted Chinese secretary and friend, Chiang-ssu-yeh, who had proved so valuable on my second journey. Since then he had been rewarded by being appointed Chinese Munshi at the Consulate-General. But notwithstanding this comfortable berth I think he would have been glad to rejoin me had not his increasing years and a serious affection of his ears warned me against accepting the sacrifice and risks which such a step would have involved for my old companion.

Li-ssu-yeh, the shrivelled-up weakly young man whom Chiang provided for the post of camp-*literatus*, turned out to be a poor substitute, as I had apprehended from the first. But there was no other choice at Kashgar. Wholly absorbed in the task of treating his ailments, real and imaginary, with every Chinese quack medicine he could lay hold of, and as taciturn and inert as a mummy, Li was useless for the manifold scholarly and practical labours in which Chiang had engaged with such cheery energy. But anyhow he managed to indite my Chinese epistles, and he did not play me false in my dealings with Chinese officials.

For this negative virtue I had reason to feel specially grateful. The revolution of 1911 had greatly changed many aspects of Chinese officialdom even in this distant province, and scarcely for the better. A series of assassinations of Mandarins, and petty outbreaks fomented by unscrupulous office-seekers, had during 1912 seriously disturbed the peace of the "New Dominion," though they were confined to the numerically weak Chinese element, and left the mass of the people, respectable Turki Muhammadans, in their characteristic unconcern. It had been due largely to the wise counsels and moderating influence of Sir George Macartney, who for many years past has enjoyed wide and richly deserved respect among all classes, that the province had escaped complete anarchy. Under the influence of a somewhat stronger régime at headquarters things had become more settled before the time of my return. But it was difficult not to realize that the so-called revolutionary movement in Hsin-chiang had in various respects adversely affected the general type of officials in power. Some of the best qualities of the old local Mandarin world, including regard for scholarly aims and labours, had manifestly been discarded, while the beneficial effect hoped for from "Western learning" and republican methods was still conspicuous by its absence. There was only too much justification for Sir George Macartney's shrewd warning that I could not safely reckon upon finding always the same favourable disposition at Chinese Yamens which had facilitated my explorations so much during previous journeys.

After a stay which reunion with the kindest of friends, Sir George and Lady Marcartney, and the glorious autumn season had combined to render most pleasant, I left the Kashgar Consulate-General on October 9 for my first winter's work in the desert. Its main goal was the region around the dried-up Lop-nor, in the extreme east of the Tarim Basin, and the whole length of the Taklamakan, that great sea of drift-sand over 600 miles in a straight line, separated me from it. A variety of considerations obliged me to revisit Khotan, and once there I was bound to proceed by the only possible route which skirts the southern edge of the Taklamakan. Much of the ground to be traversed there was already familiar to me from my previous expeditions, and for this reason I was all the more eager to use whatever chance of new routes the limits of time left me on my way to Khotan.

This induced me to move first due east to the oasis of Maral-bashi along the foot of the steep and barren mountain chain which forms here the southernmost rampart of the Tien-shan. It had in its main part remained so far unsurveyed; but reports, previously collected, seemed to indicate that an old route, now but vaguely remembered in local lore, had during earlier periods of Chinese domination skirted the foot of that chain and been in use for traffic instead of the present high "road," *recte* caravan track, leading much further south along the actual course of the Kashgar River. The accurate survey now effected confirmed that tradition and proved the existence of a series of small ruined sites scattered along a line of some 160 miles and dating from pre-Muhammadan times. The ground occupied by them on the gentle desert glacis of the hill chain is now wholly without water. There were also other physical observations of interest to be gathered, clearly pointing to desiccation within historical times, and not explainable by the fact that the winding bed and inundation marshes of the Kashgar River were found to have at one period, perhaps relatively recent, approached that desert glacis in places more closely than they do at present. We had met with serious trouble about water, no drinkable supply having been found on three successive marches. This served as a suitable preparation for difficulties to be faced on our desert travel ahead.

By October 18 we were glad to reach the fields and fruit-gardens of Maral-bashi. The survey of some badly injured Buddhist ruins in the vicinity, and of the curious canal system by which the oasis obtains the major portion of its by no means abundant irrigation from the Kashgar-darya here approaching its end, occupied me for a few days. But in the main my short stay was taken up with careful preparations for the attempt I planned to make my way to the desert hills of the Mazar-tagh on the lower Khotan River by a short cut through the Taklamakan. I knew well the formidable obstacles and the risks presented by the wide intervening belt of absolutely waterless drift-sand desert. But by sending all baggage, except an absolutely necessary minimum, to Khotan by the caravan route

Ak-kul Lake.

Karambar Valley.
Old moraines in foreground.

FIG. 5.—PANORA

S. Shitam Glacier.

High range between Ghund and Shakhdarra Valleys.

Arête form

FIG. 6

The

d.

East Karambar Glacier,
with bifurcating drainage.

Main Kar
Y

FIG. 5.—PANORAMIC VIEW TAKEN FROM KARAMBAR SADDLE (CIRC. 14,050 FEET ABOVE SEA) DIVIDING

The view extends from north-east, on extreme left (main Hindukush watershed towards Oxus), to west-s

Arête forming Shitam Pass.

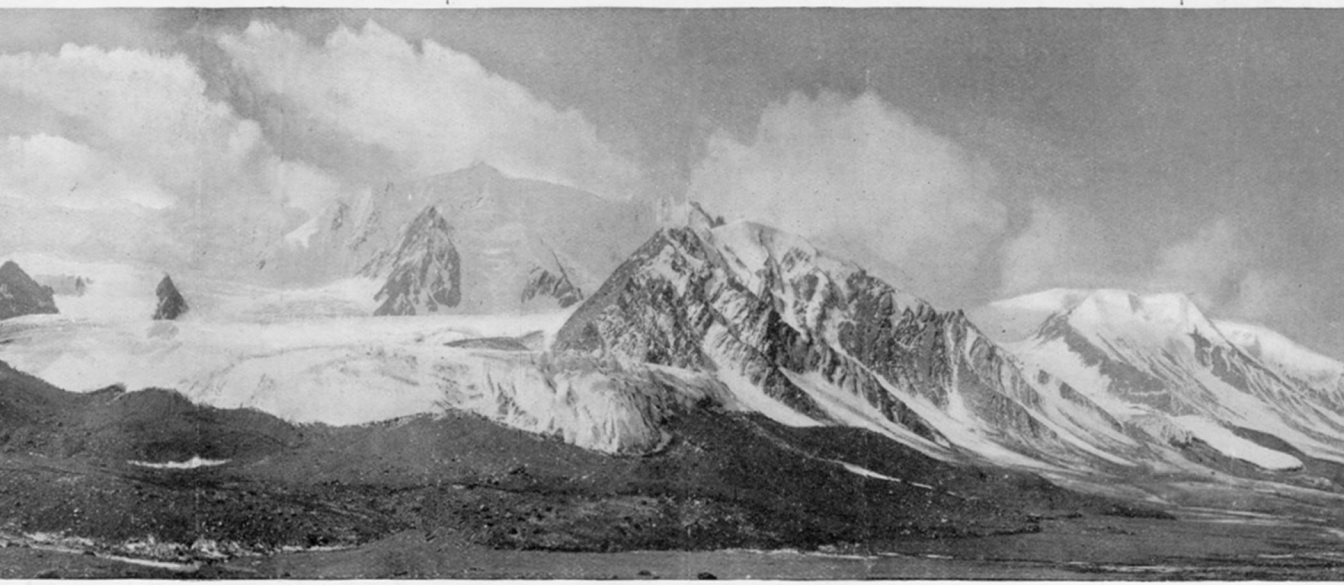
Distant Badakhshan ranges.

FIG. 6.—PANORAMIC VIEW TAKEN FROM SHITAM PASS (CIRC. 16,100 FEET ABOVE SEA), ON

The view extends from south, on extreme left (high range dividing Ghund and Shakhdarra Valleys), to north-west

Main Karambar Glacier feeding Yarkhun River.

Glaciers above Murghach.

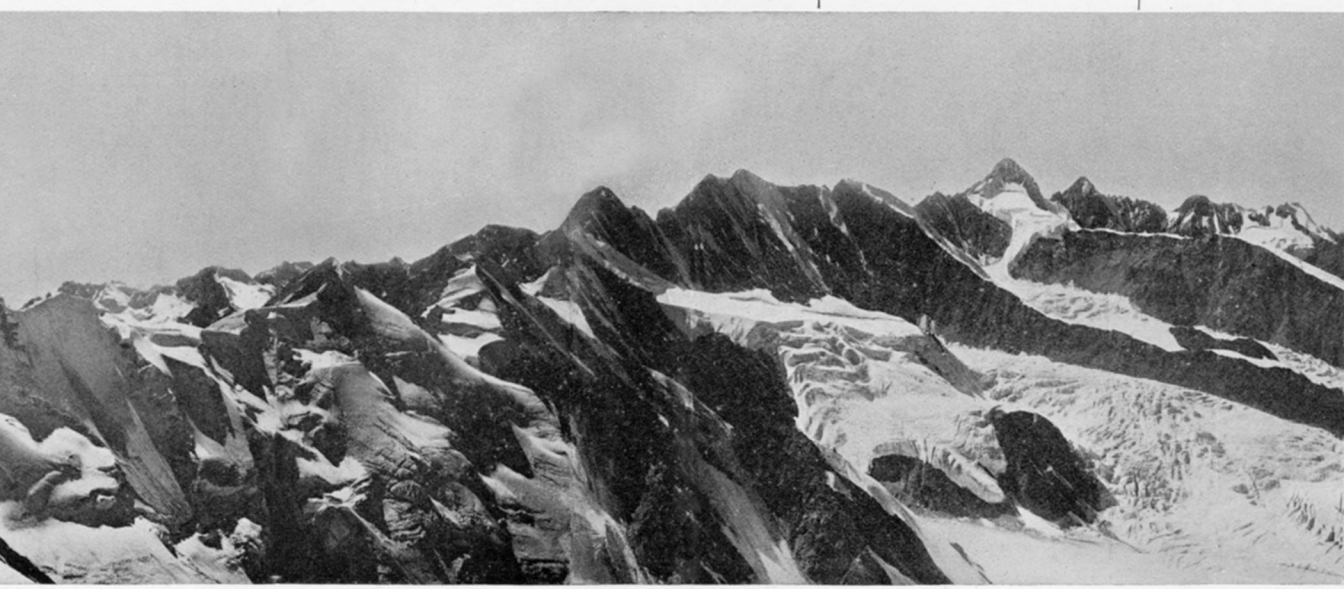


. 14,050 FEET ABOVE SEA) DIVIDING HEADWATERS OF KARAMBAR AND YARKHUN, OR MASTUJ, RIVERS.

Hindukush watershed towards Oxus), to west-south-west, on extreme right (uppermost Yarkhun Valley).

ges.

Glaciers feeding large ice-stream at head of Raumed



CIRC. 16,100 FEET ABOVE SEA), ON WATERSHED RANGE BETWEEN SHUGHNAN AND ROSHAN.

Ghund and Shakhdarra Valleys), to north-west on extreme right (range between Roshan and Yazghulam Valleys).

Glaciers above Murghach.

Peaks above Darkot and Chatiboi Glaciers.

MASTUJ, RIVERS.

rs feeding large ice-stream at head of Raumedh Valley.

Range north of Roshan Valley.

SHAN.

rs).

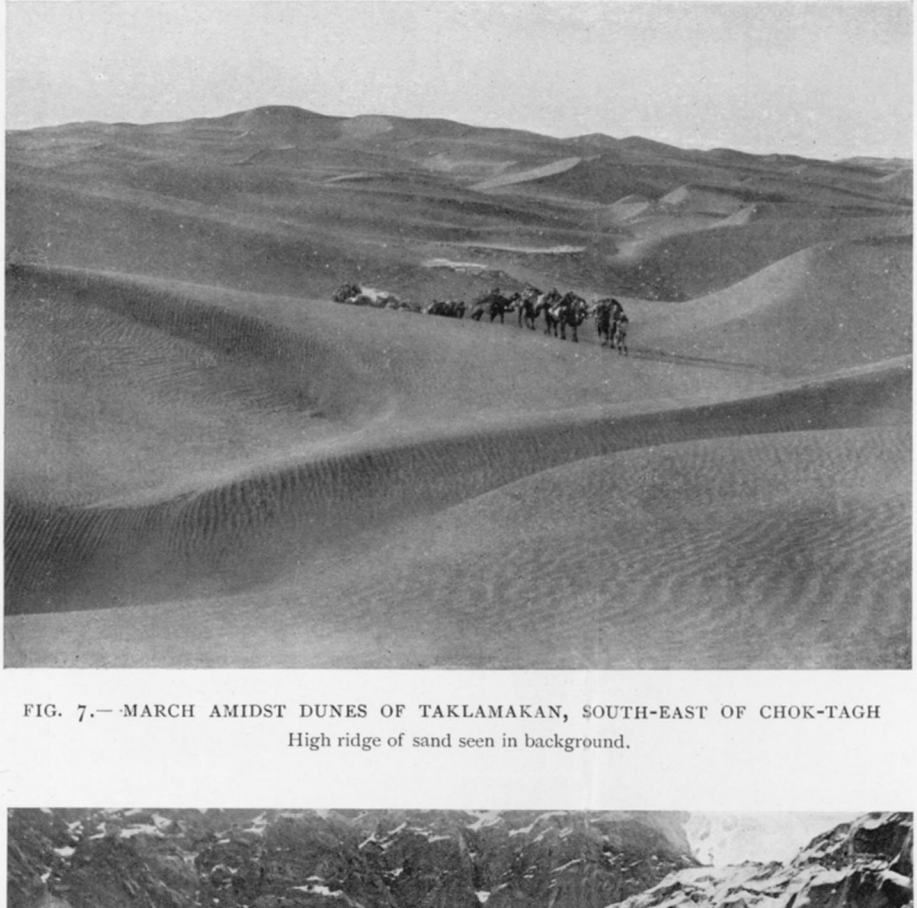


FIG. 7.—MARCH AMIDST DUNES OF TAKLAMAKAN, SOUTH-EAST OF CHOK-TAGH
High ridge of sand seen in background.

FIG. 8.—SNOUT OF NAMELESS GLACIER BLOCKING KARAMBAR RIVER BELOW RUKHNI.

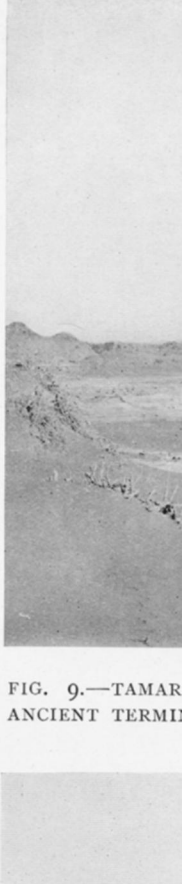


FIG. 9.—TAMAR
ANCIENT TERMI

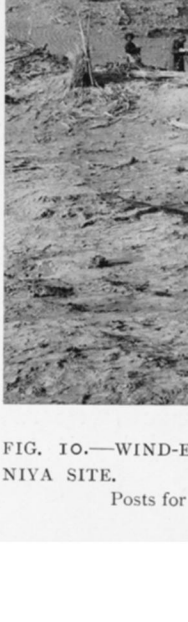


FIG. 10.—WIND-E
NIYA SITE.
Posts for

FIG. 9.—TAMARISK-COVERED SAND CONES ABOVE WIND-ERODED GROUND NEAR ANCIENT TERMINATION OF NIYA RIVER.

FIG. 10.—WIND-ERODED REMAINS OF ANCIENT ORCHARD (3RD CENTURY A.D.), NIYA SITE.

Posts for trellis, once carrying vines, on right, and tamarisk cones in background.

GROUND NEAR

NTURY A.D.),

ound.

FIG. 11.—GROUND CUT UP BY WIND EROSION INTO CLAY TERRACES, SOUTH-WEST OF LOU-LAN SITE.

Dead tree-trunks in distance on left mark ancient river course.

FIG. 12.— INTERIOR OF ANCIENT FORT WITH WIND-BREACHED PORTION OF RAMPART, SOUTH-WEST, OF LOU-LAN SITE.

Heavy timber débris in foreground marks position of completely eroded structure.

viâ Yarkand; by reducing in the same way my camp to a few indispensable followers, and keeping most of our fine camels for the transport of water in my six galvanized iron tanks and the very numerous goatskins I had brought from India, I could hope safely to overcome the difficulty about water. The advent of the cold season would help our brave camels to face a long fast from grazing and water.

Apart from the attraction presented by the short cut and the fascination of such a desert cruise, there was an important geographical task to justify the enterprise. Our surveys of 1908 had shown reason for the belief that the Mazar-tagh hills, then traced for over 20 miles into the Taklamakan, belonged in geological structure to an ancient range which started at an angle from the outermost T'ien-shan near Maral-bashi and once extended across the Taklamakan in a south-easterly direction. The way in which the bold island-like hills to the east of Maral-bashi have been carved out and isolated by the manifest action of wind-driven sand prolonged through endless ages left little doubt as to how the continuity of that assumed ancient hill range had been broken up. But only actual survey of the ground could supply definite proof.

On October 25 I left Maral-bashi with six hired camels, all I could secure, to act as a "supporting party" to lighten the loads of our own on the initial stages of the desert journey, and three days later we reached the last of those sand-scoured hills in the desert south-eastwards, known as Chok-tagh. From a lake near it, which inundations from the Yarkand River feed but which we found brackish at its end, Hedin had started in May 1896 on that bold journey through the sandy wastes eastward which ended with the destruction of his caravan and his own narrow escape. Steering a south-easterly course we forced our way for three trying marches into the sea of dunes. Closely packed and steep from the start, they grew steadily higher and invariably rose in a line running diagonally across our intended direction. By the second day all trace of vegetation dead or living was left behind, and an endless succession of mighty ridges, with not a patch of level sand between them, faced us (Fig. 7). The ridges to be climbed soon reached 200–300 feet in height, and progress became painfully slow with the heavily laden camels. Careful levels taken along our track showed an aggregate ascent of some 400 feet over a single mile's distance, with corresponding descents even more trying to the camels.

It was by far the most forbidding ground I had ever encountered in the Taklamakan. By the evening of the third day the hired camels of the "supporting party" had either broken down completely or showed serious signs of exhaustion. Next morning I ascended the highest dune near our camp, and carefully scanning the horizon saw nothing but the same expanse of formidable sand ridges like huge waves of an angry ocean suddenly arrested in movement. There was a strange allurement in this vista suggesting nature in the contortions of death. But hard as it seemed to resist the Syren voices of the desert which called me onwards, I felt

forced to turn northward. Though we men might have struggled through, I should probably have had to incur the needless sacrifice of some of our brave camels which were to be the mainstay of our transport for the winter's explorations, besides the loss of indispensable equipment. It was as well that I took that hard decision in time; for by the third day after there sprung up a violent 'Buran,' which, by its bitter cold, proved most trying even where fuel was abundant, and if met with amidst the high sand ridges would have brought us to a stand-still and caused serious suffering and risks.

Sorry as I was to give up the effort two interesting discoveries had already rewarded it. Again and again we had come between the high dunes upon patches covered with minute but easily recognizable fragments of rock flakes of the wind-eroded hill range once extending right through to the Khotan River. Elsewhere, fully 30 miles from the nearest traceable bed of the Yarkand River, a small belt of eroded ground displayed on its surface abundant remains of the Stone Age, proving occupation by a Palæolithic settlement of what is now absolutely lifeless desert. Neolithic arrow-heads turned up on similar ground nearer to Chok-tagh.

After crossing the Yarkand River behind that hill chain we fortunately secured ponies from a grazing-ground, and were thus enabled to push on rapidly through hitherto unsurveyed tracts of riverine jungle, largely dead, to where, near Gorachöl, the last dried-up offshoots of the Kashgar-darya bed lose themselves. Thence, with fresh animals, we gained the delta of the Khotan River by a route not previously surveyed. It showed me the great change which, since my passage of 1908, had taken place in the river's terminal course. A series of rapid marches by the Khotan-darya, then completely dry, carried me back to the end of the Mazar-tagh range I had first visited in 1908. There I found the transport and labourers ordered ahead from Khotan duly awaiting me, and was able by resumed spade-work to secure interesting archæological results at the ruined fort. Besides additional written records of Tibetan times there came to light remains of a Buddhist shrine, immediately below the alleged Muhammadan saints' tombs, from which the desolate desert hill derives its present designation. Thus the continuity of local worship, so important a feature in the history of Asiatic religious beliefs, received another striking illustration.

On November 21 I regained my old haunts at Khotan town, and was cheered by a warm welcome from my old local friends. A brief halt necessitated by manifold practical arrangements was used also to gather such antiques as my old friend the Indian Aksakal Badruddin Khan, now rewarded by the title of Khan Sahib for his help in the past, and others had collected for me from Yotkan, the site of the ancient Khotan capital, and from the desert sites which Khotan "treasure-seekers" are in the habit of annually searching. On November 28 I left the familiar base of my former expeditions to resume the long journey eastwards. There

was still a marching distance of close on 700 miles separating me from Lop-nor, and it was essential for the work planned in that desert region that I should reach it in time while the winter cold lasted and allowed water to be transported in the convenient form of ice.

But rapid as my progress had to be I could not forgo such convenient opportunities for archæological work as familiar sites near my route still held out. Thus we recovered some interesting fresco remains from the ruin of a Buddhist shrine which had come to light since my last visit in the area of tamarisk-covered cones of sand north of Domoko, near which Hsüan-tsang's *Pi-mo* (Marco Polo's Pein) must be located. From the Niya oasis, which was reached on December 9, I revisited the fascinating sand-buried settlement in the desert northward below the pilgrimage place of Imam-Ja'far-Sadik. Abandoned to the desert since the third century A.D., it had yielded plenty of important relics and records in the course of my former explorations. But owing to the deceptive nature of the dune-covered ground and other reasons, it had not been possible to exhaust it completely. It did not disappoint me now either. By a close search of previously unexplored ground to the south-west of the main portion of the ancient oasis we discovered more ruined dwellings of the same early period hidden among the high tamarisk-covered sand-cones (Fig. 9). The employment of a large number of diggers rendered rapid clearing possible also in the case of certain structures which before had seemed too deeply buried in the sand for complete exploration. Thus, apart from furniture, household implements, etc., we recovered a further collection of Kharoshthi documents on wood, written in the Indian language and script which had prevailed in official and Buddhist ecclesiastical use from Khotan to Lop-nor during the first centuries of our era.

It was a particularly curious discovery when, not far from the still traceable dry river-bed, we came upon the remains of a large and remarkably well-preserved orchard, where the carefully arranged rows of various fruit trees and the trellis-carried vines, though dead for many centuries, could be examined in almost uncanny clearness (Fig. 10). It was not surprising to find there also the rafters of a foot-bridge, once spanning the river, still stretched out across its dry bed. It had meant a week's constant work under high pressure, and it was only by the light of bonfires that the final excavation of the large structure was finished, which in 1901 we had called the Yamên. It was a curious chance that just its last room, which then had baffled us by its deep sand, proved to contain those "waste papers," *i.e.* wooden records, of the office, we had before vainly hoped for. It seemed like a farewell gift of the ancient site which I had somehow come to look upon as my own particular estate, and I found it hard to tear myself away from it.

No appropriate return was possible to the dead. But at least I could do something for those living who were nearest. My renewed visit to this ground had allowed me also to make observations of direct geographical

interest concerning changes in the terminal course of the dying Niya River, etc. Among these I had noticed the instructive fact that cultivation at the tiny colony of Tulkuch-köl, established at the very end of the present river-course, below Imam-Ja'far-Sadik's Ziarat, had recently been abandoned, not from want of water, as the usual theory might have suggested, but, on the contrary, owing to a succession of ample summer floods which carried away the canal-head, and with which the locally available labour could not cope. My resumed excavations had brought a large *posse* of able-bodied labourers near the spot. So when I had come back with them from the ruins and was leaving, they were set to work to raise a new barrage across the deep-cut flood-bed, and thus secure water for the little canal, a couple of days' work. As I deposited the small sum needed for their wages with the Mazar Shaikhs, the task was carried through with a will.

From the end of the Niya River I led my caravan through unexplored desert, with high sand ridges in places, and more of salt-encrusted and often boggy ground, to the Endere River. Thence we had to follow the old caravan track to Charchan, which we reached by December 28. It was bitterly cold in the desert, with minimum temperatures down to 50° Fahr. below freezing-point. But there was compensation in the exceptionally clear weather, which allowed us to sight day after day the grand snow-clad rampart of the main Kun-lun range far away to the south. At most seasons it remains quite invisible from the caravan track connecting Charchan with Niya and Keriya. In 1906 numerous peaks on it had been triangulated by Rai Ram Singh, and with their help we could now map our route to Charchan and onwards, far more accurately than had been previously possible.

At Charchan I found the oasis distinctly increased since my last visit, and was able to pick up nine additional hired camels badly needed for the work ahead in the Lop region. But the news received about events which were said to have occurred at Charkhlik, its chief inhabited place, was by no means welcome. A band of Chinese "revolutionaries," *recte* gamblers and adventurers, had a short time before started for that place from Charchan, and was reported to have attacked and captured the district magistrate of Charkhlik, besides committing other outrages *en route*. The Chinese sub-divisional officer of Charchan had been helpless to prevent the outbreak, and was evidently sitting on the fence. He considerately provided me with two introductions for Charkhlik, one to the unfortunate Amban, assuming that by any means he had regained freedom and authority, and the other for the leading spirit of the "revolutionaries," whom he shrewdly guessed to have been installed in office instead of him.

We left Charchan on New Year's Eve, 1914, and did the desert journey to the western border of the Lop district by seven long marches, mainly through the jungle belt on the left bank of the Charchan-darya, which was a route new to me. Splendidly clear weather favoured us, and so did the severe cold, which had covered the river and its marshes with strong ice.

We did not meet with a single wayfarer, which struck me as strange at the time. On approaching the jungle belt of Vash-shahri, an outlying little colony of Lop, we found the route guarded by a large party of armed Muhammadans, who at first mistook us for a fresh batch of "revolutionaries" (many of the Chinese had taken to masquerading in queer European clothes). But Roze Beg, the headman of Vash-shahri and an old acquaintance, soon recognized me. From him I learned the queer story how the little band of "gamblers" from Charchan had captured the hapless Amban, all the local Muhammadans first deserting him, and then looking on with placid indifference when some days later their magistrate was cruelly put to death by the bandits, after having been forced to disclose the place where his official moneys were hidden. The leader of the band had set himself up as Amban *ad interim*, and was duly obeyed by the local chiefs, Roze Beg himself included. Fortunately his régime proved short-lived, and there was no need of my introduction to him either; for within a week a small detachment of Tungan Government troops had arrived from far-away Kara-shahr in the north, under a capable young officer. Stealthily introduced at night into the oasis by the same adaptable Begs, they found little difficulty in surprising the "revolutionaries," most of whom were killed in their sleep and the rest captured. So tranquillity once more ruled at Charkhlik, and Roze Beg was now engaged in laying an ambush for more "gamblers" expected to come from Charchan, in ignorance of the turn their affairs had taken. In this loyal task he duly succeeded within a day of my passage.

On January 8 I arrived at Charkhlik. It was from this modest little oasis, the only settlement of any importance in the Lop region, representing Marco Polo's 'City of Lop,' that I had to raise the whole of the supplies, labour, and extra camels needed by the several parties for the explorations I had carefully planned during the next three months in the desert between Lop-nor and Tun-huang. I knew well the difficulties which would attend this task even under ordinary conditions. But now I found them greatly increased by the preceding local upheaval and all its consequences. The irruption of the "revolutionaries" and its subsequent repression by the Tungan troops, who had "by mistake" killed even the few Chinese subordinates of the legitimate Amban, had left no Chinese civil authority whatever, and in its absence no effective help could be hoped for from the easy-going Lopliks and their indolent Begs. The trouble about adequate supplies and transport became all the more serious as the passage of relatively large bodies of Tungan troops sent to operate against the numerous "revolutionary" elements which were known to lurk among the Chinese garrisons of Keriya and Khotan, threatened completely to exhaust the slender resources of Charkhlik.

The six days' stay I was obliged to make at Charkhlik in order to secure at least a portion of my requirements through the help of a few old Lop friends, was thus an anxious time for me. I greatly chafed at the

delay, little realizing at the time what a boon in disguise the revolutionary disturbance had been for me. Fortunately I was able to use my stay also for some profitable archæological labour. While executions of captured rebels, requisitions for the troops marching on towards Keriya, etc., kept the little oasis in unwonted animation, I managed to search two small sites near by on the river but beyond the southern edge of cultivation, which previously had escaped me. From ruined Buddhist shrines there I recovered remains of Sanskrit manuscripts on birch-bark, palm-leaf, and silk, fragmentary but of special interest as suggesting import from India by the direct route which still leads from Charkhlik across the Tibetan plateaus to the south.

On the last day of my stay I had the great satisfaction of seeing R. B. Lal Singh safely rejoin me after fully four months of separation. After leaving me in September in the mountains of the Muztagh-ata range he had pushed on and started triangulation of the main K'un-lun range from near Kapa by the middle of October. The work carried on at great elevations and on ground devoid of all resources implied very considerable hardships. But my indefatigable old travel companion faced them with his often proved zeal and succeeded in extending his system of triangles, based on Ram Singh's work of 1906, eastward for over five degrees of longitude before excessive cold and heavy snowfall obliged him to stop it in the mountains. Thus a net with numerous carefully fixed stations and exactly observed angles to many high peaks had been carried well beyond the actual Lop-nor marshes and linked up at the other end with the Indian Trigonometrical Survey. Not satisfied with this achievement, Lal Singh had then continued survey work with the plane-table towards Tun-huang, taking special care to obtain many height observations by mercurial barometer, etc., along his route through those inhospitable snow-covered mountains. After reaching Nan-hu he had struck through the desert north and returned by the track leading along the southern shore of the ancient dried-up salt sea of Lop. The difficulties of this track, the only one through the Lop desert which now, as in Marco Polo's time, is practicable for caravans, were illustrated by the fact that Lal Singh's party found no ice yet formed at the most brackish of the springs along it, and consequently suffered much from the want of drinkable water.

By 15 January 1914 I left Charkhlik for Miran, two marches off to the east, where in 1907 I had made important discoveries among ruins which mark the site of the earliest capital of the " Kingdom of Shan-shan or Lou-lan," corresponding to the present Lop region. Apart from abundant records found in a fort of the Tibetan period I had brought to light in two ruined Buddhist shrines of far earlier date wall paintings of great artistic interest, strikingly reflecting the influence of the Græco-Buddhist art of Gandhara and some almost Hellenistic in character. Owing to the shortness of the time then available for a task presenting exceptional technical difficulties, we had in 1907 been able to remove the frescoes from only one of these temples,

that remarkable series forming the "angel dado" which was exhibited in 1914 in the new galleries of the British Museum together with other selections from my former collection. Of the paintings adorning the walls of the other shrine only specimens could then be safely taken away, and the subsequent attempt made to save the rest was frustrated by the tragic fate which struck my old assistant Naik Ram Singh with blindness at this very place.

I had special reason to regret this when on my renewed visit I found that a portion of the fresco frieze, representing an interesting Buddhist legend, had been broken out by a later visitor in a clumsy fashion which must have caused serious injury if not loss. But the very interesting frescoed dado with its cycle of youthful figures, representing the varied joys of life, set between graceful garland-carrying putti, had fortunately escaped under the cover of sand with which the interior had been filled in as a precautionary measure, and this we now were able to remove intact with all needful care. It proved a delicate task, which greatly taxed the trained skill of Naik Shams Din, my "handy man," and under the icy blasts to which we were almost continually exposed the work was particularly trying. I used the fortnight's stay necessitated by these labours also for a careful search of the adjoining desert belt north, where hidden away amidst tamarisk-covered sand-cones we discovered shattered ruins of two more Buddhist temples of somewhat later date, and secured from them stucco sculptures and other relics of interest.

Simultaneously I had to push on preparations for the explorations which were to take our several parties into the waterless desert north and north-east of the extant Lop-nor. It was some help that the small colony of Lopliks, formerly living at Abdal, whom a slow impulse is gradually turning from semi-nomadic fishermen and hunters into somewhat casual agriculturists, had since 1908 transferred their homesteads to the patches of land now again irrigated from the stream of Miran. But apart from their exceedingly scanty resources and the struggle with their evasive cunning, I had another source of worry to face during those anxious days. Within a week of my arrival at Miran I received a letter from Sir George Macartney bringing serious news. From the headquarters of the provincial Government at Urumchi an edict had issued ordering the district authorities to prevent all surveying work on our part, and in case of any attempt to continue our explorations to arrest and send us under escort to Kashgar "for punishment under treaty." There is neither room nor need here to discuss the probable motives of this intended obstruction, or the alleged regulations by the General Staff of the Chinese Republic quoted in explanation. I knew that the intercession of our Minister at Peking had been immediately invoked from Kashgar by my ever-watchful friend and protector. But that help could make itself felt only after months. In the meantime I should have to contend, if not with an attempt at forcible interference, yet with Chinese passive obstruction easy enough to

apply in my circumstances and particularly dangerous to my plans. Soon there arrived a copy of the edict from the officious Amban at Kara-shahr, whom I had previously asked for a Mongol interpreter. I could gauge the force of the import and language when I saw the sallow face of my poor shrivelled Chinese secretary turning a livid grey as he read through the document and explained it.

Evening after evening as I came back from the day's work at the ruins I looked anxiously among my indolent Lopliks for the first signs of the feared passive resistance to my plans which would have so well suited their natural bent. But fortunately the expected prohibition from Charkhlik never came. As I found out later, I owed this lucky escape to the opportune "revolutionary" outbreak. It had disposed of the original district magistrate before he could take any action. His rebel successor, who had taken charge of the Yamên and found the orders there, had more urgent and profitable business to attend to before he was killed himself. Subsequently the military commandants, in strict observance of Chinese official convention, had carefully abstained from looking into civil affairs, and kept the Yamên papers sealed up until the new Amban had arrived from Urumchi and taken charge of the seal of office. But what a relief it was when I had safely collected all I needed and could set out for the waterless desert where I should know myself completely protected from any risk of human interference! Great as were the difficulties and risks from lifeless nature to be faced there, I was buoyed up by the assurance of freedom for the timely execution of my plans.

On January 23 I had started Lal Singh northward by the Tarim to Tikenlik, where he was to pick up the seven strong camels I had asked Abdur Rahim, the hardy hunter from Singer and our old guide in the Kuruk-tagh, to provide. Thence he was to carry out an exact survey of the ancient river-bed and its branches by which the waters of Konche-darya once reached the area, now wholly desiccated desert, south of the Kuruk-tagh foothills, where Hedin in 1900 had first discovered the ruins of the "Lou-lan" site. The latter was to be our rendezvous. Surveyor Muhammad Yakub Khan, some days later, was sent off with five camels by the desert track to Tun-huang in order to carry a series of exact levelling operations from the eastern end of the great salt-encrusted basin which marks the ancient dried-up Lop sea, towards the termination of the Su-lo Ho drainage.

My own tasks included the excavation of any ruins which the intended exploration of the dried-up delta of the "Kuruk-darya" and the search for the ancient Chinese route once leading eastwards from Lou-lan might reveal. In order to assure adequate time for the latter rather hazardous task and for the survey of the unexplored north and east portions of the great salt-encrusted sea-bed, which, there was reason to assume, that ancient route must have passed through or skirted, it was essential to effect excavations rapidly, and therefore to take along as many

labourers as I could possibly manage to keep supplied with water, *recte* ice. What with big loads of ice sufficient to assure minimum allowances of water for thirty-five people for at least one month, with food supplies of one month for all and of an additional month for my own people, and what with the indispensable outfit of furs, felts, etc., to afford protection in the wintry desert exposed to icy gales, the thirty camels I had succeeded in raising, including our own, were by no means too many. It goes without saying that everybody had to walk, and that the labourers had to help by the carriage of light loads.

It was a great relief when, on February 1, I had safely started this large column for the desert north-eastward. Next day we took up our water-supply in the shape of big blocks of ice packed in bags from a terminal lagoon of the Tarim. Thence four marches brought us to my immediate goal, a large ruined fort (Fig. 12) which had first been sighted by Tokhta Akhun, my faithful old Loplik follower, apparently in 1910, when he returned from the Lou-lan site after guiding there Mr. Tachibana, the young Japanese explorer. By clearing the substantial dwellings within we recovered plentiful relics in the shape of architectural wood-carvings, implements, coins, etc.; these proved occupation to have ceased here about the same period, early in the fourth century A.D., as at the Lou-lan site. Wind-erosion had deeply scoured the ground outside, but had not succeeded in more than breaching in places the very solid enclosing rampart built of alternate layers of brushwood fascines and stamped clay, after the fashion of the ancient Chinese *Limes*. A well-marked dry river-course near the fort was easily traced by the rows of fallen dead trees once lining the banks, and the direction clearly proved it to have been a southern branch of the ancient Kuruk-darya ("the dry river"), which once had carried water to the Lou-lan site.

By following up this river-course we came upon a second and smaller fort, and a reconnaissance north of it soon led to the discovery of the scattered remains of an extensive settlement. The dwellings, built of timber and wattle after the fashion of those at the Niya site, had suffered greatly through the erosive action of wind-driven sand. Yet, where consolidated refuse heaps had helped to protect the original floors, we found ancient records on wood and paper in Kharoshthi and another Indian script, as well as in Chinese and Early Sogdian, besides very interesting and well-preserved remains of furniture, personal equipment, fabrics, and the like. There could be no doubt that this settlement, too, had been occupied down to the beginning of the fourth century A.D., and by people sharing the same well-developed civilization due to the mixture of Indian, Chinese, and Western influences which my finds of 1906 at the Lou-lan site had illustrated.

The exact antiquarian evidence here obtained has its special value, because it enables us to date a variety of physical features which I could observe in the immediate vicinity of the ruined settlement. They throw

fresh light on the hydrography and early occupation of this part of the Lop-nor region during historical times and those immediately preceding them. For the latter the abundant finds of stone implements, such as Neolithic arrow-heads and jade celts, which were picked up from the eroded surface of the ground near these ruins afforded a very useful guide. The fact that these finds of stone implements continued over most of the wind-eroded ground up to the Lou-lan site had a significant bearing on the so-called "Lop-nor problem," the discussion of which has long been carried on without an adequate basis of surveys.

It was similarly important that on the two long marches which brought us there we met a succession of ancient river-beds all lined by rows of dead Toghrak (wild poplar) trees, and clearly recognizable by their direction as having branched off from the "Dry River" skirting the foot of the Kuruk-tagh (Fig. 11). It was plainly a considerable delta, not a large terminal lake, which had existed here during the historical times accessible to antiquarian evidence, and our new surveys have shown how far it extended south and south-west. Finds of Chinese Han coins and of small metal and pottery fragments of undoubtedly the same historical period mingled freely with those of the Stone Age, just on the ground where (according to a recent theory) we ought to have been crossing the position assumed for the Lop-nor of the epoch when Lou-lan was occupied.

It was long after nightfall on February 10 that we struggled through to the old Chinese station marked by the chief ruins of the Lou-lan site. It was very trying ground we had to cross all day, cut up by wind erosion into an unending succession of narrow and steep clay terraces all running east-north-east to west-south-west, the direction of the prevailing wind, and very difficult for the camels to pass. From our base camp at the foot of the familiar Stupa ruin I pushed out reconnaissances into the unknown desert to the east and north-east, while keeping my diggers at work on deeper deposits of refuse, etc., which had escaped attention during the stress of our previous visit. Among the numerous finds of ancient documents on wood and paper which rewarded this clearing, I may specially mention one, unfortunately fragmentary, which shows a script as yet unrepresented among all our former collections. The rest were in Chinese, Kharoshthi, and the Iranian language known since my finds of 1906–07 as Early Sogdian.

Quite as interesting to me were the series of close observations I was able to make on ground immediately adjoining the ruins, as to the levels at which the process of denudation and wind-erosion had been arrested from time to time by a temporary return of moisture and desert vegetation affording protection to the soil. These clearly showed that the process, striking as its effects everywhere are, had been neither constant nor uniform during the sixteen hundred years which have passed since the abandonment of the station. Hence a mere line of levelling carried across areas which wind-erosion has affected in such

different ways, could not, in the absence of dateable marks in the shape of structural or other remains, be expected to yield reliable outlines of the hydrographic configuration of the ground at earlier periods.

But the chance for more exciting work came when I could follow up what the reconnaissance surveys, carried out particularly by Afrazgul Khan, my young Pathan surveyor, with great zeal and intelligence, had revealed towards the north-east. There on ground wholly untouched by human feet for so many centuries, I had hoped to find ruins near what I conjectured to have been the line of the earliest Chinese route leading into the Tarim Basin from Tun-huang and the extreme west of China proper. A succession of important discoveries soon confirmed that hope. On the top of a large clay terrace or Mesha, rising steeply some 35 feet above the eroded ground-level, I came upon most interesting remains of an ancient burial-ground. On the sides of the mound graves had been partially exposed and destroyed by wind-erosion undercutting the banks and causing them to fall. But the top of the Mesha had been safe from this destructive agent, and there we found a series of large grave pits which yielded a rich antiquarian haul in quite bewildering confusion.

Mixed up with human bones and fragments of coffins there emerged here in abundance household implements of all sorts, objects of personal use such as decorated bronze mirrors, wooden models of arms, Chinese records on paper and wood, and, above all, a wonderful variety of fabrics which delighted my eye. Among them were beautifully coloured silks, pieces of rich brocade and embroidery, fragments of fine pile carpets by the side of coarse fabrics in wool and felts. It soon became evident that these remnants of garments of all sorts had been used for wrapping up bodies, perhaps partially embalmed. I could not have wished for a more representative exhibition of that ancient Chinese silk trade which we know to have been a chief factor in opening up this earliest route for China's direct intercourse with Central Asia and the distant West, and which had passed along here for centuries.

A variety of very interesting problems as to the origin of designs, etc., usually attributed to Persian art of the Sassanian period, had been raised by the fine decorated silk fabrics I had discovered on my former journey in the walled-up cave temple of the "Thousand Buddhas" near Tun-huang. Here a mass of far older and dateable materials was coming to light to help to solve those problems. I soon realized from various indications that the contents of these pits must have been collected, before the final abandonment of the Chinese military station of Lou-lan, from older graves which wind-erosion or some similar cause had exposed or was threatening. Consequently the relics here saved, in obedience to a pious custom still prevalent among the Chinese, could safely be assigned to that period of the rule of the Han dynasty which followed the first expansion of Chinese trade and power into Central Asia about the close of the second century B.C. There was no time then to examine the wealth of beautiful

designs and colours making a feast for my eyes. But I felt that in this utter desolation of the wind-eroded clay desert, where nature was wholly dead and even the very soil was being reduced, as it were, to the condition of a skeleton, there had opened up a new and fascinating chapter in the history of textile art. It will take years to read it in full clearness.

My satisfaction was equally great when, after a long and fatiguing tramp from our base, I found myself by nightfall at a large walled enclosure near to where one of the dry river-beds passing the Lou-lan site seemed to merge in the hard salt expanse of an ancient terminal marsh. We had struck the fortified *castrum* which, as close examination soon showed, had served as a *point d'appui* for Chinese missions and troops where they first reached Lou-lan territory after having crossed the salt-encrusted dry lake-bed and skirted its absolutely barren north shores. Its walls, built with regular alternate layers of clay and carefully secured reed fascines, and remarkably well preserved after two thousand years' exposure, showed constructive features in closest agreement with those observed in the westernmost extension of the ancient Chinese border wall which I had discovered and explored in 1907 in the desert of Tun-huang.

There could be no doubt that the fort dated, like the Tun-huang *Limes* itself, from the first military advance of the Chinese into the Tarim Basin, about 104 B.C., and that it represented, as it were, the bridge-head of the desert route by which that advance was made possible. I had become so familiar with that ancient *Limes* and the technical skill displayed in its construction that I could not help rejoicing at the way in which this work from the hands of the same old Chinese engineers had withstood the attacks of that most formidable enemy in this region, wind-erosion. The walls of reed fascines had nowhere been seriously breached, while inside the circumvallation the force of the wind has worked terrible havoc, scouring out big hollows down to 20 feet and more below the ground-level and reducing a large central structure to a bare clay terrace strewn with scattered débris of timber. Under the shelter of the north wall, however, refuse heaps had survived, and these yielded Chinese records on wood and paper.

Beyond this fortified Chinese station other remains were traced. Of these it must suffice to mention a small ruined fort which occupied a commanding position on the narrow top of a precipitous clay ridge fully 100 feet high (Fig. 14). It had evidently served as a stronghold and look-out post for some chief of the indigenous population of Lou-lan. Of the type, habits, and civilization of the Lou-lan people as the Chinese found them on the first opening of the route through the desert, the Han Annals have preserved some curious notes. The accuracy of these was illustrated in a most striking fashion by the examination of the graves covering the other end of the clay ridge. Here we found the bodies of men and women, probably members of the old chief's family, in a truly wonderful state of preservation, due, no doubt, to the absolute dryness of the climate and the safe elevation

of their resting-places. The peaked felt caps of the men decorated with big feathers and other trophies of the chase, the arrow-shafts by their side, the simple but strong woollen garments fastened with pins of hard wood, the neatly woven small baskets holding the food for the dead, etc., all indicated a race of semi-nomadic hunters and herdsmen, just as the Chinese describe them.

It was a strange sensation to look down on figures which but for the parched skin seemed like those of men asleep, and to feel brought face to face with people who inhabited, and no doubt liked, this dreary Lop-nor region in the first centuries A.D. The features of the heads closely recalled the *Homo alpinus* type, which, judging from my anthropometric records, worked up by Mr. T. A. Joyce, still supplies the prevalent element in the racial constitution of the indigenous population of Chinese Turkestan and is seen in its purest form in the Iranian-speaking tribes near the Pamirs. The general appearance of these Lou-lan people seemed curiously to accord with the significant juxtaposition in which small bronze objects of Chinese origin were picked up on the slope below the little fort together with stone implements. There were indications elsewhere, too, suggesting that the interval separating the latest Neolithic period in Lou-lan from the advent of the Chinese may not have been a very long one.

Apart from their direct interest, the discoveries here briefly indicated had a special importance by furnishing me with a safe starting-point and some guidance for the difficult task still before us, that of tracing the line of that famous ancient route through the forbidding desert eastwards. But it was impossible to set out for it at once. Incessant toil in the waterless desert with constant exposure to its icy winds had exhausted our Loplik labourers, hardy plants as they were and pleased with the rewards I gave them. When the last digging at the outlying ruins to the north-east had been done, I had to take them back to our Lou-lan base camp, whence they could return in safety under Ibrahim Beg's guidance to the world of the living.

The season's initial sand-storm, which had broken with full fury on the preceding night and which the Lopliks attributed to the wrath of the dead we had disturbed, made this march exceptionally trying, apart from the risks of straying which the semi-darkness involved for the men. To my great relief I found Lal Singh safely arrived after accomplishing his survey tasks in the west on a circuit of some 400 miles. He had been duly joined by that plucky hunter, Abdur Rahim, who with his life-long desert experience and his magnificent camels brought fresh strength for our column. It may serve to illustrate the stamina of his animals, bred and reared in the Kuruk-tagh, that the baby camel to which one of them gave birth at the Lou-lan site subsequently traversed with us all those waterless wastes of salt and gravel unharmed and almost throughout on its own legs.

Together we then moved north to the Kuruk-tagh in order to secure

for our hard-tried camels a few days' rest with water and grazing at the salt springs of Altmish-bulak. The new route followed on the three days' march allowed me to examine more burial-grounds on the gravel glacis which overlooks the ancient riverine belt, now dried up and eroded by the wind. Their remains proved very helpful for explaining my previous finds east of the Lou-lan site. But even more welcome was the four days' halt at Altmish-bulak. Its springs, saline as they are, gave our brave camels their first chance of a real drink after three weeks, and on the reed beds around them they could gather fresh strength for the hard task still before them. After the dead world we had toiled in, this little patch of vegetation seemed delightful, too, to us humans.

After replenishing our ice supply and taking a carefully arranged store of fuel, we started on February 24 for our respective tasks. The one allotted to Lal Singh was to survey the unknown north-east shores of the great salt-encrusted basin, which represents the fullest extension of the dried-up ancient Lop-nor, and the barren hill ranges of the Kuruk-tagh overlooking them. I myself, accompanied by Afrazgul and Shams Din, proposed to search for the ancient Chinese route where it left the edge of the once inhabited Lou-lan area, and to trace it over whatever ground it might have crossed, right through to where it was likely to have diverged from the line still followed by the desert track, which leads from Tun-huang along the southern shore of the great dried-up Lop sea towards Miran. It was a fascinating task after my own taste, combining geographical and historical interest, but one attended also by serious difficulties and risks.

From what I knew of the general character of the ground before us, it was certain that we could not hope for water, nor over most of it for fuel to melt our ice with, before striking the Tun-huang caravan track, a matter of some ten days' hard marching judging from the approximately calculated distance. There was a limit to the endurance of our brave camels, and with the heavy loads of ice, fuel, and provisions which had to be carried for the sake of safety, I could not expect the animals, already hard tried by the preceding weeks' work in absolute desert, to remain fit for more than ten to twelve days. It was impossible to foresee what physical obstacles might be met and might delay us beyond the calculated measure of time in this wilderness devoid of all resources and now more barren, perhaps, than any similarly large area of this globe. There remained the problem how to hit the line of the ancient route and to track it through on ground which long before the dawn of historical times had ceased to offer any chance for human occupation. For a careful search of any relics left behind by the ancient traffic, which had passed through what the Chinese Annals vaguely describe as the terrible "desert of the White Dragon Mounds," there would be no time. Much, if not most, had to be left to good fortune—and, combined with what hints I could deduce from previous archæological and topographical observations, Fortune served me better than I had ventured to hope.

Physical difficulties soon presented themselves as we made our way south through and across a perfect maze of steep clay terraces all eroded by the same east-north-east wind which had sculptured the usual 'Yardangs' of Lou-lan, but of far greater height. Having thus regained the vicinity of the terminal *point d'appui* above mentioned of the ancient route, I soon found confirmation for my previously formed conjecture that the initial bearing of the route lay to the north-east. It was marked by the almost completely eroded remains of an outlying indigenous camping-place and of an ancient watch-tower of the type familiar to me from the Tun-huang *Limes*, which I opportunely discovered on towering terraces at the very edge of ancient vegetation. We had reached here the extreme eastern limit of the area to which the waters of the Kuruk-darya had once carried life. Beyond there were no ruins to guide us. The desert eastwards was even in ancient times as devoid of plant or animal life of any sort as it now is. As we left behind the withered and bleached fragments of the last dead tamarisk trunk lying on the salt soil, I felt that we had passed from the land of the dead into ground that never knew life—except on the route to be tracked.

As we steered onwards by the compass across absolutely barren wastes of clayey *shōr*, detritus or hard salt crust, chance helped us in a way which at times seemed almost uncanny. Again and again finds of early Chinese copper coins, small metal objects, stone ornaments and the like gave assurance that we were still near the ancient track by which Chinese political missions, troops and traders, had toiled for four centuries through this lifeless wilderness. It is impossible to record here exact details of all such finds. But I may at least briefly mention two thrilling incidents which by their nature helped greatly to raise the spirits of my men and filled them with superstitious confidence in some spirits' safe guidance. At the time they made me too feel as if I were living through in reality experiences dimly remembered from some of Jules Verne's fascinating stories I had read as a small boy.

Thus, on the third day of our march, when the last traces of ancient desert vegetation had long remained behind, we suddenly found the ancient track plainly marked for about 30 yards by over two hundred Chinese copper coins strewing the dismal ground of salt-encrusted clay. They lay in a well-defined line running north-east to south-west, just as if some kindly spirit among those patient old Chinese wayfarers, who had faced this awful route with its hardships and perils, had wished to assure us that the bearing I was steering by was the right one. In reality they must have got loose from the string which tied them and gradually dropped out unobserved through an opening in their bag or case. The coins were all of the Han type, and seemed as if fresh from some mint. Some 50 yards further on in the same direction we came upon a similar scattered heap of bronze arrow-heads, all manifestly unused and looking as if newly issued from some arsenal of Han times. Their shape and weight

exactly agreed with the ancient Han ammunition I had picked up so often along the *Limes* of Tun-huang, which was garrisoned during the first century before and after Christ. The way in which the coins and arrow-heads had been allowed to remain on the ground suggested that they had dropped from some convoy of stores in Han times which was moving at night-time, and probably a little off the main track but still in the right direction.

Next day's long march brought another discovery equally stirring and useful. We had followed our north-easterly course across easy ground of bare clay and mica detritus when it approached at a slant a forbidding belt of salt-coated erosion terraces, clearly of the type to which the Chinese of Han times had applied the graphic designation of "White Dragon Mounds." I knew it foreboded the close vicinity of that ancient sea-bed encrusted with hard crumpled salt which I was anxious to steer clear of as long as possible, on account of the terrible surface it would present for our poor camels' feet. They were sore already, and the painful process of "re-soling" (by pieces of ox-hide sewn on to the live skin) had to be resorted to night after night. I was just preparing to climb the prominent Mesha which had served as our guiding point, and to use it as a look-out, when we found on its slopes Chinese coins, soon followed by quite a collection of metal objects, including bronze ornaments and a well-preserved dagger and bridle in iron. Evidently the terrace had served as a regular halting-place, and a careful inspection of the ground ahead suggested that it had been used for this purpose, because at its foot was the first piece of ground level and tolerably clear of salt which travellers would strike after passing through the forbidding maze of "White Dragon Mounds" and the dried-up sea-bottom beyond.

I had to decide whether I was to strike across the latter now or to skirt the ancient seashore by continuing the north-east course, which threatened to take us further and further away from where we hoped to find water. It might have meant a détour of days, and the interpretation I put on our lucky find encouraged me to avoid this by heading straight for the dead salt sea. That evening we had reached its shore-line, and the crossing effected next day proved how wise the change of direction had been. The march across the petrified sea, with its hard salt crust crumpled up into knife-like small pressure ridges, was a most trying experience for camels and us men alike. But when this weary tramp of 20 miles, more fatiguing than any I ever had in the desert, had safely brought us to the first spot of soft salt in front of the opposite line of salt-covered erosion terraces, and we could halt for a night's rest, I had good reason to feel glad for my choice and grateful for the find which had prompted it. As the following marches proved, we had crossed the forbidding sea of hard crumpled salt at the very point where it was narrowest, and had thus escaped a night's halt on ground where neither beast nor man could have found a spot to rest in comfort. It was, no doubt, this

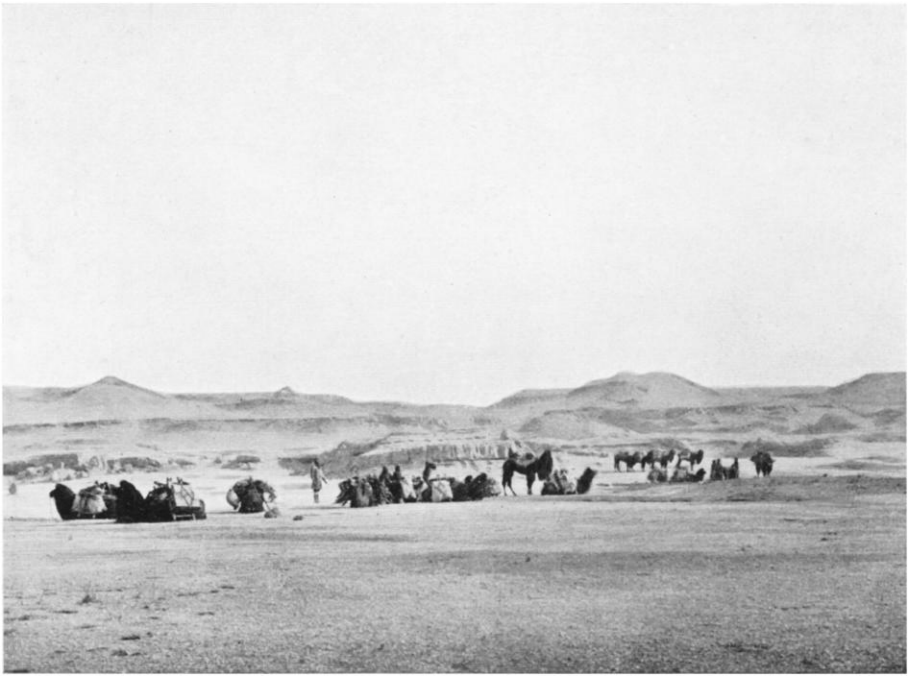


FIG. 13.—CLAY TERRACES MARKING SHORE-LINE TOWARDS EASTERN END OF ANCIENT LOP SEA-BED.

FIG. 14.—WIND-ERODED CLAY RIDGE NORTH-EAST OF LOU-LAN SITE, BEARING REMAINS OF ANCIENT FORT.

FIG. 15.—ANCIENT SALT-ENCRUSTED LAKE-BED NORTH OF KUM-KUDUK.
Patch of actual salt bog shows up white.

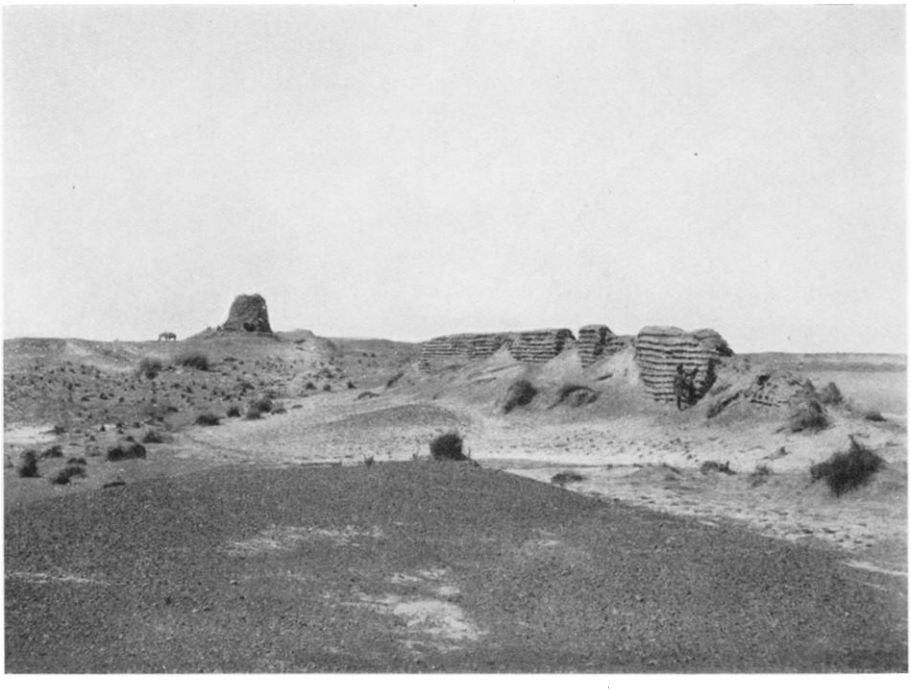


FIG. 16.—RUINED WATCH-STATION ON ANCIENT CHINESE FRONTIER WALL, WEST OF TUN-HUANG.
The projecting horizontal lines in wall on right mark layers of reed fascines.

advantage which had determined those old Chinese pioneers in the choice of this line for their route.

Helped by finds of coins and the like, we continued to track the route over ground still absolutely barren, until we reached, three days later, the last offshoot of the low desert range which overlooks from the north the extreme eastern extension of the ancient dried-up sea-bed. Then, as we skirted its shore-line under steep cliffs looking exactly like those of a sea still in being (Fig. 13), I had the satisfaction of finding the ancient track in places still plainly marked in the salt-encrusted ground. It was a strange sensation when my eyes first caught the straight line of the ancient road, where it cuts for nearly two miles across a small bay of the petrified sea. It showed a uniform width of some 20 feet, and was worn down to a depth of about one foot in the surface of hard salt cakes, as a result of the passage for centuries of transport animals, and probably carts too. There was ocular evidence here of the magnitude of the traffic which had once moved through these barren solitudes. But how those patient old Chinese organizers of transport had maintained it over some 150 miles of ground without water, fuel, or grazing still remains somewhat of a problem.

It was a great relief when by the ninth day from Altmish-bulak we came upon the first scanty scrub and reeds growing on sandy soil by the shore of the ancient dried-up sea. Next day a long march to the south-east brought us safely across the wide, salt-encrusted expanse, here showing patches of actual salt bog (Fig. 15), to the lonely caravan track towards Tun-huang. There at the well of Kum-kuduk I had the great satisfaction of finding brave Lal Singh just arrived after carrying out an interesting survey of the north-eastern shores of the dried-up sea-bed and of the straggling low ranges which abut upon them. One day later our successfully arranged concentration was completed by the arrival of our heavy baggage from Miran.

Letting it move on towards Tun-huang by the caravan track we turned once more north across the end of the dried-up Lop sea, and continued to explore the ground close to the foot of the Kuruk-tagh where the ancient route had passed. Further to the north-east the desert area near the present terminal basin of the Su-lo Ho River, with its dried-up depressions and mazes of lacustrine Meshas, offered opportunities for geographically interesting new surveys. There I picked up Surveyor Muhammad Yakub Khan, who had carried a carefully observed line of levels all the way up from the southern shore of the ancient dry sea. Coupled with other observations, its result has confirmed my belief that the waters of the Su-lo Ho at a period relatively recent in a geological sense had drained into the Lop-nor Basin. We found them still percolating in the same direction the sandy soil at the foot of the Kuruk-tagh, within a few feet from the surface. Evidence that this drainage had been more considerable during historical times was furnished by the remains we traced of a canal, which appears to have been constructed for

the purpose of carrying water along a portion of the ancient Chinese route where it approached the eastern end of the dried-up salt sea.

Leaving the surveyors behind for supplementary tasks, I reached by March 16 the westernmost point of that fortified ancient Chinese border line which I had first discovered and successfully explored in 1907. It was a cheering experience for me during the next few days to revisit the ruined watch-stations of the "Great Wall" in this desolate gravel waste, and clear up on the spot antiquarian questions raised by the ancient records they had yielded. I felt quite at home here as I followed again the tracks still clearly visible for long distances which the tramp of the patrols marching along the wall for centuries had worn into the soil. The fact that in places I could quite distinctly recognize my own footprints of seven years before, and those of my little dog, was the best illustration how long this bare gravel surface might retain traces of regular tracks even if trodden about the time of Christ. From Lake Khara-nor onwards I then completed my detailed exploration of the Tun-huang *Limes* by searching all the ruined watch-towers along a portion of the line where circumstances had in 1907 obliged me to leave a gap in my survey (Fig. 16). These small watch-stations usually occupied the top of high erosion terraces, and their ruins and refuse heaps were thus well protected from damp. So our search was rewarded by plentiful finds of Chinese records on wood, curious articles of equipment and other interesting relics going back to Han times.

(*The remainder of the paper, with Map, will be published in the September number of the Journal.*)

NOTES ON THE GEOGRAPHY OF IMBROS.

Alan G. Ogilvie.

THE following notes are presented for what they are worth, partly because no geographical account of this Ægean island exists, so far as I know, and partly as an indication of the directions in which Imbros offers a field for profitable scientific investigation. The notes are necessarily based on somewhat superficial observations made in about one-quarter of the total area—observations practically confined to the few afternoon walks which my military duties connected with the operations on Gallipoli allowed me. They were made at intervals between August 1915 and January 1916.

No accurate topographical map of Imbros exists. Only a very sketchy idea of the relief and river system can be gained from the best published map—1 : 250,000 War Office, London. Imbros is shown geologically coloured on the International Geological Map. But this should not be accepted.

species were found to be common to the Niger or the Nile ('From the Niger to the Nile,' 1907, p. 315).

Considering now only the former connection of the Nile with Lake Chad, it should be remembered that Captain Stigand's explanation need not be the only one. If, as is supposed (F. R. Cana, "The Sahara in 1915," *Geographical Journal*, 46, p. 342, 1915), the Wadi-el-Fardi reached the Nile near the head of the Delta, then a connection of the Wadi with the Bahr-el-Ghazal would be sufficient to account for the common fish fauna of Chad and the Nile. It may also be considered whether the Bahr-el-Ghazal (of Lake Chad, not of the Nile) did not once connect with the Wadi Hower, which "according to native reports reaches the Nile near Dongola" (*Ibid.*, p. 345). Against this, however, is a doubt as to the very existence of the Wadi Hower.

Africa has still its mysteries even for explorers, and while the channels of the Wadi-el-Fardi and the Wadi Hower remain doubtful, who can satisfactorily trace the former connections of the Nile? Already the advancing traveller has dispersed most of the clouds of speculation in which Africa for long was shrouded. May the travellers of the future continue to unfold the more elusive secrets of the continent, and among them, let us hope, those of its volcanoes, its regional movements, and its river systems.

DR. TAFEL'S TRAVELS IN TIBET.

'Meine Tibetreise.' D'Albert Tafel (Berlin, 1914; 2 vols.); and "Reise in China und Tibet, 1905–8," *Geographische Ergebnisse*, Teil I., "China." S. Mittler & Sohn, Berlin. 1912.

DR. TAFEL'S travels in North-West China and Central Asia in company with Lieut. Filchner and subsequently by himself have been the subject of several reviews and notes in this *Journal*. The notices of his individual researches have mostly been based on communications addressed to the Berlin Geographical Society, published in the *Zeitschrift* and *Petermanns Mitteilungen* (vide *Geographical Journal*, vols. 27, 28, 29, 30). A preliminary account of the journeys was published by the Berlin Geographical Society in 1908, but a detailed history of the whole experiences of his long and eventful journeys such as has now been published has been awaited with great interest.

The first addition given to our knowledge is a description of a journey made, when on his way from Hankow to the Yellow River, to the country lying south of the west-east course of the Han River. Striking south from Kün-chou he made his way to Wu-tang-shan, a beautiful piece of mountain land in the eastern part of Ta-pa-shan, a range first visited by Père David, later by Richthofen, and more recently by Colonel Manifold and others, but still awaiting fuller exploration.

After reaching the T'ung Kuan bend of the Yellow River he spent

May and June in making a survey of the north-south reach of that river, and claims to have been the first European to reach Pao-ti since the seventeenth century, when Père Gerbillon accompanied Kang Hsi on his expedition against the Eleuths. The map which he has produced, on a scale of 1 : 200,000, is a wonderful piece of work in view of the immense difficulties which faced him in obtaining observations of the river's course. It is also in itself an exquisite specimen of workmanship. On the completion of this survey he struck east to So-ping *viâ* the sources of the Fen River and Yang-fang-k'ou, and then again west across the Ordos country to Kansu and so to the Yellow River near Ling Chou.

In reading the account of the journey between T'ung Kuan and Pao-ti and thence to So-ping, one is struck again and again by the picture the traveller gives of the desolation caused by the famine years of 1876–8. This tract of country is so little known that its sufferings during those cruel years passed unnoticed by the public, but from the traces left and still enduring it would seem that the natural poverty of the land rendered it even more sensible to the cruel scourge of famine than those other parts of Shan-si on which attention was most concentrated.

Several side excursions, the object of which is not quite clear, were made by Tafel in his travels. One of these in Hu-peh has been already mentioned. From Kuei-hua-chêng a short journey was made across the Ching Shan (the Yin-shan of maps); and from Ling Chou on the Yellow River a visit was paid to Fu-ma Fu, the residence of the exiled Prince Tuan, on the north of the Ala-shan Mountains. Returning from this point to Ning-hsia Fu, he again took up the mapping of the Yellow River, which with one break occasioned by the insuperable difficulties presented where the river passes through a cañon in the Nan-shan range, he carried on to Lan-chou. To the natural difficulties of the road were added others occasioned by the outcome of a struggle with followers of the Boxer general, Tung Fu-hsiang, who, in spite of his death as officially reported, was living in a fortress guarded by his own troops near Ning-ling-ting, in the rich irrigated country near the Yellow River.

Leaving Lan-chou for Si-ning Fu he gathered together all that was required for a long journey westwards. But on the shore of Kuku Nor an attack made in a wild winter storm at night robbed him of his transport and nearly cost him and his followers their lives.

Returning to Si-ning Fu he spent the winter in endeavouring to replace his losses. Part of the stolen property was recovered through the Chinese authorities, whose influence even in places out of their control was considerable, and some consolation was derived from the opportunity of witnessing the New Year ceremonies in Hsi-ning and the temples at Kumbum, Dankar and Wei-yuan-pu. The collection of nomads from Kuku Nor, Mongolian Tsaidam, Lhasa, and Kam, with their beasts and families; the great "butter" festival at Kumbum on the occasion of the feast of lanterns, the masks of the priests and the motley assembly of men

and women from all parts together with the hospitality shown to all guests are dwelt upon by Tafel with great delight. He himself was treated with great consideration by abbots, officials, and all. Nothing was hidden from him of the treasures of the temples, which he describes at great length. The services, which two thousand monks attend, are rendered specially imposing by the magnificent bass voice which breaks the stillness of the hall and is followed by an outburst of music from cymbals, flutes and drums, and the murmur of the hymn chanted by the priests.

From Si-ning he made an excursion to the Wei-yuan-pu, the home of the "Turen," formerly an independent people, but subject to China since the Ming dynasty. The striking dress of men and women and the great festival held at the beginning of the second moon are described with much detail and enthusiasm. There, as elsewhere, the writer showed an unusual ability for entering into the feelings of the people and making himself a welcome guest.

In the following May Tafel left Hsi-ning and striking south to the Yellow River crossed the Lao-yeh-shan, a range extending south from Kuku Nor, which forms the divide between the Yellow and Si-ning Rivers. Tafel alludes *en passant* to the gradual diminution in height of the range as it stretches eastwards, a characteristic which he found to be common to it and other ranges north of lat. 32°, and opposed to Richthofen's theory of a sharply defined ascent from China to the Tibetan plateau.

News of ravages by rinderpest forced Tafel to leave his pack-yaks behind in the Lao-yeh-shan, while he made a hurried visit to the south bank of the Yellow River, and thence to Kuei-tê. On his way back accident threw him almost into the arms of the same gang who had attacked him at Kuku Nor. But escaping this danger he rejoined his caravan and travelled with it to Shara Koto and Dunkar, another great religious centre.

Proceeding west he crossed the water-parting between Kuku Nor and the Yellow River, and at last reached the plateau of Higher Tibet where great valleys (*Yung*), filled in parts with piles of colossal stones and *débris*, point to the existence of large rivers in the past, but are now dry or nearly so. Here Tafel took a new route southwards across the great Ta-la steppe, which lies between the south Kuku Nor and Semenov Mountains on the north and south, and extends from the south-north bend of the Yellow River on the east to Dubassu Nor on the west. The unexpected discovery of a river, the Chabcha-chu, and cultivated ground in this region led to its identification with the Hu-yu-yung (whose source had previously been ascribed to the Dubassu Nor), after tracing it to the freshwater lake Si-ni-tso into which it empties itself.

Valleys filled in with blocks of stone, river courses diverted from their original beds, and occasional stretches of loess are some of the main features of the Ta-la steppe, which Tafel compares with similar features seen at Kuei-te, Si-ming, and also in Shan-si and the Han Valley. To

the loess he assigns a more recent date than to that occurring in the east, but the great depressions (*Yung*) now filled with blocks of stone are of an earlier age, and to the deep, ever deepening, ravines in which the Yellow River has cut its way he ascribes an intermediate date. Signs of climatic changes and of periods when a moister atmosphere than that of to-day prevailed are also evident.

Continuing south Tafel then struck across the Si-an-si-pei Mountains, which he found to be a part of the Semenov Range, to the country of the Si-dia tribe, near the Chu-rong River. This he speaks of as the largest affluent on the left bank of this section of the Yellow River. Foiled in an attempt to cross it he pushed west. Fever and the rains and storms which ushered in the spring in June rendered the journey slow and difficult; but the beauties of the season and the glorious views of the Amne Machin mountains, 20,000 feet, as seen from the shore of Tossun Nor, compensated in part for all the sufferings *en route*. Thence he made his way by the valley of the Yogho-re Gol to Barun Tsaidam, where he was well received by the Jassak and most courteously entertained, except by mosquitoes, which below an altitude of 13,000 feet proved most trying even to these hardened travellers.

On leaving Barun the caravan struck south towards the Burkhan Buddha range, which was crossed at the Turketse Pass (14,500 feet). At Odontala the presence of sand-dunes in the quivering morass presented a puzzle difficult to solve. Enormous herds of wild yak, antelopes, kyang, etc., and frequent bears gave life to scenes of great beauty, which changed almost in a moment to misery under the influence of rain and snow on a surface which yielded to any pressure. These morasses with their beauties extended west to the brook which Tafel claims to be the source of the Yellow River. In the lake close by he found the last home of hundreds of wild yak, driven to its waters by the fever of rinderpest. Fear of contagion forced the traveller to abandon this position in all haste, and marching south he crossed the range which forms the water-parting of the Yangtse until he came to the river itself. Tibetans prevented the crossing of the river and obliged him to turn westward until he struck and crossed the Chu-mar. Everything seemed favourable to the success of the journey, when an attack by Tibetans robbed him of his ponies, yaks, and sheep. Only six yaks were left; tents, food, clothing, and all scientific treasures had to be destroyed save such as could be carried by the party of travellers, and sadly they set their face northwards towards Taidshinar Tsaidam.

Only once did fortune smile on the disconsolate travellers as they journeyed north. For twenty-five days they saw no sign of any human beings. But two tame yaks abandoned as worthless by other travellers were a welcome addition to the carrying capacity of the party. As time went on loads had to be reduced, for neither man nor beast had proper food, and the high altitude immensely increased the strain. But eventually

after crossing the Marco Polo range by a pass (14,650 feet) they reached first Choga-gol, first discovered by Prjevalski, and after mounting another pass (14,000 feet), the Nachi-gol. But few animals survived, and all baggage had been thrown aside or cached before the first tents were reached at Golmo. Even then great difficulties had to be overcome before help was extended, for strangers were regarded with suspicion as possible spies of the dreaded Gholoks.

At Golmo animals were hired to fetch the more recently discarded baggage and to start the travellers on their way east. Passing through the country of the Dsun and Wang-ka Mongols, and skirting the Lakes Dubassu and Kuku Nor, Tafel made his way to Dankar (where he met the late Lieut. Brooke), and finally to Hsi-ning.

While refitting at Hsi-ning in preparation for the continuance of his explorations Tafel paid a visit to Kumbum, where the Dalai Lama was then staying on his way from Urga to Lhasa. With his usual luck the doctor obtained an interview with this sacred personage, through the good offices of Mr. Teramoto, a Japanese, who in the dress of a Mongol priest had visited Lhasa and was then in attendance on the Lama. The impressions formed in the interview seem somewhat to have toned down those derived from the very unfavourable criticisms current in the country of the Dalai Lama's pretensions, exactions, and private life.

On January 20 the expedition again left Hsi-ning and took the road south to Kam. Thanks to the cruel cold the country was in good condition for travelling, for the morasses on high altitudes through which in summer men and animals toiled painfully foot by foot were now frozen. But the danger of an attack by Gholokhs was ever present. After crossing many ranges, the highest of which lay by the Tsassora Pass (13,700 feet) in the Semenov Range, the party eventually reached the broad valley through which the Yellow River flows, and there found themselves in the arms of a very large encampment of Gholokh-Khorgan. But the experience was better than expected, and two days later the journey was resumed and the Yellow River (about 900 feet broad) safely crossed on ice. Soon afterwards a caravan returning from Hsi-ning to Kam was met; the two parties joined forces, and travelling south-west across the water-parting at Rava-niembo-la (15,000 feet) of the Yangtse and Yellow Rivers, proceeded by rapid stages past the headwaters of the Ya-lung to Tendu. In spite of the friendly relations which had existed on the journey with the caravan, now that it had reached the home of its chief at Tendu an atmosphere of suspicion and distrust sprang up, and accompanied the expedition until it reached Jerku-ndo (Rockhill's Jyékundo) on the Dre'chu or Tung-tien Ho. Great calls were made on the tact and determination of the leader of the party in order to overcome the difficulties and dangers which thus arose. But at Jyékundo a most friendly reception awaited him, and Chinese traders *en route* to Lhasa or established in the place added their welcome to that of the natives.

But an attempt made to travel further west into Nan-chen was forcibly checked, and requests made to the prince for permission to visit his territory were sternly refused. Finally the traveller was informed that he must leave Jyékundo. But though he had overstayed his welcome, his followers had not, and after he had started on his way south to Ta-chien-lu several desertions occurred among his most reliable men, who hastened back to dry the tears of Tibetan maidens, whom Tafel had refused to enrol in his company. The journey south practically followed Rockhill's route. After leaving the Dre'-chu valley much hostility was encountered at the hands of Tibetan monks, and the crossing of the Ya-lung was made under a hail of stones, which led to the loss of a mule laden with photographic plates of life at Tendu and Jyékundo.

At Ta-chien-lu Tafel determined to strike north through the mountains to Sung-pan Ting, a journey in which new perils were encountered in the swinging bridges which cross the foaming torrents. Even his dog proved faint-hearted when faced with these terrors, but more beasts were lost in swamps than from bridges. Persons who suffer from lack of excitement might do well to apply for posts as bridge-keepers in this country, where assistance to man and beast forms part of the keeper's duties. This part of Tafel's journey lay through the most exquisite scenery that can be formed by forests, water, and flowers at high altitudes, as described by Mrs. Bishop (vide *Geographical Journal*, vol. 10, 1897) in her account of her visit to Somoland, which lies a little east of Tafel's route.

On his way from Sung-pan Ting to Hsi-ning Fu Tafel struck north-west to discover the bend made by the Yellow River, which Watts and Birch are believed to have reached in 1900. This was found in lat. 33° 33′ N., long. 102° 15′ E., in a broad valley through which the river meandered in great curves, entirely out of character with the fierce torrent hidden in narrow ravines to which Tafel had been accustomed elsewhere. This discovery was the crowning exploit of his very eventful journey.

The book is full of most interesting information on the different sects of Lamaism which were met, of the customs of the people, their religious festivals, the habits of Mongols in encampments, of Tibetans in their villages, the attempts to introduce cultivation in high altitudes, of Chinese traders, Gholokh robbers, and Mohammedan fugitives from China. The adventures of travel and sport were most varied. The herds of wild yak recalled to mind in their numbers the buffalo of the American prairies; kyang and antelope abounded; eight bears were seen in a single day near Odontala; and troops of monkeys in the country between Jyékundo and Tachien-lu devastate the crops.

Of the journeys themselves and the additions made in them to geographical and geological science earlier articles in this *Journal* have given some details. But it is perhaps advisable to recall that the journeys were carried out on lines suggested by the late Baron von Richthofen in order to fill lacunæ in our knowledge of the Yellow River, Tsaidam, and the

west fringe of the Red Basin of Szechuen, and their results are embodied in Richthofen's 'China,' vol. 3. Among the physical features of the country to which attention is specially called by the author are the huge trenches in the Tala steppe, the erratic blocks and vast moraines in the Bayan Kara and other western ranges far distant from any existing glacier field, the existence of loess in widely separated districts in most of the country traversed, and the presence of sand-dunes among the morasses of Odontala, where holding ground for tents was difficult to find.

The photographs are excellent and most varied in spite of losses and many accidents, and the map (a second volume of maps of the journey in Tibet, in thirty-seven sheets, has been published, but is not in the library of the Society) which accompanies the second volume is well executed. Indeed, the only imperfection in the book is the index, which is not complete.

W. R. CARLES.

REVIEWS.

EUROPE.

Early Distribution and Valley-ward Movement of Population in South Britain.—H. J. Fleure and **Wallace E. Whitehouse,** of the University College of Wales, Aberystwyth. Reprinted from *Archæologia Cambrensis*, April 1916.

THE authors of this paper give evidence to show that the areas of South Britain attractive to primitive man were "dry uplands with a porous subsoil, suitable pasture, and a convenient water and fuel supply, with access to raw material for the making of implements" (p. 110), such as are to be found on the Chalk Downs, the Derbyshire Moorlands, the Pennine Range, the Yorkshire Wolds, and the Malvern Hills. A map (p. 107) shows their conjectural distribution in Neolithic times, during which, as well as possibly during much later times, people must have lived "mostly either on the uplands exceeding 600 feet in height or along a coastal fringe," whereas "modern man in South Britain lives, as a general rule, below the 400-feet contour line" (pp. 23–24). Among evidences adduced for the valley-ward movements are facts indicating the survival of descendants of the Neolithic upland folk in inland valleys of those uplands and some features of "the distribution of old villages in several districts along hillsides sloping down from prehistoric uplands" (pp. 124–126). Nearly all the lower tracts in early times must have been forest or marsh, and the descent of man was prepared for by the downward retrogression of the forest, partly in consequence of man's action, partly through the natural extension of peat or heath on the forest fringe (pp. 128–131). The authors show no disposition to exaggerate the cogency of the evidence for their thesis, and state in conclusion that the purpose of their paper is "mainly to draw the attention of local archæologists and geographers to the importance of recording any evidences in custom or right or monument of the valley-ward movement, and to ask those who study records to collect mentions of forest clearings and of pastoral migrations and other related matters" (p. 139). At the end there is a bibliography containing forty-seven entries.

G. G. C.

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A THIRD JOURNEY OF EXPLORATION IN CENTRAL ASIA, 1913-16.

Sir Aurel Stein, K.C.I.E., D.Sc., D.Litt.

Read at the Meeting of the Society, 5 June 1916. *Continued from p. 130. Map following p. 288.*

BEFORE the close of March 1914 I had regained my old haunts of Tun-huang, and after a very brief halt to allow men and animals to recover from our trying winter campaign I started for the explorations planned eastwards. They were to take me mainly into the deserts which fringe on the south and east the great barren hill region usually designated as the Pei-shan Gobi. The distances were great and short the remaining season during which that waterless ground could be visited before the great summer heat set in. But even thus I could not forego a renewed visit to the famous cave temples of the "Thousand Buddhas" south-east of Tun-huang. There in 1907 I had been fortunate enough to secure such abundant antiquarian and artistic spoil from the walled-up temple cella, in which a whole library of Buddhist and other manuscripts and hundreds of fine paintings on silk had been hidden away early in the eleventh century together with a multitude of other relics.

I could not expect to make such a haul now. For when a year after my own visit, Professor Pelliot, on a mission from the French Government, had, with his expert knowledge of Chinese, searched the hoard and carried off a considerable selection of its remaining manuscripts, the attention of the authorities at Peking had been attracted to the old library, and its transfer to the capital was decreed. Of the careless and in reality destructive way in which the order had been carried out I found evidence in the many scattered rolls of Chinese Buddhist texts undoubtedly derived from this source which were offered to me for purchase at a number of towns both in Turkestan and Kansu. So it was satisfactory to find that somehow a considerable quantity of Chinese manuscripts from the walled-up cella still remained behind at the "Thousand Buddhas," and that my old priestly friend, Wang Tao-shih, was prepared to part with them in regard for a proper compensation for his pious establishment. He showed me with genuine pride the good use to which he had put the sum previously received from me, by building some gaudy new shrines and comfortable pilgrims' quarters. It was also reassuring to see that his personal relations

with the pious people of Tun-huang and their official guardians had evidently in no way suffered by our former little transaction. The only regret which it had left behind in the quaint little monk was that he had not been shrewd enough to accept the offer made by me in 1907 for the whole hoard, and had thus failed to save it from dispersion and to secure its full value for his shrine. Our reunion was throughout very cordial, and when we parted again my collection had received an appreciable addition of cases with old manuscripts and other relics in evidence of Wang Tao-shih's good will, and his appreciation of my ever-faithful attachment to the memory of holy Hsüan-tsang.

My immediate task, and one cherished ever since 1907, was to trace the line of the ancient Chinese *Limes* as far as possible to eastward, and to explore whatever ruins might have survived along it. After striking across a difficult belt of salt marshes, which nearly embogged my camels, I came again upon the ancient border wall halfway between Tun-huang and An-hsi. From there we succeeded in exploring its line for close on 250 miles eastwards. For almost the whole of this distance the wall, with its watch-towers and small military posts, had been built across what already in ancient times was absolute desert ground. The resulting immunity from human interference had contributed greatly to the preservation of the remains for fully two thousand years; but the remarkable method of construction employed was an even more important factor. The most destructive of natural forces in this region has always been slow-grinding but relentless wind-erosion. The wall or *agger*, built of carefully secured fascines of reeds, brushwood, or tamarisk branches, whichever of these materials were available in the immediate vicinity, was specially adapted to withstand it. Even where the watch-towers, once massively built in sun-dried bricks or stamped clay, had been under-cut by erosion at the base and been subsequently reduced to shapeless low mounds, difficult to recognize from a distance, the direction of the wall still clearly revealed itself, as it stretched away in a characteristic straight line across wastes of gravel or drift-sand.

The remains proved to have suffered most along that stretch of ground where the *Limes*, after crossing the Su-lo Ho to its right bank east of An-hsi, ran close to the deep-cut river-bed, and in a due easterly direction. On the bare riverine loess crossed here by the wall the erosive force of the prevailing north-east winds, blowing down with great violence from the gravel plateaus of the Pei-shan, could fully assert itself. But even where all structural features had been completely effaced it was easy for us with the experience gained elsewhere accurately to determine the position of the posts once guarding the border, from the fragments of pottery, coins, metal objects, and other hard débris which could be picked up at these points from the wind-worn surface. It was quite an exciting chase to search for these indications, and my Indian assistants and Turki followers had by now become expert in the game.

Where the Su-lo Ho valley bends sharply southward the line of the *Limes* was found to turn to the north-east, and to approach closer and closer to the foot of the Pei-shan. The ground crossed by it had remained so far unsurveyed, and the difficulties of our search were much increased by the distances which separated the long-forgotten border from the nearest water. Fortunately the days had now grown longer, and I was able to take out my little detachment of diggers mounted on the hardy big donkeys which abound at the oases of this region. Ample finds of ancient Chinese records on wood, articles of furniture, fragments of arms and implements rewarded the rapid search of the ruined watch-stations. That all these had been left behind by the Chinese troops, who during the first century before and after Christ had guarded this most dismal of frontiers, was made clear on the spot by conclusive archæological evidence. The finds of records still await expert examination by M. Chavannes, my learned Sinologue collaborator at Paris. They may be expected to furnish an important addition to the collection of early Chinese records resulting from my former explorations, which he had published in 1913.

Interesting light was thrown on the climatic conditions prevailing here from early times by the fact that here too the inscribed slips of wood, the "waste papers," to use an anachronism, thrown out of ancient office-rooms, were found often in refuse layers covered by a few inches only of gravel or débris. Their preservation in such conditions presupposes a remarkable dryness of the climate for the last two thousand years. Apart from this and the uniform barrenness, there was considerable variety in the natural features of the ground traversed by this eastern portion of the *Limes*. Thus all the more opportunity presented itself of observing the remarkable skill and topographical sense with which those old Chinese engineers of Han times had adapted their defensive border-line to different local conditions.

That they were prepared for great and sustained efforts demanding real powers of organization in the face of formidable natural obstacles was clearly demonstrated when, some 30 miles to the north-east of the little oasis of Ying-p'an ("the garrison") we found the *Limes* boldly carried into and through what since ancient times must have been a big area of drift-sand. Where not completely buried by high dunes, the wall built with tamarisk fascines, and of the usual thickness of 8 to 9 feet, still rose to close on 15 feet. Special difficulties must have been encountered in assuring water and supplies for the men guarding this section. In order to safeguard what evidently was an important line of communication and supplies leading to it, a chain of small fortified stations had been constructed to the south independently of the wall, but at the same period. It ran in the direction of the big oasis of Su-chou, an important Chinese base ever since Han times, and to this I turned when early in May it became necessary to make preparations for our next move northward.

I had planned to follow the united course of the rivers of Su-chou and

Kan-chou down into southernmost Mongolia, and to explore the ruins which the reports of Russian travellers had led me to expect along it and in its terminal delta. I was specially attracted to this ground by its geographical character, which suggested close resemblance to that of the Lop-nor region, and by the interest attaching to its earliest historical past. For we know that this region of the Etsin-gol, as the river is called by the Mongols, had been included in the wide dominion held by those earliest nomadic masters of Kansu, the "Great Yüeh-chih," the later Indo-Scythians, and the Huns, whose successive migrations westwards were destined to affect so deeply the history of Central Asia as well as of India and the West.

The effective intercession of H.M.'s Minister at Peking had secured for me a very friendly reception by the Chinese administration of the Kansu Province. The Tao-tai of Su-chou agreed to provide me with a recommendation to the chief of the Torgut Mongols who now graze in the Etsin-gol delta, and on May 10 I was able to set out northward. The track I followed down the river of Su-chou allowed me to approach once more the area where we had previously lost the line of the ancient frontier amidst high dunes. Pushing a reconnaissance into the stony desert north-west of the Chint'a oasis, I came upon remains of the *Limes* where it emerged on less impracticable ground near the south-eastern extremity of the Pei-shan. Thence we tracked it right through to the north of the Mao-mei oasis, the last Chinese settlement. There Lal Singh rejoined me after having followed a hitherto unsurveyed route along the river of Kan-chou, where it breaks in a picturesque gorge through the westernmost hill range of the Ala-shan.

In the valley of the Etsin-gol nature, by affording water and grazing, has ever provided an easy route for raids and invasions from the Mongolian steppes into the line of the westernmost Kansu oases, which itself constitutes the great natural highway connecting China with the Tarim Basin and innermost Central Asia. Ruined forts of imposing size and evident antiquity were found to guard the point where this route of invasion cuts through the ancient border-line drawn by the Chinese when they first occupied those oases in the reign of the great Han Emperor Wu-ti. One fort built with clay walls of exceptional strength looked an exact counterpart of the ancient frontier post of the "Jade Gate," famous in Chinese historical records, and previously identified by me on the Tun-huang *Limes*. We found evidence that the fortified border-line after crossing the Etsin-gol, north of Mao-mei, had continued through the desert eastwards. But when we came back in June from the Etsin-gol delta the summer heat had become too great to permit of further search on this waterless ground.

We found even in May our long marches trying as we moved down by the sandy bed of the Etsin-gol, nearly a mile wide in places, but absolutely dry at that time. Only at rare intervals could water be obtained from wells dug in deep hollows below the banks. Some 90 miles below

Mao-mei the river passes through a low rocky spur thrown out from the easternmost Pei-shan, and spreads out in a delta, which extends for over 110 miles to the north, terminating in a line of brackish lakes and marshes. The conditions brought about here by a succession of low-water seasons furnished a striking illustration of the appearance which the ancient Lou-lan delta we had explored in the winter may have presented before its final desiccation. Where river-beds lined by narrow belts of riverine jungle had been left dry for long years, we found many of the wild poplars already dead or dying. The wide stretches of ground separating the several beds showed but scanty scrub, or else were absolutely bare. No wonder that we heard sad complaints in the scattered camps of the two hundred odd Mongol families which are established in the Etsin-gol delta, about the increasing difficulties caused by inadequate grazing. Their chief, whom I visited on May 25 in his modest encampment, proved a well-meaning but weak individual, and his subjects as indolent as they were "much given to deceit," to use an expression of my Chinese patron saint. It was no easy matter to secure an adequate number of labourers for my intended excavations, and still more difficult to keep them at work, in spite of very generous pay.

Advantages of geographical position must at all times have invested this extensive riverine tract, limited as are its resources, with considerable importance for those, whether armed host or traders, who would make the long journey from the heart of Mongolia in the north to the Kansu oases. It had been the same with the ancient Lou-lan delta, without which the Chinese could not have opened up the earliest and most direct route for the expansion of their trade and political influence into Central Asia. The analogy thus presented could not fail to impress me even further when I proceeded to examine the ruins of Khara-khoto, the "Black Town" (Fig. 17), which Colonel Kozloff, the distinguished Russian explorer, had been the first European to visit during his expedition of 1908–09. There remained no doubt for me then that it was identical with Marco Polo's "City of Etzina." Of this we are told in the great Venetian traveller's narrative that it lay a twelve days' ride from the city of Kan-chou, "towards the north on the verge of the desert; it belongs to the Province of Tangut." All travellers bound for Kara-koram, the old capital of the Mongols, had here to lay in victuals for forty days in order to cross the great "desert which extends forty days' journey to the north, and on which you meet with no habitation nor baiting place."

The position thus indicated was found to correspond exactly to that of Khara-khoto, and the identification was completely borne out by the antiquarian evidence brought to light. It soon showed me that though the town may have suffered considerably, as local tradition asserts, when Chingiz Khan with his Mongol army first invaded and conquered Kansu from this side about 1226 A.D., yet it continued to be inhabited down to Marco Polo's time, and partially at least for more than a century later.

This was probably the case even longer with the agricultural settlement for which it had served as a local centre, and of which we traced extensive remains in the desert to the east and north-east. But the town itself must have seen its most flourishing times under Tangut or Hsi-hsia rule from the beginning of the eleventh century down to the Mongol conquest.

It was from this period, when Tibetan influence from the south seems to have made itself strongly felt throughout Kansu, that most of the Buddhist shrines and memorial Stupas dated, which filled a great portion of the ruined town and were conspicuous also outside it. In one of the latter Colonel Kozloff had made his notable find of Buddhist texts and paintings. But a systematic search of this and other ruins soon showed that the archæological riches of the site were by no means exhausted. By a careful clearing of the débris which covered the bases of Stupas and the interior of temple cellas we brought to light abundant remains of Buddhist manuscripts and block prints, both in Tibetan and the as yet very imperfectly known old Tangut language, as well as plenty of interesting relievos in stucco or terra-cotta and frescoes. The very extensive refuse heaps of the town yielded up a large number of miscellaneous records on paper in the Chinese, Tangut, and Uigur scripts, together with many remains of fine glazed pottery, and of household utensils. Finds of Hsi-hsia coins, ornaments in stone and metal, etc., were also abundant, particularly on wind-eroded ground.

There was much to support the belief that the final abandonment of the settlement was brought about by difficulties of irrigation. The dry river-bed which passes Khara-khoto lies some 7 miles to the east of the nearest branch still reached by the summer floods. The old canals we traced, leading to the abandoned farms eastwards, are removed considerably further. It was not possible to determine by conclusive evidence whether this failure of irrigation had been the result of desiccation in the Etsin-gol delta or been caused by some change in the river-course at canal-head, with which the settlement was for some reason unable to cope. But there seemed to me good reason to believe that the water-supply now reaching the delta during a few summer months would no longer suffice to assure adequate irrigation for the once cultivated area. Even at the Mao-mei oasis, over 150 miles higher up the river, and with conditions of ground far more favourable for the maintenance of a system of canals, serious trouble had been experienced for years past in securing a sufficient discharge early enough in the season, and much of the once cultivated area seemed to have been recently abandoned.

With the rapidly increasing heat, work at the desert sites had become very trying both for the men and our camels, upon which we depended for the transport of water. With the completion of our task at Khara-khoto, and of the surveys which had meanwhile taken Lal Singh to the terminal lake-basins of the Etsin-gol, I was glad to let the hard-worked camels depart for their much-needed summer holiday in the Kongurche

hills north-eastward and to start myself with Lal Singh south to the foot of the Nan-shan. The new route, which we were able to follow for part of the journey, took us through hitherto unexplored portions of the desert hills to the east and north of the river of Kan-chou. But owing to the heat and the scarcity of springs it implied serious fatigues, and it was a relief when Kan-chou was safely reached before the close of June.

A short but refreshing halt in that large and pleasant oasis was devoted to the arrangements needed for the new surveys I had planned in the Central Nan-shan. Their object was to extend the mapping which in 1907 we had effected in the high mountains near the sources of the Su-lo Ho and Su-chou River by accurate surveys of the high ranges further east, containing the headwaters of the river of Kan-chou. In conjunction with our labours in the Etsin-gol region, they were intended to complete the mapping of that large north-western portion of Kansu which, inasmuch as it sends all its waters into drainageless basins, may well be claimed in respect of its hydrography and general physical conditions as belonging to Central Asia rather than to China. Knowing the reluctance of the local Chinese to venture far into those mountains, I was prepared for the difficulties experienced at the outset in securing transport. But a fortunate chance brought just then an old Chinese friend to the military command of Kan-chou in the person of worthy General Tsai, whose kindness I remembered so well from my visits to Su-chou in 1907, and his opportune help enabled us to set out for the mountains by the first week of July.

The route followed during the first marches acquainted me with a series of old Buddhist cave temples at Ma-ti-ssŭ, containing sculptures of Sung times, and with other interesting Buddhist remains in the pretty little town of Nan-kou-ch'êng at the foot of the mountains. The visit did not pass without profit for my collection of antiques, and also helped to make me realize that we were now near a dividing line of distinct geographical interest. For while to the west cultivation, whether in the plain or along the foot of the mountains, requires irrigation, we now came upon loess slopes and big alluvial fans which rainfall alone suffices to make fertile. Our approach to the watershed of the Pacific Ocean was appropriately foreshadowed by this marked change in climatic conditions.

Following the route which leads towards Hsi-ning and ascending through the picturesque gorge and the pass of O-po, we reached the broad valley where the easternmost feeders of the river of Kan-chou gather at an elevation of over 11,000 feet. Thence we were making our way westwards over high alpine grazing grounds frequented in the summer by Tangut herdsmen and horse-breeders, when I met with a serious riding accident which might well have put an end for ever to all my travelling. My Badakhshi stallion reared suddenly, and over-balancing himself fell backwards upon me, with the result that the muscles of my left thigh were severely injured. For over two weeks I was unable to leave my camp bed or to use the crutches we improvised. But fortunately the arrangements

already made allowed me to let Lal Singh proceed for the topographical tasks I had planned. He carried them through with all his wonted devotion and energy, and no time was lost in our programme. Nearly three weeks had passed when, with my leg still feeling the strain severely, I managed to get myself carried down in a litter to Kan-chou.

During a ten days' halt there I experienced much kindness from Father Van Eecke and other Belgian missionaries, and received the first confused news of the great European conflagration. Then I set out by the third week of August for the long-planned journey through the Pei-shan Gobi. It was to take me back to Turkestan for the work of the autumn and winter. Eight long marches brought me to Mao-mei by a new route skirting the hills on the right bank of the river of Kan-chou, and allowed me to view the remains of the late mediæval "Great Wall" which runs on to, and ends near, Su-chou. The complete decay into which it has fallen for considerable distances, notwithstanding its relatively recent origin, helped me to appreciate all the more the time-resisting solidity which the methods of construction employed by the engineers of Han times had assured to their *Limes* wall. I reached Mao-mei exhausted by the effort which it had cost me to do this journey on horseback, because of the severe strain to my leg. But I found there my brave camels safely arrived and was cheered by Lal Singh rejoining me. By exceptional efforts my indefatigable old travel companion had succeeded in extending our Nan-shan surveys eastwards over an area quite as large as that mapped in 1907.

On 2 September 1914 we commenced the journey which was to carry us right across the great desert area occupied by the ranges of the Pei-shan, where its width is greatest, in the direction from south-east to north-west. The routes we followed for close on 500 miles had never been surveyed, and I knew that only at one point, the cross-roads of Ming-shui, could we expect to touch ground the position of which was known relative to the routes previously visited by Russian travellers. Wherever possible we moved in two parties and by different routes, in order to increase the extent of the area mapped. For this purpose I had secured at Mao-mei the only two guides available, both Chinese. But their local knowledge, even when combined, proved very inadequate, and after less than half of the journey it gave out altogether. We were thus obliged to trust largely to the guidance of the faint caravan tracks traceable and to what information we opportunely obtained at the single small Mongol camp encountered. The scarcity of wells and of grazing implied serious risks in this mode of progress and made it an anxious time for me, especially as I had found the strain of riding too painful and was obliged to direct our moves from an improvised pony litter.

It was reassuring when, after passing the well of Ming-shui, the great snowy mass of the Karlik-tagh came into view, far away to the north-west, and served to direct us in the rough. But great difficulties still awaited us in the last barren hill range through which we had to make our way, owing

to want of water and the very confused and, in places, rugged configuration of its valleys. It proved an easternmost extension of the T'ien-shan system. When we had safely emerged from it through narrow tortuous gorges which ever threatened to stop our camels far away from water or grazing, it was a real relief to look down on the open Dzungarian slopes and sight some 15 miles away a tiny spot of dark trees. It was the little village of Bai, for which I had wished to make all the time, and after nearly four weeks of continuous travel it was no small satisfaction to have safely reached it without the loss of a single animal. There was reward for our troubles in the extensive plane-table surveys, supported here as all through our journeys by astronomically observed latitudes and by many careful height observations with mercurial barometer and clinometer. They will throw fresh light, I hope, on the morphology of the Pei-shan ranges.

A rapid journey subsequently carried me during October along the north foot of the eastern portion of the T'ien-shan range, already bearing its first winter snow, to Barkul and Guchen (Ku-ch'êng-tzŭ). The ground crossed here, topographically better known, had a special interest for me as it helped to acquaint me with the peculiar physical conditions of a region through which many of the great historical migrations westwards, like those of the Yüeh-chih or Indo-Scythians, Huns, and Turks, must have passed. These valleys and plateaus of Dzungaria, favoured by a climate less dry and possessed of abundant grazing-grounds, have often played an important part in the history of Eastern Turkestan. They have again and again afforded a temporary home to nomadic tribes. These could never have maintained their flocks and herds in the arid planes of the Tarim Basin; but they were always able from across the T'ien-shan to carry out their raids into it and exact tribute from its flourishing oases. I could observe a curious if faint reflex of those great tribal movements in the numerous camps of Muhammadan Kazaks, fine men of Turkish speech and descent, whom the Mongols had driven south under Chinese protection since they secured the "independence" of Outer Mongolia.

After leaving Guchen I surveyed, near Jimasa, the remains, extensive but badly decayed, marking the site of an ancient capital of this region, which under the names of Chin-man and Pei-ting often figures in the Chinese Annals from Han to T'ang times. Its connection with the Turfan oases to the south had been a very close one from an early historical period, and as Turfan was to be my base for the winter's labours I was very glad to march there by the most direct route, hitherto unsurveyed. It led me across the Bogdo-ula range, a rugged portion of the T'ien-shan rising to numerous snowy peaks, by a pass close on 12,000 feet (Fig. 18), and once again confirmed the accuracy of the early Chinese itineraries in which this route is described.

The first week of November 1914 found the four parties into which my expedition had divided since September safely reunited at Kara-khoja, an important ancient oasis in the centre of the Turfan depression. A

combination of geographical and archæological reasons had made me fix upon Turfan as the base and chief ground for our labours of the ensuing winter. It was certainly the natural and most convenient starting-place for the series of tours I was anxious to organize for the exploration of unknown or as yet inadequately surveyed portions of the Kuruk-tagh and Lop deserts to the south. I myself, ever since my brief visit of 1907, had felt drawn back to Turfan by the hope that its abundant ruins of Buddhist times were not yet completely exhausted, even though, easily accessible as they are, within or quite close to oases, they had received much attention from successive archæological expeditions, Russian, German, and Japanese. Finally, geographical and antiquarian interests united in prompting me to make an accurate large-scale survey of the Turfan Basin; for, apart from its containing in its terminal salt lake what probably is one of the deepest depressions below sea-level of our globe, there is the important fact that, within close topographical limits, and hence in a concentrated form, as it were, it exhibits all those characteristic physical features which make its great neighbour and counterpart, the Tarim Basin, so instructive both to the geographer and historical student.

This detailed survey of the Turfan depression, on the large scale of 1 mile to an inch and with clinometrically observed contours, was taken in hand by Surveyor Muhammad Yakub almost as soon as he had joined me after a difficult desert crossing from the terminal drainage basin of Hami or Kumul. A few days later I could send off R. B. Lal Singh, pining as always for fresh hard work, to the Kuruk-tagh. The rapidly increasing cold, felt even here close to sea-level, gave hope by then that he would be able to overcome the difficulties arising in those truly "Dry Mountains" from the want of drinkable water, by the use of ice formed on salt springs —or of snow if such happened to fall.

With my remaining two Indian assistants I had already started the archæological labours that were to keep us busy for the next three and a half months. The ruined town, known as Idikut-shahri, which was their first scene and adjoins Kara-khoja, has long ago been identified as the site of Kao-chang (or Khocho in early Turki), the Turfan capital during T'ang rule (seventh to eighth century A.D.) and the subsequent Uigur period. Massive walls of stamped clay enclose here an area, nearly a mile square, containing the ruins of very numerous structures, built of sun-dried bricks or clay. Most of them were Buddhist shrines and several of imposing dimensions. For generations past these débris-filled ruins have been quarried by the cultivators of the adjoining villages in search of manuring earth for their fields, and many of the smaller structures had been levelled to gain more ground for cultivation. Since the excavations made here between 1902–06 by Professors Grünwedel and Von Lecoq, of the Berlin Ethnographic Museum, the villagers had extended their destructive operations in the hope of securing manuscript remains and antiques as valuable by-products for sale to Europeans. Of such finds I was able to acquire

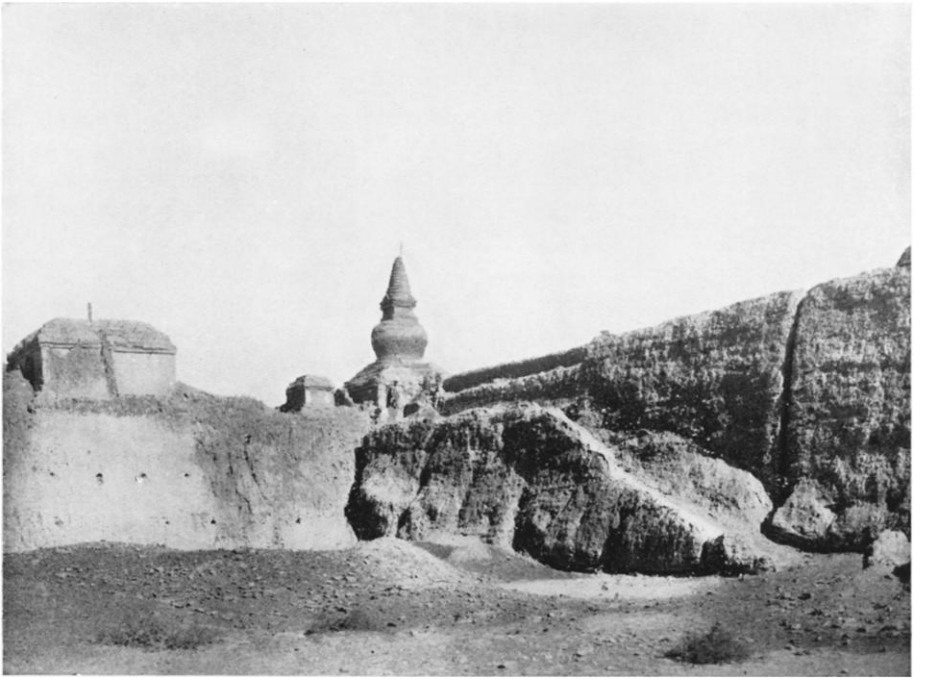


FIG. 17.—RUINED BUDDHIST RELIC TOWERS ON NORTH-WEST CORNER OF TOWN WALL, KHARA-KHOTO.

FIG. 18.—VALLEY BELOW PANOPA PASS, BOGDO-ULA RANGE, LOOKING SOUTH.

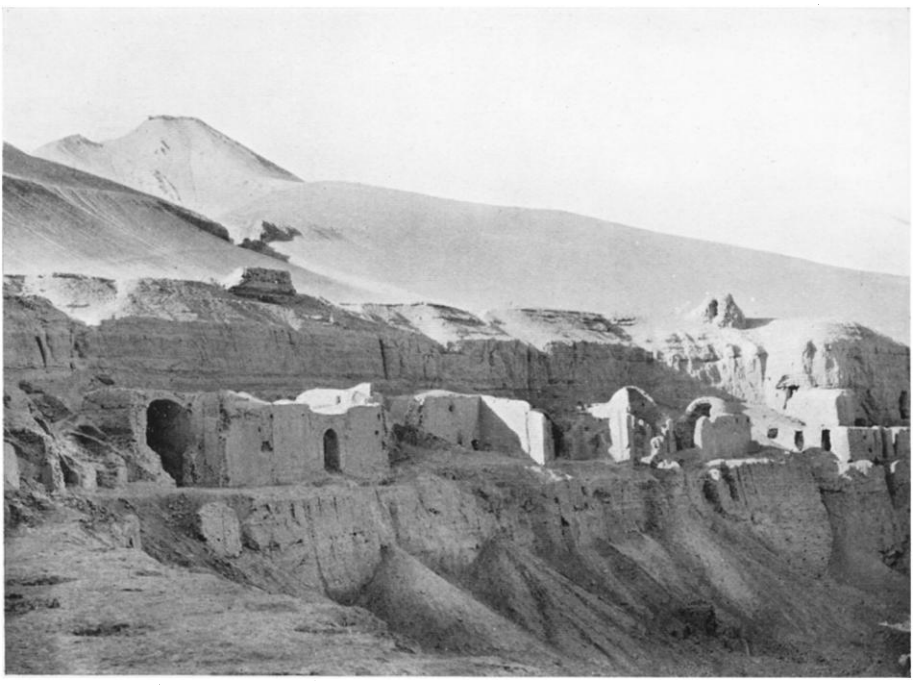


FIG. 19.—RUINED BUDDHIST SHRINES AND CAVE-TEMPLES BELOW MURTUK, TURFAN. Drift-sand covers hill slopes in background

FIG. 20.—HEAD OF BOSTAN-ARCHE VALLEY, ULUGH-ART RANGE, LOOKING WEST. Surveyor Afrazgul in foreground. Clouds above head of valley hide snowy peak over 22,000 feet.

a fair number. But it was more satisfactory to find that in some ruins deeper débris strata had escaped exploitation. Their systematic clearing was rewarded by a variety of small but interesting remains, such as fresco pieces, fragments of paintings on paper and cloth, stucco relievos, illustrating Buddhist art at Turfan. Manuscript fragments in the Uigur, Tibetan, Chinese, and Manichæan scripts were also recovered. The discovery of a hoard of well-preserved metal objects, including decorated bronze mirrors, ornaments, etc., offered special interest, as the large number of coins found with it permits the date of its deposit in Sung times to be fixed with approximate accuracy. Simultaneously with these clearings I had an exact plan of the whole site prepared.

After rapid visits to smaller sites in the eastern portion of the Turfan Basin I turned, towards the close of November, to the ruins in the picturesque gorge of Toyuk. There numerous rock-cut caves, once occupied by Buddhist priests, honeycomb precipitous cliffs rising above the small stream that waters a flourishing little oasis, famous for its grapes. Where the slopes are less steep, narrow terraces have been built, bearing small Buddhist shrines, now in ruins. At the most conspicuous of these the second German expedition had made important manuscript finds. Stimulated by these in their monkey-like emulation, native searchers for antiques had subsequently wrought terrible havoc among ruins which had before remained more or less untouched. Lower down, however, we succeeded in tracing remains of shrines which had been protected by heavy covering masses of débris, and the employment of large numbers of diggers to clear them was easy. After the difficulties to which my previous work at desert sites far away from habitations and water had accustomed me, conditions of work in the Turfan district seemed, in fact, quite "suburban," as it were. In the end we recovered at Toyuk a considerable quantity of fine frescoes and stucco relievo pieces. Fragments of Chinese and Uigur texts were numerous.

From Toyuk I proceeded by the middle of December to an important Buddhist site below the village of Murtuk. It occupies a conglomerate terrace on the steep west bank of the stream watering the Kara-khoja oasis, where it breaks in a narrow wild gorge through the barren hill range overlooking the main Turfan depression (Fig. 19). The extensive series of ruined shrines, partly cut into the rock, had been decorated with frescoes representing scenes of Buddhist legend and worship in a great variety of subject and style. In richness and artistic merit they surpassed any similar remains in the Turfan region, and recalled the pictorial wealth of the "Thousand Buddhas" caves near Tun-huang. In 1906, Professor Grünwedel, with his intimate knowledge of Buddhist iconography and art, had carefully studied these big wall paintings, and a considerable selection of fresco panels was then removed to Berlin. For long centuries the frescoes had been liable to suffer casual injury at the hands of iconoclast Muhammadan visitors. During recent years they had been exposed to even

greater damage from natives, who, in vandal fashion, cut out small pieces for sale to Europeans. The risk of further destruction in the near future was only too obvious, and careful systematic removal presented the only means of saving as much as possible of these fine remains of Buddhist art. Fortunately, I could utilize for this long and difficult task the trained skill and manual experience of Naik Shams Din. Working with devoted energy, and valiantly helped by Afrazgul, he successfully accomplished it in the course of six weeks. Carefully drawn plans had been prepared for their guidance. Meanwhile I was able to pay a rapid visit to Urumchi, the provincial headquarters, where I had the great satisfaction of seeing again my old Mandarin friend, learned P'an Ta-jên, then holding high office as Financial Commissioner of the 'New Dominion.' As on my former journeys he did his best to help me in my scientific aims.

Early in January 1915 work had progressed sufficiently to allow me to apply myself to the clearing of smaller Buddhist ruins near Murtuk, and then to a task which proved as fruitful as it was to me novel and in some ways unpleasant. Below the debouchure of the gorge which brings down the streams of Murtuk and Sengim, and above the large village of Astana adjoining Kara-khoja from the west, there extends over the gravel-covered waste a vast ancient burial-ground. It is marked by small mounds covered with stones and by low lines of embanked gravel which enclose these mounds to form scattered groups. The mounds indicate the position of tomb chambers which are cut into the underlying hard layer of fine conglomerate or sandstone. A narrow rock-cut passage, originally filled in again, led deep down to the entrance of each tomb, which itself was closed with a wall. Most of these tombs appear to have been searched for valuables during the last Muhammadan rebellion, and probably also earlier. But drift-sand had completely closed up the passages of approach, and only during the last few years had the tombs attracted attention from local antique-hunters. Their operations had not proceeded far, and gave anyhow useful assurance as to the absence of any local prejudices.

Willing labour could be secured in plenty, and made easy the opening of very numerous tombs in rapid succession. The systematic search of each has conclusively demonstrated that the cemetery dates from the early T'ang period, and mainly the seventh century A.D. Then Kao-chang, the present Turfan, was an important administrative centre and garrison of the Chinese after their reconquest of Eastern Turkestan. Exact dates, names of persons, and other details are furnished by the Chinese inscriptions on bricks which were found intact near the approaches of many tombs. Their decipherment by my distinguished Sinologue collaborator, M. Chavannes, is likely to clear up the question as to whether the tombs were occupied exclusively by Chinese or contained also dead from among the indigenous population. Without a detailed examination and comparison of all these finds and observations, which may not be possible for some time, it would be premature to interpret the interesting burial customs revealed

by these tombs; nor can I find space here to discuss them and their variations.

The dryness of the Turfan climate accounts for the remarkable state of preservation in which most of the bodies and the objects deposited with them were found. The latter comprised a great variety of articles of food, dress, personal use and the like, which the dead were supposed to need. Among them I may mention pastry of many shapes, showing familiar Indian ornamental motifs; boxes with ladies' toilet outfits; arms, etc. Whether of actual size, or reproduced in miniature, these objects, together with the painted stucco figurines representing attendants, richly caparisoned horses, household animals, etc., acquaint us with many aspects of the daily life led in Turfan at that period. I cannot pause to give details. It must suffice to record that the archæological spoil has been as varied as it was abundant. But I may at least briefly refer to finds strikingly illustrating the position which Turfan and probably other oases of Chinese Turkestan occupied at that period, as places of trade exchange between Western Asia and China. Thus we found Byzantine gold pieces regularly placed, much in the fashion of the classical obolus, in the mouth of the dead, and Sassanian silver coins over their eyes. The custom of wrapping up the bodies in torn pieces of manifold garments has provided us with a rich collection of fine silk materials. Among these there is a curious abundance of brocades and other decorated fabrics showing designs which are usually associated with Persian work of Sassanian times. Paintings on silk, too, were found, meant to decorate the dwellings of the dead, and a quantity of manuscript records, mainly Chinese.

Interesting and fruitful as this search was, I felt a strong longing for a chance of resuming exploratory tasks in the open air of the desert. But my leg had not yet recovered from the accident in the summer, and could not face long tramps such as a return to the wastes of the Lop desert would have necessitated. So I had to be content with what satisfaction Lal Singh's safe return towards the close of January from his expedition into the 'Dry Mountains' brought me. In the face of great physical difficulties and risks he had accomplished important survey work. After reaching Singer, the only permanent homestead in that vast area of barren plateaus and hills, he had started triangulation, and in accordance with my instructions carried it south-east to the vicinity of the Lou-lan ruins in the wind-eroded desert. His patient wait there for a week, amidst icy gales and with temperatures falling well below zero Fahrenheit, was rewarded when the dust-laden atmosphere cleared at last and allowed him to connect his triangles with previously "fixed" high peaks of the snowy K'un-lun range some 150 miles south. Thus it became possible later on to realize my hope of getting the Indian triangulation system extended by this link to the T'ien-shan range in the north.

With Abdur Rahim, the experienced hunter of wild camels from Singer, whose help had proved so valuable to us a year before, Lal Singh

had then pushed into the unexplored and absolutely sterile region to the north-east of Altmish-bulak. His fuel supply had given out for several days, and he had to brave the severe cold of the nights without a fire before he decided to turn again westwards from beyond 91° long. He then picked up an old desert track once used by hunters of wild camels from Hami, before certain salt springs had dried up, and followed it down to the salt marsh that forms the deepest part of the Turfan Basin. There he took numerous observations with the mercurial barometer which, I hope, will make it possible to determine its depression below sea-level with greater accuracy. In spite of all he had gone through, Lal Singh allowed himself but a brief rest at our base, and by the first week of February set out afresh for the Kuruk-tagh.

The packing of our plentiful "archæological proceeds" from Turfan had cost great efforts. But at last, on February 6, I could start my big convoy of antiques, making up fifty camel-loads, under Ibrahim Beg's care for its two months' journey to Kashgar. On the same day I sent off Afrazgul Khan to the Lop desert for a supplementary survey of the Lou-lan region and the dried-up ancient sea-bed to the east and south. I myself proceeded to Yar-khoto for a detailed survey of this curious site, where a maze of ruin dwellings and shrines carved out of the loess soil of an isolated and naturally strong plateau represents the remains of the earlier Turfan capital during Han times. Some days more were taken up by arrangements for the completion of the large-scale map of the Turfan depression in six sheets and by the collection of supplementary data bearing on its extant irrigation resources. Their comparison with those which must be assumed to have existed in Buddhist times is made particularly instructive by the fact that now the greater portion of the cultivated area is irrigated from *karezes* or springs tapped by underground canals, a system which is known to have been introduced into Turfan from Iran only during the eighteenth century. My last days at Turfan were made somewhat anxious by a renewed attempt at Chinese obstruction, now directed against my archæological activity. Fortunately this time, too, I was on the point of starting into desert parts where no interference with my plans was practicable, and the safe transit of my antique collection, about which I had reason to feel apprehensive, was secured by the prompt steps my old friend, Sir George Macartney, took to parry the stroke from Provincial headquarters.

On February 16 I left Turfan for the Kuruk-tagh, and having secured from Singer Abdur Rahim's youngest brother as guide, examined several localities in the mountains westwards, such as P'o-ch'êng-tzŭ and Shindi, where traces of earlier occupation were reported. The succession of remarkably rugged ranges and deeply eroded valleys through which we had to thread our way contrasted strikingly with the appearance of worn-down uplands presented by most of the Kuruk-tagh eastwards. I was able to map here a considerable extent of ground which had remained

unsurveyed. Apart from another brother of Abdur Rahim, who was grazing his flocks of sheep in the gorge of Shindi, and a solitary Turki who was taking supplies to a spot where a few Chinamen were said to dig for lead, we met no one. The absence of springs or wells precludes the regular use of what scanty grazing is to be found in the higher valleys. Yet in the Han Annals this westernmost portion of the Kuruk-tagh is referred to as a sporadically inhabited region under a separate chief.

Over absolutely barren gravel wastes I then made my way south-eastwards to the salt spring of Yardang-bulak, or *recte* Dolan-achchik, at the extreme foot of the Kuruk-tagh, where wild camels were encountered in plenty. Taking my ice-supply from there, I proceeded by the second week of March into the waterless desert south, and mapped there the dried-up ancient river-bed, which once had carried the water of the Konche-darya to the Lou-lan sites, over the last portion of its course left unsurveyed last year. The season of sand-storms had now set in, and their icy blasts made our work here very trying. It was under these conditions, fitly recalling the previous year's experience at the Lou-lan cemeteries, that I explored two ancient burial-grounds of small size, which were found on clay terraces rising above the wind-eroded plain. The finds closely agreed with those which the graves, searched on the fortified Mesha in the extreme north-east of Lou-lan, had yielded. There could be no doubt that the people buried here had belonged to the autochthonous population of hunters and herdsmen living along the 'Dry River' until the tract became finally desiccated in the fourth century A.D. The objects in these graves and the clothes of the dead strikingly illustrated how wide apart in civilization and modes of daily life these semi-nomadic Lou-lan people were from the Chinese frequenting the ancient high-road which passed by the dried-up river.

I had been eagerly looking out along the foot of the Kuruk-tagh for traces of Afrazgul, who was overdue, and had taken the precaution to leave messages for him under cairns. So it was a great relief when, the day after my return to Yardang-bulak, he safely rejoined me with his three plucky Turki companions, including doughty Hassan Akhun, my camel factotum, and Abdul Malik, a fourth hardy brother from Singer. Considering the truly forbidding nature of the ground they had to traverse, and the length of the strain put on our brave camels, I had reason to feel anxious about the safety of the party. Now I was cheered by the completeness with which Afrazgul had carried through the programme I had laid down for him. Having gained Altmish-bulak by the most direct route and taken his supply of ice there, he had explored certain ancient remains in the extreme north-east of the once-watered Lou-lan area, for the examination of which I had been unable to spare time on last year's march.

He then struck out for the point where the ancient Chinese route had entered the salt-encrusted bed of the dried-up sea, and thence traced its shore-line to the south-west, until he reached, at Chainut-köl, the northern

edge of the area, where the spring floods of the Tarim finally spread themselves out, to undergo rapid evaporation in lagoons and marshes. He arrived, as I had intended, just in time before the usual inundation could interfere with his progress. After a few days' rest, with water and grazing for the camels, he turned into the wind-eroded desert north, and traced more remains of the ancient settlement discovered a year before along the southernmost branch of the 'Dry River.' Finally, after crossing an area of formidable high dunes, he gained the foot of the outermost Kuruk-tagh. From this exceptionally difficult exploration, which had kept the party from contact with any human being for a month and a half, Afrazgul brought back, besides interesting archæological finds, an accurate plane-table survey and detailed diary records. It is impossible here to discuss the results. But when considered with those which the previous year's surveys had yielded they will, I feel confident, help to show the so-called Lop-nor problem in a new light.

We subsequently moved west to the point known as Ying-p'an, where the ancient bed of the Kuruk-darya is crossed by the Turfan-Lop track. I made use of a short halt there for exploring the interesting remains of a ruined fort and small temple site, found some miles beyond at the debouchure of the dried-up stream of Shindi, and first noticed by Colonel Kozloff and Dr. Hedin. The finds we made here of fragmentary Kharoshthi records on wood and of Han coins were important as proving that the ruins belonged to a fortified station occupied during the early centuries of our era when the ancient Chinese high-road coming from Lou-lan passed here. The station was meant to guard an important point of the route where it must have been joined by the road leading up from Charchan and Charkhlik. That it held a Chinese garrison became evident from the remains we found on clearing some well-preserved tombs in a scattered cemetery near by. There was definite evidence showing that the site abandoned for many centuries had been reoccupied for a while during Muhammadan and relatively recent times. Now the water needed for irrigation is wholly wanting.

Proceeding from Ying-p'an I first surveyed in the desert westwards the ancient bed, still marked by its rows of fallen dead trees, in which the waters of the Konche-darya had once passed into the 'Dry River' of Lou-lan. My subsequent journey to Korla, by a route leading through the desert north-westwards, and first followed by Dr. Hedin in 1896, enabled me to explore the remains of an ancient line of watch-stations extending for over 100 miles along the foot of the Kuruk-tagh. These watch-towers, some of them remarkably massive and well-preserved, showed the same characteristic features of construction with which my explorations along the ancient Chinese *Limes* of Kansu had made me so familiar. There can be little doubt, I think, that these towers date back to approximately the time (*circ.* 100 B.C.) when the Emperor Wu-ti had the route leading from Tun-huang towards Lou-lan protected by his wall and line of watch-

stations. From the great height and intervening distances of the towers, as well as from other indications, it may be safely inferred that they were primarily intended for the communication of fire signals, such as are frequently mentioned in the early Chinese records I recovered from the Tun-huang *Limes*.

The need for such signalling arrangements must have been specially felt here, as it was mainly from the direction of Kara-shahr and Korla that the Hun raids must have proceeded, which we know from the Annals to have more than once threatened the Chinese hold upon Lou-lan and the security of their route to the Tarim Basin. With the gradual extension of Chinese political influence north of the T'ien-shan these conditions changed, and subsequently the abandonment of the Lou-lan route, and the desiccation of the region it led through, must have greatly reduced the importance of this ancient line of communication along the Konche-darya. Yet the line marked by the towers appears to have continued in use as a high-road down to T'ang times, as was shown by the finds of coins, torn documents on paper, etc., we made on clearing the refuse heaps near them.

My visit to the quasi-peripatetic modern colony of Kara-kum on the upper Konche-darya gave me opportunities for curious observations about irrigation conditions and Chinese administrative methods; but I cannot pause to describe them. At the large and flourishing oasis of Korla higher up the river I had soon the satisfaction of seeing, by the beginning of April, our four surveying parties safely reunited. Lal Singh had succeeded in carrying his triangulation from Singer through the western Kuruk-tagh to the snow-covered peaks north of Korla. His dogged perseverance had triumphed over exceptional difficulties, both from the very broken nature of the ground and the adverse atmospheric conditions, which a succession of the violent duststorms usual at this season had created. The reward was the successful linking I had aimed at, of the T'ien-shan range with the system of the Trigonometrical Survey of India.

From Korla we set out on April 6 in three separate parties for the long journey to Kashgar. Lal Singh's task was to keep close to the T'ien-shan and to survey as much of the main range as the early season and the available time would permit. Muhammad Yakub moved south across the Konche and Inchike Rivers to the Tarim, with instructions to survey its present main channel to the vicinity of Yarkand. I sent most of our brave camels with him in order to let them benefit by the abundant grazing in the riverine jungles after all the privations they had gone through. My own antiquarian tasks obliged me to keep in the main to the long line of oases which fringes the south foot of the T'ien-shan and through which the chief caravan route of the Tarim Basin still passes, just as it has always done since ancient times. Well known as this high-road is over which lay most of my journey to Kashgar, some 900 miles in length, the opportunities it gave for interesting observations, both on the historical geography and the present physical and economic conditions of this

northern fringe of oases, were abundant. But here a brief reference to the result of my work round Kucha must suffice.

Three busy weeks spent within and around this historically important oasis enabled me with Afrazgul's help to survey both its actually cultivated area and that which, by the evidence of the numerous ancient sites found scattered in the scrubby desert to the east, south, and west, must have formed part of it. This survey, which archæological finds of interest at a number of ruined sites usefully supplemented, has given me strong grounds for assuming that the area occupied in Buddhist times demanded for its cultivation irrigation resources greatly in excess of those at present available, of which I secured careful estimates. It seems to me clearly established that the discharge of the two rivers feeding the canals of Kucha has diminished considerably since T'ang times. But the antiquarian evidence at present obtainable does not allow us definitely to answer the questions as to what extent this obvious "desiccation" was the direct cause for the abandonment of once irrigated areas, and at what particular periods it proceeded. Here I may also mention in passing that remains of the ancient Han route, in the shape of massive watch-towers, could be traced as far as Kucha, and that their position clearly indicated that the old caravan route had followed the same line as the present one.

After visiting a number of interesting Buddhist ruins in the district of Bai, I travelled to Aksu, where Lal Singh's and my own routes opportunely allowed a brief meeting. He had managed to carry his plane-table survey at three points up to the snow-covered watershed of the T'ien-shan, including the glacier pass below the high massif of Khan-tangri. Help I secured from the obliging Tao-tai of Aksu subsequently enabled him to follow a new route on his way to Kashgar, between hitherto unexplored outer ranges of Kelpin.

Regard for urgent tasks obliged me to move in rapid marches to Kashgar, which was reached on 31 May 1915. There at my familiar base I was received with the kindest hospitality by Colonel (now Brigadier-General) Sir Percy Sykes, who had temporarily replaced Sir George Macartney as H.B.M.'s Consul-General. Though a shooting-trip to the Pamirs soon deprived me of the congenial company of this distinguished soldier-statesman and traveller, I continued to benefit greatly by all the help and comfort which the arrangements made by him assured to me during my five weeks' stay at Chini-bagh.

The safe repacking of my collection of antiques, filling 182 heavy cases, for its long journey across the Kara-koram to Kashmir, and a host of other practical tasks kept me hard at work all through that hot month of June. In the midst of it I felt greatly cheered by receiving the final permission of the Imperial Russian Government for my long-planned journey across the Pamirs and the mountain north of the Oxus, which the kind offices of H.E. Sir George Buchanan, H.B.M.'s Ambassador at Petrograd, at the instance of the Government of India in the Foreign

Department, had secured. Considering how long I had wished to see this extreme east of ancient Iran, and that part of the "Roof of the World" under which it shelters, I could not feel too grateful to the Imperial Russian Government for having shown this readiness to give me access to ground which for the most part had never before been visited by any British traveller. Its diplomatic representative at Kashgar, Consul-General Prince Mestchersky, lost no chance of facilitating the arrangements for my journey by kind recommendations to the Russian authorities across the border. But throughout it was a great comfort to feel, during that time of preparation, and still more on actual travel, how much of that kind help and attention I directly owed to Lord Hardinge, and the alliance of the British and Russian Empires he had done so much to render possible.

By 6 July 1915 I was able to leave Kashgar for the mountains westwards, after having completed all arrangements for the safe passage of my eighty heavy camel-loads of antiques to India. But the summer floods in the K'un-lun valleys, due to the melting glaciers, would not allow the valuable convoy to be started at once towards the Kara-koram passes. So R. B. Lal Singh, to whose care I had to entrust it, had set out in the meanwhile to complete our topographical labours in Turkestan by a careful survey of the high snowy mountains, which continue the Muztagh-ata range to the headwaters of the Kashgar River. Before he rejoined me for manifold final instructions I could enjoy a week of delightful seclusion for much urgent writing work, on a small fir-clad alp above the Kirghiz camp of Bostan-arche (Fig. 20). Lower down in the valley my brave hardy camels had enjoyed weeks of happy grazing in coolness, badly needed after all their long travels and trials. When the time came for my start, I confess I felt the final separation from them almost as much as the temporary one from my devoted Lal Singh. Of my other assistants I kept by me only young Afrazgul, whom I knew to be ever useful, even where survey work or digging could not be done. The rest were to accompany my collection to India.

It was with a delightful sense of freedom that on July 19 I started from my mountain camp for the high Ulugh-art Pass and the Pamirs beyond. For across them the road lay now open for me to those mountain regions north of the Oxus, which by reason of their varied geographical interest and their ethnic and historical associations have had a special fascination for me ever since my youth. On the following day I crossed the steep Ulugh-art Pass, about 16,200 feet above sea-level, flanked by a magnificent glacier some 10 miles long. There I felt duly impressed with the fact that I had passed the great meridional mountain barrier, the ancient Imaos, which divided Ptolemy's "Inner" and "Outer Scythia," as in truth it does now Iran and Cathay. The same night, after a 33 miles' walk and ride, I reached the camp of Sir Percy Sykes returning from the Pamirs, and next day enjoyed a time of happy reunion with him and his sister, that well-known traveller and writer, Miss Ella Sykes.

Five days of rapid travel then carried me over the northernmost Chinese Pamirs and up the gorge of the westernmost headwaters of the Kashgar River, until I struck the Russian military road to the Pamirs on the Kizil-art Pass where it crosses the Trans-Alai range. At the little rest-house of Por-döbe, which I reached that evening on my descent from the pass, I soon received most encouraging proof of the generous and truly kind way in which the Russian political authorities were prepared to facilitate my travels. There I had the good fortune to meet Colonel Ivan D. Yagello, who holds military and political charge of the Pamir Division, including now also Wakhan, Shughnan, and Roshan; he was then just passing on a rapid visit to Tashkend. I could not have hoped even on our side of the Hindukush border for arrangements more complete or effective than those which proved to have been made on my behalf by this distinguished officer. It was for me a great additional pleasure to find in him an Oriental scholar deeply interested in the geography and ethnography of the Oxus regions, and anxious to aid whatever investigations could throw fresh light on their past. It was mainly through Colonel Yagello's unfailing aid that I succeeded in covering so much interesting ground, far more than my original programme had included, within the available time and without a single day's loss. I shall always look back with sincere gratitude to his friendly interest and all the generous help which he and his assistants, officers at the several Russian Pamir posts, gave me.

One of the chief objects which I had in view, when planning this extension of my journey across the Pamirs and the Russian territories on the Oxus, was to study there questions of historical geography, in the way which experience elsewhere in the East had taught me to be the best, *i.e.* on the spot. Hence it was a special satisfaction to me that at the very start I was able to march down the whole length of the big Alai Valley, a distance of over 70 miles. In the topographical configuration, climatic conditions, and local resources of this great Alpine basin I could trace additional indications supporting the belief that through this wide natural thoroughfare, skirting the northern rampart of the Pamirs from east to west, passed the route which the ancient silk traders from China followed down to the Middle Oxus, as outlined by that much-discussed record of classical geography where Marinus of Tyre describes the progress in the opposite direction of the agents of "Maës the Macedonian" from Bactria to the great silk mart in "the country of the Seres" or China. Similar observations make it appear to me very probable that the famous "Stone Tower" mentioned in that record must be located at or near Daraut-kurghan, a small Kirghiz village and now a Russian frontier customs post, where the route up the main Kara-tegin Valley emerges upon the Alai; it is the only direct one between Bactria and Eastern Turkestan which is practicable throughout for laden camels.

From Daraut-kurghan, where our supplies could conveniently be

FIG. 21.—GLACIER PEAKS OF 'MUZ-TAGH' ABOVE MUK-SU, SEEN FROM WATERSHED (CIRC. 11,000 FEET) ON TARS-AGAR PASS.

FIG. 22.—HEADMEN OF UPPERMOST ROSHAN VALLEY AT SAUNAB.

FIG. 23.—GORGE OF BARTANG RIVER, ABOVE BARCHIDIW, BLOCKED BY LANDSLIDE.

Newly formed tarn in foreground; former river-bed buried under rock-débris.

replenished, I turned south to strike across the succession of high snowy ranges which separate the headwaters of the Muk-su and the rivers of Roshan and Shughnan from the uppermost Oxus. It was the only route, apart from the well-known one leading across the Kizil-art and past Lake Kara-kul, by which I could cross the Russian Pamirs and their western buttresses from north to south, and this accounted for my choosing it. But it proved a distinctly difficult route to follow, even with such exceptionally hardy animals as Colonel Yagello's orders secured for me from the rare Kirghiz camps encountered. There was, however, abundant reward in the mass of interesting geographical observations to be gathered and in the splendid views which it offered into a region of permanent snow and ice little explored and in parts still unsurveyed.

As far as the Tanimaz River, a large tributary of the Bartang or Murghab River, our route led past a grand glacier-clad range, vaguely designated as Sel-tagh or Muz-tagh, and still awaiting exact survey, which forms, as it were, the north-western buttress of the Pamirs. Rarely have my eyes in the Himalaya, Hindukush, or Kun-lun beheld a sight more impressive than the huge glacier-furrowed wall of the "Muz-tagh" (Fig. 21) as it rose before me with magnificent abruptness above the wide torrent beds of the Muk-su, after I had crossed the Tars-agar, our first pass from the Alai. Its boldly serrated crest-line seemed to rise well above 20,000 feet, and individual ice-peaks may reach a considerably greater height. No approximately exact elevations seem so far to have been determined with the theodolite or clinometer for this and some other prominent ranges towering above the western portion of the Pamirs, and neither Afrazgul nor myself could help feeling again and again regret at the obvious considerations which precluded our attempting survey work however modest in scope. Subsequently it was a real satisfaction to come across evidence of the systematic triangulation work which the Topographical Service of Russian Turkestan has been extending over the Pamirs for some years past, and to learn that it was steadily being continued in spite of the war.

Our direct route past the Sel-tagh would have led up the valley by which the Zulum-art and Takhta-koram passes, giving access to the Kara-kul and Tanimaz drainage areas, are approached. But the floods fed by the huge Sel-darra Glacier completely close this route from spring time till the late autumn, just as they render the track lower down the Muk-su quite impracticable for the greater part of the year.* So we were obliged to make our way first over the glacier pass, *circ.* 15,100 feet high, at the head of the Kayindi gorge. The latter proved to be completely blocked in places by ancient moraines and offered very difficult going. Here, as

* This Muk-su gorge is in places even during winter too difficult for laden animals. To find it actually marked in a recent cartographical representation as traversed by the ancient silk trade route seemed an illustration of the risks which beset the work of the historical geographer when it has to be done solely in the study.

elsewhere, in the high mountains west of the Pamirs, evidence could be noted of glaciation having considerably receded during recent times.

Beyond the Kayindi the ground assumed a much easier Pamir-like character, and after crossing the Takhta-koram Pass, *circ.* 14,600 feet, we reached on August 8 the first encampment of Kirghiz grazing in the open valleys to the south-west of the Great Kara-kul. Having obtained there fresh transport from imposing old Kokan Beg, the Ming-bashi of the northern Pamirs, and having started my anthropometric work, I moved down the Tanimaz Valley to its junction with that of the Murghab or Bartang River. Here at the picturesque hamlet of Saunab, the Tash-kurghan of the Kirghiz, I reached the first Iranian-speaking settlement of hill Tajiks or Ghalchas, all fine-looking men (Fig. 22). Their ethnic type of pure *Homo alpinus*, their old-world customs, preserved by alpine isolation, and the survival of much that seems ancient in domestic architecture, decorative motifs, etc., interested me greatly and amply justified a day's halt, which allowed me to secure anthropological measurements and arrange for the load-carrying men we needed.

The only route open to us for reaching the southern Pamirs led up by the Bartang River, and progress in its narrow gorges proved exceptionally trying owing to the results of the great earthquake of 18 February 1911, which had transformed the surface of this mountain region in a striking fashion. Already on the lower Tanimaz we had come upon huge masses of rock débris which had been thrown down from the slopes of the flanking spurs and now spread for miles across the open valley bottom. Here in the defiles of the Bartang the huge landslides attending that memorable earthquake had choked up in many places the whole river passage and practically destroyed what tracks there ever existed along or above it. The big river once rivalling in volume the main feeder of the Oxus, the Ab-i-Panja, had here ceased altogether to flow. Strings of deep alpine tarns, with colours of exquisite beauty, had replaced it here and there and helped to increase the difficulties of progress (Fig. 23). It took three days' hard scrambling along steep spurs almost impassable for load-carrying men, and over vast slopes of rock débris spread out in wildest confusion, to get beyond the point near the mouth of the Shedau side valley (Fig. 24), where the fall of a whole mountain has completely blocked the river, and converted the so-called "Sarez Pamir" into a fine alpine lake over 15 miles long now and still spreading up the valley.*

Enormous masses of rock and detritus had been shaken down from the range on the north and had been pushed by the impetus of the landslip

* In an important paper (*Comptes rendus de l'Académie des Sciences*, clx. pp. 810 *sqq.*, Paris, 1915), reference to which I owe to Mr. E. Heawood's kindness, Prince B. Galitzine has shown strong reasons for the belief that the Sarez landslide was not the consequence but the cause of the earthquake of 18 February 1911, which was registered at many distant seismological stations. This earthquake is declared to present an exceptionally interesting case where the epicentre can be proved to coincide with the hypocentre itself.

FIG. 24.—BARRAGE THROWN ACROSS BARTANG VALLEY BY LANDSLIDE, WITH WESTERN END OF NEWLY-FORMED SAREZ LAKE.

View from circ. 12,000 feet height on Marjanai spur, looking to north-west. Clouds of dust raised by rock movement on higher slopes mark where mountain had fallen in earthquake of 1911.

FIG. 25.—OXUS VALLEY AT JUNCTION OF AB-I-PANJA AND GREAT PAMIR RIVER, SEEN FROM RATTIN ABOVE LANGAR-KISHT.

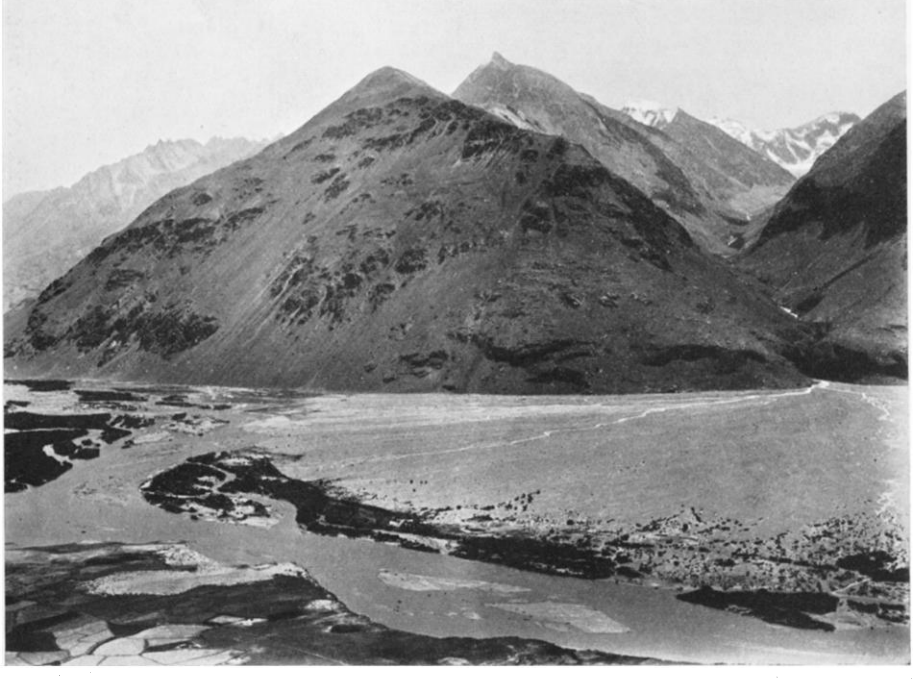


FIG. 26.—OXUS VALLEY WITH HINDUKUSH PEAKS ABOVE DARRA-I-PANJA, SEEN FROM RUINED FORT ABOVE ZANG (VIEW TO SOUTH-EAST).

up the steep spur flanking the Shedau debouchure. They had thus formed a huge barrage which even now seemed to rise more than 1200 feet above the level of the new Sarez Lake, and is likely to dam it up for years, if not for centuries. It cost another day's stiff, and in places risky, scramble before we succeeded in getting the baggage safely across the few miles of precipitous rock slopes and dangerous débris-shoots above the Yerkht inlet. Fortunately the men collected from the uppermost hamlets of the Roshan Valley proved all excellent cragsmen and quite expert in building *rafaks* or galleries of brushwood and stones along otherwise impassable precipices.

Opportunely succoured by Kirghiz ponies, which had been sent from the Alichur Pamir to meet us, we crossed the Langar Pass, close on 15,000 feet above the sea, by August 20. It gave us easy access to the Yeshil-köl Lake, where I found myself on ground of varied geographical interest. I can mention only two points here and those in all briefness. On the one hand, with the experience gained at the newly formed big lake fresh before me, it was easy to recognize those topographical features which clearly point to the Yeshil-köl having derived its existence from a similar cataclysm at some earlier period. To the eyes of the non-geologist the formation of the Buruman ridge, which closes the western end of the lake, seemed to bear a close resemblance to the newly formed barrage which has created the Sarez Lake. Of glacier action, which might have produced the same result, I could see no trace on either side of the Yeshil-köl exit. On the other hand, what I observed on my way up the open Alichur Pamir, and subsequently in the main Shughnan Valley below it, bore clear evidence to the advantages which the route leading through them had offered for Chinese expansion to the Upper Oxus and Badakhshan ever since Kao Hsien-chih's memorable Pamir and Hindukush campaign of 747 A.D.

Having crossed the Bash-gumbaz, our fourth pass over 15,000 feet since leaving the Alai, I descended to the glittering big expanse of Lake Victoria or Zor-köl, where the Great Pamir branch of the Oxus rises, and the Pamir borders of Russia and Afghanistan meet. Ever since my youth I had longed to see this, the truly "Great" Pamir and its fine lake, famous in early local legends, and the "Great Dragon Lake" of the old Chinese pilgrims. As I looked across its deep blue waters to where in the east they seemed to fade away on the horizon, I thought it quite worthy to figure in early tradition as the legendary central lake from which the four greatest rivers of Asia were supposed to take their rise. It was a delightful sensation to find myself on ground closely associated with the memories of those great travellers, Hsüan-tsang, the saintly Chinese pilgrim-geographer, Marco Polo, and Captain Wood, the first modern explorer of the Pamir region.

The day of halt, August 27, spent by the sunny lake-shore, undisturbed by any sign of human activity, was most enjoyable, in spite of the bitterly cold wind sweeping across the big alpine basin, *circ.* 13,400 feet above sea-

level. It allowed me to gather local information, which once more confirmed in a striking fashion the accuracy of the Chinese historical records. In describing Kao Hsien-chih's expedition across the Hindukush, the T'ang Annals specially mention the concentration of the Chinese forces by three routes from east, west, and north, upon Sarhad, the point on the Ab-i-Panja branch of the Oxus, which gives direct access to the Baroghil and Darkot Passes. The routes from the east and west, *i.e.* down and up the Ab-i-Panja Valley, were clear beyond all doubt. But of the northern route no indication could be traced in maps or books, and the existence of a pass, vaguely mentioned in native intelligence reports as possibly leading to Sarhad, across the high snowy range south of the Great Pamir, had been denied by members of the British Boundary Commission of 1895 who visited this region.

It was hence a pleasant surprise when inquiries from two much-travelled Kirghiz among our party elicited definite and independent evidence as to an old track still used by Tajik herdsmen, which leads from Sarhad across the range to the glacier-filled head of the Shor-jilga Valley, clearly visible from Lake Victoria, and thence down to the western shore of the latter. All I could observe through my glasses, and what I had seen in 1906 from the other side of the mountain range, seemed to plead for the accuracy of the Kirghiz' information. My only regret was the impossibility of testing it on the spot. This, alas, would have necessitated my trespassing on His Afghan Majesty's territory. How often did I later on, too, look wistfully across the boundary drawn by the River Oxus with the fond wish that I might yet be allowed to pass "through the gate of favour" into those fascinating valleys and mountains on the Afghan side of the border, which I was now able to skirt for hundreds of miles!

Three rapid marches down the Great Pamir River then carried me to Langar-kisht, where we reached the main Oxus Valley (Figs. 25, 26), and the highest of the villages on the Russian side of the river. Here, too, everything was done by the Commandant of the Russian frontier post and the local Wakhi headmen to facilitate my journey. My subsequent journey down the Oxus was attended by an abundant harvest of observations bearing on the historical topography, archæology, and ethnography of Wakhan, which in early times had formed an important thoroughfare between Bactria, India, and the Central-Asian territories controlled by China. But it would cost too much time and space if I attempted here to give any details. It must suffice to mention that the exact survey of a series of ruined strongholds, some of them of very considerable extent, acquainted me with numerous features of distinct archæological interest in their plans, the construction and decoration of their bastioned walls, etc. (Fig. 28). The natural protection offered by unscaleable rock faces of spurs and ravines was always cleverly utilized in these defences. But some idea of the labour, which even thus their construction must have cost, can be formed from the fact that at one of these strongholds, known as Zamr-i-atish-parast,

the successive lines of walls, with their bastions and turrets solidly built in rough stone or in sun-dried brick, ascend the slopes of a precipitous spur over 1000 feet high, and have an extent of more than 3 miles.

It is certain that these hill fastnesses date back to pre-Muhammadan times and to a period when this portion of the Oxus Valley contained a population far denser than at present and enjoying a higher degree of material civilization. Their attribution by the present Wakhi people to the "Siahposh Kafirs" merely gives expression to a vague traditional recollection that they date back to times before the advent of Islam, the "Siahposh" of Kafiristan south of the Hindukush never having reached the stage of civilization which these ruins presuppose. Some architectural details seemed to suggest a period roughly corresponding to late Indo-Scythian or early Sassanian domination, during which our scanty records from Chinese sources indicate that Wakhan enjoyed a state of relative affluence and importance.

All along the big valley of Wakhan there opened glorious vistas to the south, where towering above narrow side valleys, and quite near, appeared magnificent ice-clad peaks of the Hindukush main range (Fig. 27), looking just as early Chinese pilgrims describe them, like peaks of jade. I realized now what an appropriate invention the "popular etymology" was, which in Muhammadan times has connected the old and much-discussed name of *Bolor*, vaguely used for the Hindukush region, with the Persian *billaur*, meaning crystal. The effect was much heightened by the unexpectedly verdant appearance which the cultivated portion of Wakhan still presented at that season, in spite of the elevation from 8000 to over 10,000 feet above sea-level, and doubly welcome after the bleak Pamirs. It was pleasant to note abundant evidence of how much the resources of the Wakhis on the Russian side of the valley had increased, both in respect of cattle and sheep and of land brought under cultivation, since annexation under the settlement arrived at by the Anglo-Russian Pamir Boundary Commission had removed all trouble from Kirghiz raids and Afghan exactions.

For all these reasons I felt glad that plentiful antiquarian and anthropometric work kept me busy in Wakhan during the first half of September. To this was added a philological task when, on entering that portion of the valley which adjoins the great northward end of the Oxus and is known as the tract of Ishkashim, I could collect linguistic specimens of the hitherto unrecorded *Ishkashmi*, one of the so-called Pamir dialects which form an important branch among the modern representatives of the Eastern Iranian language group. At the pretty little Russian post of Nut, which faces the main settlement of Ishkashim, I enjoyed the kind hospitality of Captain Tumanovich, its commandant, and benefited much by his local knowledge and help. Then I passed down the Oxus through the very confined portion of the valley known as Gharan, which until the recent construction of a bridle-path with Russian help was ground very difficult of access, even on foot, and visited Colonel Yagello's headquarters at Kharuk.

It lies at the fertile debouchure of the Shughnan valleys, where the cart road now crossing the Pamirs ends, and proved a very pleasant spot, boasting of fine fruit gardens, and to my surprise, even of electric light.

The relative abundance of fertile arable land and the facility of communication both with the Pamirs and the rich grazing uplands of Badakhshan have always given to the valleys of Shughnan a certain historical importance. They figure often in Chinese and early Muhammadan accounts of the Middle Oxus region. So I was glad to visit in succession the two main valleys of Shakh-darra and Ghund. Considering that the Shughni people have always been noted for their fondness for roaming abroad, in the old days as raiders, and are now as pedlars and servants to be found in all towns from Kabul to Farghana, it was interesting to observe how much of old-world inheritance in ethnic type, local customs, domestic architecture, and implements has survived among them.

From Shitam in the Ghund Valley I crossed by a distinctly difficult glacier pass, over 16,000 feet high, into Roshan. From the watershed, overlooking large and badly crevassed glaciers both to north and south (Fig. 6), I enjoyed a glorious vista over the rolling uplands of Badakhshan, a region towards which my eyes have been turned for many years, and to which access still remains closed. The narrow, deep-cut gorges in which the Roshan River has cut its way through towering mountain masses, wildly serrated above and very steep at their foot, proved a line of progress even more troublesome than the glaciers across which we had reached them. A two days' climbing and scrambling past precipices by narrow rock ledges and frail galleries (*awrinz*), as bad as any I ever saw in the Hindukush, was relieved in places by the use of skin-rafts, where the absence of dangerous cataracts allowed their employment. Guided by dexterous swimmers, they made me glide down over the tossing river, forgetful of all fatigue, in scenery of impressive grandeur, amidst rock-walls which ever seemed to close in upon us. But it was a real relief when the last rock gate was passed, and we emerged once more in the less-confined valley of the Oxus.

Roshan, just as it is the least accessible of all the side valleys of the Oxus, seems also to have preserved the *Homo alpinus* type of the Ghalchas in its greatest purity. The men, clean of limb and made wiry by constant movement over such impossible tracks, all showed clear-cut features, and often faces of almost classical regularity. The hamlets nestling at the mouth of the ravines were often half hidden amidst splendid orchards. The dwellings invariably showed plans and internal arrangements which were obviously derived from high antiquity, so many of the features being familiar to me from the architecture traced at early sites of Turkestan and the Indian North-West. Alpine seclusion seemed to have preserved here a small corner of the world scarcely touched by the change of ages, and I wondered whether some Bactrian Greek on a visit to Roshan would have

FIG. 27.—VIEW ACROSS OXUS VALLEY TOWARDS GLACIERS OF HINDUKUSH RANGE NEAR ISHMARG PASS.

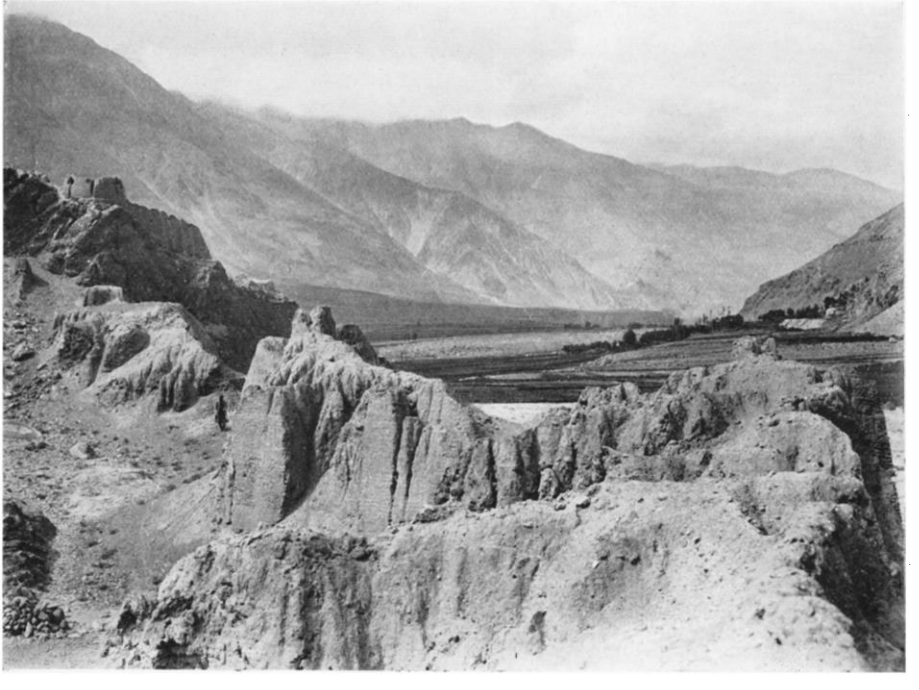


FIG. 28.—WESTERN RAMPARTS OF KALA-I-KAKA STRONGHOLD, WITH VIEW DOWN OXUS VALLEY TOWARDS NAMADGUT.

FIG. 29.—RUINS OF BUDDHIST SITE ON SLOPE OF KOH-I-KHWAJA, WITH VIEW EASTWARDS ACROSS TERMINAL HELMAND MARSHES, SEISTAN.

seen much that was different from what these simple well-built dwellings show now.

After a busy delightful day's halt at Kala-Wamar, in the garden of the ruined castle of the Shughnan chiefs, I crossed the glacier pass of Adude and made my way into the Yazghulam and Vanj valleys of Darwaz, where the territory of the Amir of Bokhara was entered. Here, too, the recommendation of the Imperial Russian political representative, Consul Belaieff, had assured me all possible attention and help. As I travelled up the Vanj Valley, and subsequently through the mountain tract known as Wakhia-bala, I could well observe the gradual change in the physical appearance, houses, ways of living, etc., of the people, bearing testimony to the historically attested conquest of Turki tribes and the influence exercised by the civilization of the Turkestan plains. But we were still high up in the mountains, and had a trying task when on October 3 we crossed the Sitargh Pass, *circ.* 14,600 feet high, with its big and badly crevassed glacier, after the first winter snow had fallen, and just in time before it became closed to traffic. Finally, we gained by the Gardan-i-kaftar Pass, also under fresh snow, the main valley of Kara-tegin.

Here on the banks of the Kizil-su River, coming from the Alai, I found myself once more on the line of the ancient silk-trade route connecting China with Bactria. A marked change in the climatic conditions was brought home to me by the fact that the fertile slopes on the hillsides are being cultivated without the need of irrigation. Kara-tegin, as its modern name attests, had been long occupied by a Turki-speaking population. It was interesting to note here how the Kirghiz settlers, who represent probably the last wave of this Turkish invasion in what was originally Iranian ground, are now being slowly ousted again from the land by a steady reflux of Tajik immigrants.

From Kara-tegin, where I had interesting opportunities for getting to know the traditional administrative methods of Bokhara, a succession of rapid marches carried me westwards through the open and remarkably fertile valleys which the rivers of Kafirnihan and Surkhan drain. It seemed hard to forego a visit south to the Oxus, where it passes nearest to my old goal of Balkh or Bactra. But time was getting short for the remaining portion of my programme. So I took the nearest route to the confines of ancient Sogdiana north-westwards by the difficult track through the mountains which connects Hissar and Regak with the rich plains about Shahr-i-sabz. Finally, on October 22, I arrived at Samarkand and the Russian Central-Asian railway. Since the start from my camp in the Kashgar Mountains my journey had lasted just over three months, and within these we had covered on foot and on horseback an aggregate marching distance of close on 1700 miles.

A new and distant field of work lay ahead for me on Persian soil. So only a few days could be spared for renewed visits to the great monuments of Muhammadan art and Mughal power at Samarkand. It was the same at

Bokhara, where I could personally thank M. Shulga, then officiating as the Imperial Russian representative, as well as the Diwan-begi, the head of H.H. the Amir of Bokhara's administration, for all the kind help and hospitality I had received in the State. So much survives, in that fascinating great city, of old-world Central-Asian life and of its own historical past that my three days' stay seemed a sadly brief time. Then the Trans-Caspian railway carried me to Askhabad, the great Russian cantonment on the Persian border, and crossing this I reached Meshed by November 4 after a four days' hard drive.

There, at the old capital of Khorasan, Colonel T. W. Haig, H.B.M.'s Consul-General for Khorasan, and a distinguished Oriental scholar, offered me the kindest welcome and the chance of a much-needed short rest. Under the hospitable roof of the Consulate and within its fine large garden I felt as if brought back to some English country house. Constant toil at much-delayed official accounts kept me busy and, alas, left little time for glimpses of the interesting city outside. Seistan was my goal for the winter's work, and considering its great distance and the uncertain state of political affairs in Persia, I had much reason to feel grateful for the kind help and shrewd advice by which Colonel Haig facilitated my rapid onward journey.

On November 11 I left Meshed for Seistan. In order to reach it I had chosen a route which, keeping off the main roads, gave opportunities for useful supplementary survey work and offered the further advantage of being the most direct (Fig. 30). It first took us by little-frequented tracks through hills held by Hazara and Baluch tribal settlements to Rui-Khaf. Thence we travelled south in an almost straight line parallel to the Perso-Afghan border, where it passes through a nearly unbroken succession of desert depressions and of equally barren hill ranges. Near a few of the little oases we passed, as at Mujnabad, Tabbas, and Duruh, I was able to examine remains of sites abandoned since early Muhammadan times. At Bandan we struck the high-road, and two days later, on December 1, reached Nasratabad, the Seistan "capital." The excellent Persian mules hired at Meshed had allowed us to cover the total distance of over 500 miles in nineteen marches. With the assistance of Afrazgul Khan a careful plane-table survey on the scale of 4 miles to 1 inch was carried over the whole ground. The disturbed conditions of Persia due to the war made themselves felt also on the Khorasan border, ever a happy raiding-ground for enterprising neighbours. But owing, perhaps, to the rapidity of our movements and the unfrequented route chosen, the journey passed off without any awkward encounters.

Once safely arrived in Seistan I received a very kind and hospitable welcome from Major F. B. Prideaux, H.B.M.'s Consul in Seistan, and could quickly set to work with all the advantages which his most effective help and prolonged local experience assured me. Ever since my student days I had felt drawn to Seistan by special interests connected

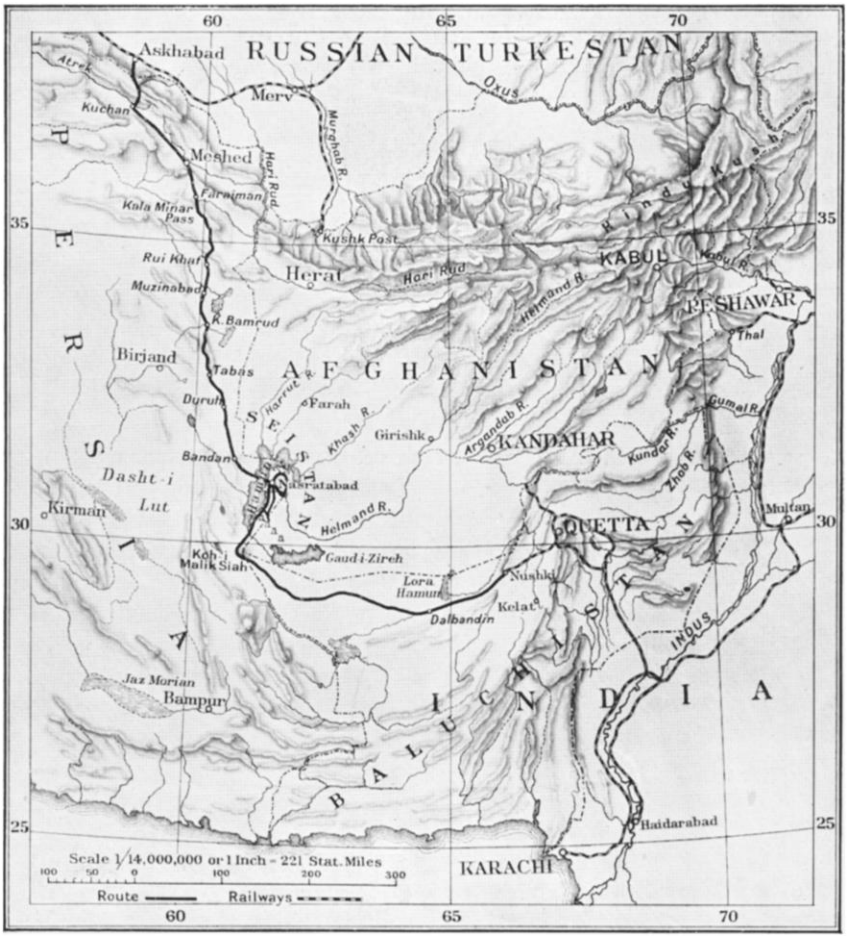


FIG. 30.—SKETCH-MAP SHOWING THE ROUTES FOLLOWED BY SIR AUREL STEIN THROUGH KHORASAN AND BALUCHISTAN.

FIG. 31.—LOWER GATE AND TERRACES ON EAST SLOPE OF RUINED SITE, KOH-I-KHWAJA HILL, SEISTAN.

FIG. 32.—ANCIENT FORTIFIED WATCH STATION, SEEN FROM NORTH-EAST, IN DESERT SOUTH OF SEISTAN OASIS.

with its geography and historical past. It had been more than chance that my very first paper, published as long ago as 1885, dealt with the ancient river names of this Iranian border-land. My present visit to Seistan, long deferred as it was, could for various reasons be only a kind of reconnaissance. Yet even thus I might hope among its numerous ruined sites to discover remains of the early periods when ancient *Sacastana*, "the land of the Sakas or Scythians," served as an outpost of Iran and the Hellenistic Near East towards Buddhist India. A strong additional reason was provided by my explorations in the Tarim Basin; for the striking analogy presented by various physical features of the terminal basin of the Helmand River was likely to throw light on more than one geographical question connected with the dried-up Lop Sea and the ancient Lou-lan delta.

It is a great satisfaction to me that in both directions my hopes have been fully justified by the results of my Seistan work. But it is only the most prominent that I can find space to record here in brief outlines. At the very start my archæological search was rewarded by an important discovery. It was made on the isolated rocky hill of the Koh-i-Khwaja, which rises as a conspicuous landmark above the central portion of the Hamuns or terminal marshes of the Helmand. The extensive and well-known ruins situated on its eastern slope (Figs. 29, 31) proved to be the remains of a large Buddhist sanctuary, the first ever traced on Iranian soil. Hidden behind later masonry, there came to light remarkable fresco remains, dating back undoubtedly to the Sassanian period. Wall paintings, of a distinctly Hellenistic style and probably older, were found on the wall of a gallery below the high terrace bearing the main shrine. Protected in a similar way from the ravages of man and atmospheric moisture they had unfortunately suffered much from white ants. The importance of these pictorial relics, which I managed to remove safely in spite of various difficulties, is great. They illustrate for the first time *in situ* the Iranian link of the chain which, long surmised by conjecture, connects the Græco-Buddhist art of the extreme north-west of India with the Buddhist art of Central Asia and the Far East. This connection was reflected with equal clearness by the architectural features of the ruins, which were also of great interest.

In the desert south of the present cultivated area we found interesting remains of far earlier times. My search here was greatly facilitated by the excellent topographical surveys on a large scale which had been effected under the direction of Mr. G. P. Tate, of the Survey of India, in connection with Sir Henry McMahon's Seistan Mission of 1902–05, and which proved very helpful also in other parts. On this desert ground which an abandoned old branch of the Helmand had once watered, excessive wind-erosion acting on alluvial clay had produced conditions exactly corresponding to those I had found in the dried-up delta north of Lop-nor. Since moisture and vegetation had deserted this soil, the

scouring effect of the sand driven by the north wind that blows over Seistan with more or less violence, but almost constantly during four months of spring and summer, had lowered the level of the ground to varying depths, down to 20 feet or more, below the original level, except where the surface had been protected by hard débris of some kind. The erosion terraces thus left rising island-like above the bare plain were always found thickly covered with prehistoric remains. They consisted of potsherds, often decorated in colours, and stone implements mainly of the Neolithic period, but in places included also relics of the Bronze Age. It was easy to pick up here an abundant archæological harvest literally on the surface.

It was a very interesting and quite unexpected discovery when in the same area I came upon the remains of a close line of ancient watch-stations, stretching right across the desert from the southernmost Hamun in the direction of the true terminal basin of the Helmand, the marsh and lake-bed of the Gaud-i-Zirreh. It was a fascinating task to trace this Seistan *Limes*, and the experience gained during my explorations along the ancient Chinese border-line once protecting the extreme north-west of Kansu helped me greatly. The fortified frontier posts (Fig. 32), solidly built with bricks of great size on a uniform plan, and, as it were, to "specification," were found always to occupy erosion terraces retaining prehistoric pottery débris. Chosen, no doubt, for the sake of increased command of ground and wider outlook, these elevated positions had helped also to save the ruins from complete destruction by the erosive force of wind and sand. The watch-stations were found at distances from half to about $1\frac{1}{2}$ miles apart. The position of sectional headquarters could also be identified by additional structures, etc.

Seistan, in spite of its dreary arid look, does not enjoy a climate quite sufficiently "desiccated" for archæological purposes, as it still receives a fairly regular rainfall of *circ.* 2 inches per annum. So the refuse heaps at these stations, which might have furnished us with interesting dateable records, were found to have decayed into mere odorous layers of earth. But a variety of archæological finds and observations pointed to centuries near the commencement of our era, as the time when this ancient border-line was established. Its object was clearly to protect the cultivated portion of the Helmand delta against raids of nomadic tribes in the south, corresponding in character and habits, if not in race too, to the present Baluch and Brahui tribes to be found there. I cannot indicate here in detail the curious points of analogy presented to the ancient Chinese frontier line of Kansu constructed *circ.* 100 B.C. against Hun raids from Turkestan. But I may hint at least at an interesting question which suggests itself in view of the geographical position. Would one be justified in regarding this fortified desert border of Seistan as a link between that ancient "Chinese Wall" in the desert and the *Limes* lines by which Imperial Rome guarded its marches in Syria and elsewhere in the Near

East against barbarian inroads? Only from future researches can we hope for a safe answer.

From these desert surveys I returned to the inhabited portion of Persian Seistan by the beginning of January 1916, and was kept busy during a few weeks with the examination of the numerous ruins surviving there. Almost all proved of mediæval Muhammadan origin or even more recent, a fact which the physical conditions of the present Helmand delta easily account for. At two sites, however, which their high level has protected from the effects of irrigation or periodic inundation, I discovered definite archæological evidence of ancient occupation. At the large ruined stronghold known as Shahristan, occupying a high alluvial terrace, this included pottery fragments inscribed in early Aramaic characters.

I should have much liked to visit the Afghan portion of Seistan, to the north of the Helmand, where Sir Henry McMahon's Mission and earlier travellers had found a large number of ruins still awaiting expert examination. Permission for such a visit could, however, not be secured, and I did not feel altogether surprised at it. So, after collecting useful anthropometric materials which help to illustrate the curious mixture of races in the population of Seistan, I returned to the desert south and supplemented my survey of the ancient *Limes* by some rapid excavations. They disclosed interesting details as to the construction and internal arrangements of those ruined watch-stations and the life once led there.

Thence I set out by the beginning of last February for the return journey to India, whither most of my archæological finds from Seistan, filling twelve cases, had already preceded me. I travelled by the Seistan-Nushki trade route which the zeal of Captain (now Colonel) F. Webb Ware, of the Indian Political Department, had first pioneered through the desert some twenty years ago. Well known as the route is, this desert journey of close on 500 miles through the wastes of Baluchistan had for me a special interest. I could not have wished for a better modern illustration of the conditions once prevailing on that ancient route through the Lop desert, which the Chinese had opened about 110 B.C. for the expansion of their trade and political influence westwards, and which two years before I succeeded in tracking through those waterless wastes after sixteen centuries of abandonment.

It is true that wells of tolerably good water at most of the stages, comfortable rest-houses at all, and good camel grazing to be found at half a dozen points, made progress along this modern desert track seem child's play compared with what we had gone through. Even in ancient times the physical difficulties successfully overcome by those early Chinese pioneers must have been vastly greater than those which the route to Seistan ever presented in the days before its improvement. And yet the latter, by the political reasons which have necessitated its opening, by its purpose, by the character of the traffic I found moving along it,

provided a most striking analogy, and neither as a geographer nor as a historical student could I fail to appreciate its significance.

By February 21 I reached Nushki, whence the railway carried me to Delhi. During my week's stay at the Indian capital I received fresh proof of the kind personal interest with which His Excellency the Viceroy, Lord Hardinge, had from the start followed and encouraged my enterprise. There, too, I was able to meet again some of my oldest friends in India, to whom I had never appealed in vain for such official support as they could give to my scientific labours. A subsequent brief visit to Dehra Dun, the Survey of India headquarters, enabled me to arrange for the suitable publication of the topographical results brought back from this journey, in an atlas of maps. At the same time I secured the admission of Afrazgul Khan to the Survey Department's service under conditions which open up to this capable young assistant the amply deserved prospects of a good career. When I subsequently paid a brief visit to H.H. Sir Michael O'Dwyer, the Lieutenant-Governor of the Punjab, at Lahore, I had the great satisfaction of learning from this kind old friend that the splendid services which R. B. Lal Singh had rendered to Government for a lifetime were to be recognized by a grant of land on one of the new Punjab canals. It meant the realization of my devoted old travel companion's most cherished hope, and a reward such as I had always wished to secure for him. Finally, after the middle of March I reached Srinagar, in Kashmir, my favourite base, from which my expedition had been begun in July 1913. It had lasted close on two years and eight months, and the aggregate of the distances covered by my marches amounted to nearly 11,000 miles.

At Srinagar the 182 cases of my collection of antiquities from Turkestan had safely arrived by October, and there the greatest part of the work demanded by its arrangement and detailed examination will have to be done with the expert help of my old friend and collaborator, Mr. F. H. Andrews, now Director of the Technical Institute and Industrial Art School of the Kashmir State.

The elucidation of the antiquities brought to light by the thousand, and in such great variety of place, time, and character, will involve heavy and manifold labours, and for them and the proper decipherment of the abundant manuscript remains, recovered in about a dozen of different scripts and languages, the help of quite a staff of expert scholars will be needed. The Government of India, though intending that the whole of my collection shall ultimately be deposited in the new museum planned at Delhi, fully realized that this expert help can for the most part be secured only in this country and in France, where after my former expedition, too, I had found the most helpful and important of my collaborators. So I was given permission temporarily to bring here whatever materials stood in need of specialist examination and research, and to come myself to England for a time to make all necessary arrangements in

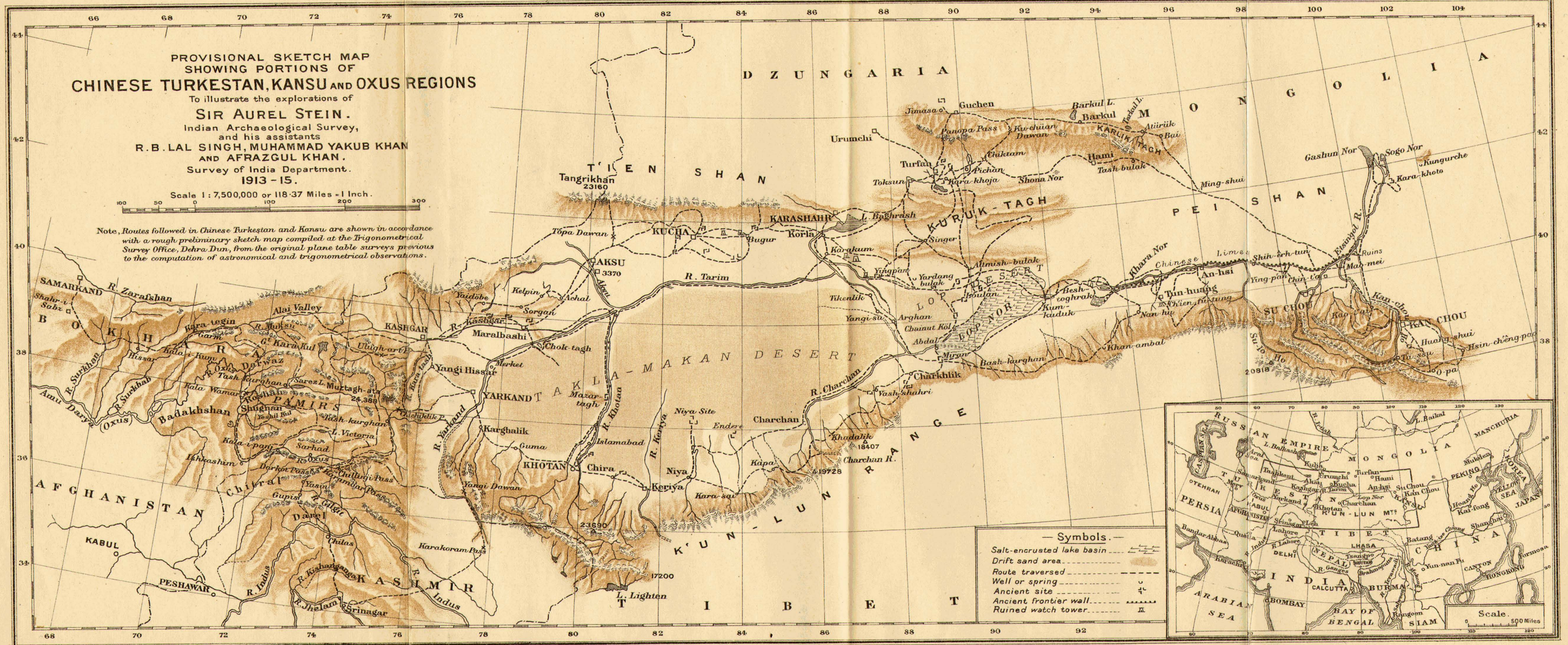
person. But after all the efforts and toils it has cost to recover those relics of past ages from their safe resting-places in the desert it would have obviously been unwise to expose a great and valuable portion of them to the grave risks to be faced at present on a long sea voyage round the shores of Europe. So I decided to transfer myself only across the seas, and to use a short rest in England for preparing a preliminary record of the results achieved and for organizing well in advance the work of my future collaborators.

After two years of the greatest struggle which the history of mankind has known I returned to England fully prepared for considerable changes, and I found such, some sad, some reassuring and hopeful. But no change has affected the kind interest shown in my scientific efforts by old friends within the Royal Geographical Society and outside, and the encouragement derived from this boon I shall ever remember with gratitude.

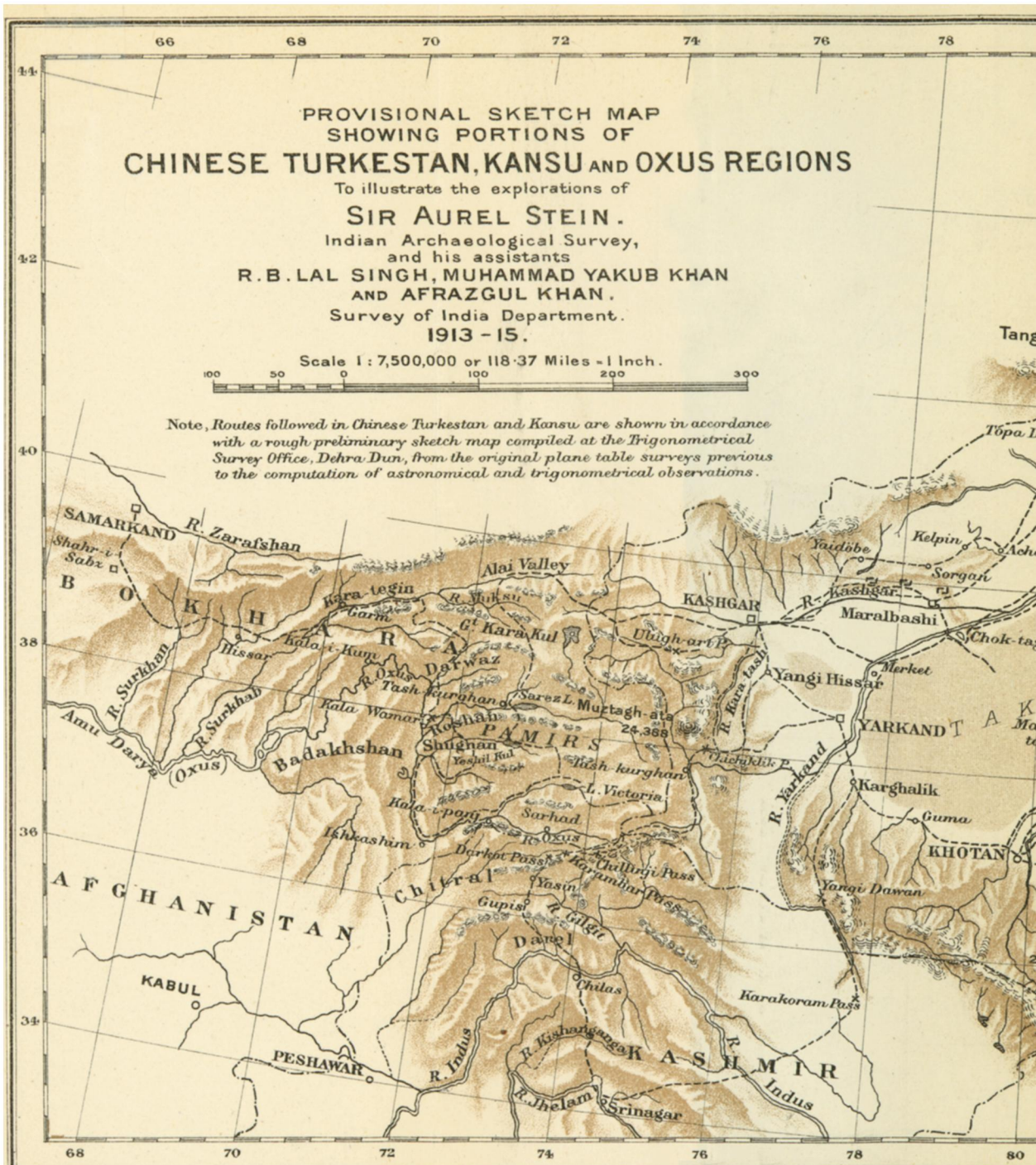
Before the paper the PRESIDENT said: Our business this evening is to welcome Sir Aurel Stein, one of our most distinguished Asiatic travellers, on his return from his third journey to the heart of Asia. He needs no introduction here. We have heard him more than once in this hall, and we know how much he has done, not only as a geographer, as a cartographer, as a surveyor, but also as an archæologist. We know that his travels have led him to one of the most interesting regions on the Earth's surface, where from times long before the beginning of our era the trade to and from Europe and the Nearer East crossed the Chinese frontier. Sir Aurel Stein has got so much to tell us that I am sure the best thing I can do is to ask him at once to begin his discourse.

(*Sir Aurel Stein then read the paper printed above and a discussion followed.*)

Mr. AUSTEN CHAMBERLAIN: When I came here to-night as the guest of one of your members, and even when on entering this building you expressed a desire that I should say a few words in the course of the evening, I did not quite understand the position of prominence which you intended to allocate to me, and I am afraid that I am wholly unfitted for it. I am not a Fellow of your Society, and I am afraid if any geographical knowledge, let alone any geographical exploration, is necessary to qualify for that position, I shall never attain to it. My recollections of geography are of a painful study which, laboriously acquired, was inevitably quickly forgotten; a study of maps of which most were already too full, and which it is the business of your Society to crowd with still more details. You and perhaps the audience will feel that these confessions hardly indicate my fitness for my present position; but at least I am trying to improve. I had the pleasure of welcoming Sir Aurel Stein at the India Office in virtue of the position I hold there, and though I learned very little from him in the brief and very modest account which he gave me of his travels, it was at any rate sufficient to make me feel the importance of the work which he had done, and the immense interests of the results which he had achieved. I think I may fairly say—for I had nothing to do with his travels at any stage—that he was fortunate in the collaboration of the representatives of two Governments. He had the good will of the Government of India, and, as we are glad to recognize, he enjoyed equally the good will of the Russian authorities. By their aid, and above all by his own indomitable



CHINESE TURKESTAN, KANSU AND OXUS REGIONS
Stein.



Conical Projection with rectified meridians and errorless parallels 36° and 44°

Published by the Royal Geographical Society.

CHINESE TURKESTAN, KANSU AND OXUS REGIONS
Stein.

perseverance, his courage, his endurance, and his enthusiasm, he has achieved results which are of interest to all of us, which are of importance to the Governments of India and of Russia, and which, I venture to add, will serve to confirm the high reputation which he has won among explorers. I am not fitted to initiate a discussion of the kind you have invited. I am glad to pay my tribute —and to pay my tribute as Secretary of State for India—to what Sir Aurel Stein has done ; but for a learned discussion of his work you must turn to other and greater authorities.

The PRESIDENT: Mr. Austen Chamberlain has alluded to one of the happiest points in the explorations of Sir Aurel Stein—that they constitute a new link in the friendship between the two great Empires that share the larger part of Asia, England and Russia. We are happy in having here to-night the distinguished Russian officer General Baron Kaulbars. I do not know if he would be kind enough to say a few words to us.

(*General Baron Kaulbars bowed his acknowledgments.*)

Sir HERCULES READ: I am personally very glad to say a few words in order to bear my small testimony to the extraordinary qualities that my old friend Sir Aurel Stein has brought to bear upon the varied aspects of the journey that he has just described to us. I know nobody among all the explorers whom I have met who has greater capacity for carrying on archæological and geographical work under conditions that we all can imagine, after having seen that beautiful series of slides he has put before us. In the intervals of extremely tedious marches he has devoted himself to archæological research in temperatures and climates which are very trying, and, as in former years, he has brought home a collection of antiquarian remains which have opened up fresh fields to archæologists in these islands. For this we who perforce remain at home are most grateful, and not only to Sir Aurel Stein, but in a very great degree to the authorities at the India Office. The atmosphere at this meeting is naturally a geographical one, and I feel that the importation of archæological questions is somewhat of an intrusion ; but I can speak only about my own business. Sir Aurel Stein has given us from time to time a *résumé* of his geographical discoveries, using archæology, if I may say so, as a series of signposts ; and very useful he has found it, as he has confessed. But when one considers that he begins with the Palæolithic period, which you may put back to any remote date, and comes up to something like the seventh or eighth century, and that we have withal not one single piece of these antiquarian remains before us, it is somewhat hopeless to discuss the archæological questions at present. When these remains come to Europe to be studied they will be distributed amongst a number of distinguished scholars, and will then go back to the central Indian Museum which is to be established at Delhi. That, I am sure, is a very proper place for them. I have myself taken considerable interest in the Museum, and have gladly given advice on certain administrative points regarding it ; but a difficulty I find as an archæologist, domiciled in England and incapable of leaving it for more than a few months, is that there will be no opportunity for European students ever to consult these antiquities, except for those fortunate ones who are able to go anywhere at any time and for as long as they please. Sir Aurel Stein's first antiquarian results were divided between the Government of India and the British Museum. There is no difficulty therefore to some extent in still seeing in England the type of object that was discovered on the first expedition. With regard to the later expeditions the case is different, and I think presents a difficulty for the people living in the British Islands of judging the culture that belongs to Central Asia, to these ancient civilizations,

dating from a century or two before our era to several centuries afterwards. Beyond the small collections to be found in Paris, nowhere in Europe will any of these remains be seen. It seems to me a pity that these objects of extraordinary interest, covering almost all periods of human activity and human industry, are not to be represented at all in these islands. I think that some measures should be taken by which adequate representations of these very interesting historical and religious remains should find their place somewhere within reach of the ordinary British citizen.

Sir FRANCIS YOUNGHUSBAND: As a traveller in both Chinese Turkestan and also on the Pamirs I can testify to the splendid exploit of our lecturer this evening. I know well the hardships he must have gone through and the indomitable courage which actuated him in carrying out these explorations. Since the time of the great Russian, General Prjevalsky, there has been no traveller in Central Asia who has shown so great a persistence over such a large number of years, and such courage and determination in carrying out his explorations, or has brought back such fruitful results, as Sir Aurel Stein. I wish to congratulate him most sincerely on his magnificent achievement.

Sir HENRY TROTTER: Some years ago I had the pleasure on the occasion of Sir Aurel Stein's last lecture before the Society of congratulating him on the success of his work, and I laid particular stress upon the magnetic influence by which he seemed to attract such very different persons as the Trustees of the British Museum, the Viceroy of India, the *personnel* with whom he worked, and last but not least the Taoshih of the Temple of the Thousand Buddhas. It is gratifying to note that he has by no means lost that magnetic power, as is proved by the record of his journey, the splendid work of his surveyor Lal Singh, and the excellent reception of the lecturer by the Russian and other authorities with whom he came in contact.

I should have liked to have made some remarks on a good many points [see note following the discussion], but the lateness of the hour prevents me from doing so. I will only take up your time with one. I was in Central Asia forty-three years ago and know many parts of the ground described by Sir Aurel. The point to which I wish to refer is the great problem as to the principal source of the Oxus River.

Lord Curzon a good many years ago gave in this hall an account of his travels in the Pamirs, and of his discovery in the mountains of Kanjud of a glacier from which flowed a river that, as he maintained, was the principal source of the Oxus. As a result of my own previous observations I (in common with some Russian geographers) looked upon the Little Pamir Lake, also fed by glaciers, as the principal source. From the lake a river, the Aksu, flows eastward, then north, and then north-west as the Murghabi, and later on as the Bartang River, which joins the Panjah branch of the Oxus a few miles above Kila Wamar, where the river makes a great branch to the west.

Lord Curzon maintained that his (*i.e.* the Panjah) branch was the more considerable of the two. I adduced the testimony of an Indian native surveyor who had visited the spot and clearly proved that the Bartang River at the time he visited it had a much greater flow of water than the Panjah; but Lord Curzon produced the testimony of a reliable European witness to prove that when he visited it, at another season of the year, the Panjah branch contained much more water than the Bartang. Both statements were probably true; but for my part I stuck to my theory. I regret that the lecturer has told us this evening that the Bartang River has now been completely blocked up from the effects of an earthquake, that a large lake has been formed, and that it is

unlikely that any water will flow down the Bartang into the Oxus for many years to come. So at last I must confess myself vanquished.

Colonel C. E. YATE: I am delighted to add any words I can to congratulate Sir Aurel Stein on his return. We have all watched the news that has been received from him from time to time with the greatest interest, and are delighted to see him back here again. We are looking forward to seeing the results of his finds displayed here as soon as the roads are safe. As to what has just been said regarding the final disposition of the treasures I too think that a certain amount should remain in this country, and all should not be taken back to India. It seems to me a fair thing to leave some part at any rate for show in this country. I cannot see any reason why all should be taken back to Delhi, as I understand from Sir Hercules Read is the present intention. I congratulate Sir Aurel Stein most heartily on his journey, and we all join in thanking him for the paper he has given us.

Dr. BARNETT: I well remember seven years ago when this Society met to hear Sir Aurel Stein's report of his second expedition and expressed appreciation of his work. It was felt that Sir Aurel Stein had added not only great areas to the Trigonometrical Survey, but even greater realms to knowledge. Further study has confirmed that view, because we have found in result that his second journey was rich to an almost inconceivable degree. His archæological discoveries throw enormous light on the ancient history of that important region which he has covered, and his literary documents have opened up new areas of literature. Similarly, his ethnological studies have been fruitful. Now Sir Aurel Stein, with his usual habit of eclipsing himself, has returned from a third expedition that has exceeded his former ones in importance, inasmuch as he has nearly doubled the net archæological proceeds of the last. From the second journey he came home with 96 cases; now he has 182, after having traversed nearly 11,000 miles. I have no doubt that, in the same way as his previous journey was epoch-making in many ways, so the results of this journey will be equally epoch-making, and I feel sure that this Society in honouring him is doing honour to itself.

The PRESIDENT: At this what Dr. Mill would call "fraudulently late hour of the evening" I will not keep you longer, but I am sure you will wish me to say a few words of most hearty thanks to Sir Aurel Stein for the very brilliant and exhaustive account he has given us of his labours in these barren and difficult regions of Central Asia—labours that are double-sided in a way I think few travellers' have been. The manner in which he first rushes over a series of glacier passes—and so many of them that I believe they would have given even the Alpine Club a surfeit—and then turns to explore buried cities and study the civilization of two thousand years ago is almost unique. We owe, I hold, special gratitude to travellers who go to the very ugly places of the Earth. It is a great temptation to most of us to go only to the beautiful places. When we see those pictures of interminable sand-dunes and rocky hummocks torn asunder and laid bare by the most cruel winds, we feel that the man who for the sake of geographical knowledge and archæology would linger among them deserves a double meed of thanks. The results are extremely interesting, because we find that these desert-places once maintained a great population. This fact opens up many subjects of inquiry, historical, meteorological, changes of climate, migrations of peoples. We also find this charm in these particular trade-routes, that they were the old trade routes between Greeks and Romans and the farthest East. Sir Aurel Stein tells me that in those days the trade caravans must have gone not over the easiest routes but over hundreds of miles of desert in order to

avoid the marauding tribes who were living where there was some possibility of human beings living happily.

We have followed, perhaps with some difficulty owing to its very complexity and richness, the account of his labours put forward by Sir Aurel Stein. We shall all read it with the deepest interest when published in our *Journal*, and we may hope that it will not be published without specimens of the appropriate illustrations which we have admired to-night. The perseverance with which Sir Aurel Stein photographed as he went along is, even in these days of photography, deserving of the highest praise. I will say no more, but offer to him the very hearty thanks of this meeting and all geographers in this country and the rest of Europe—except perhaps in Berlin, where they may grudge him some of his Buddhist frescoes; I am sure his reputation over Europe as one of the greatest travellers of modern times is now firmly established. Three times we have seen him here and each time he comes back with a richer harvest than he did the time before.

Sir Henry Trotter has kindly sent the following additional note for publication:—

I at one time took considerable interest in the geography of the Oxus below Kila Wamar. In the spring of 1874, when leaving Wakhan to return to India, I despatched the Munshi Abdul Subhan (an employé of the Survey of India) to follow the course of the river from Kila Panjah to Roshan and Shighnan. The account of his journey was published in the R.G.S. *Journal*, vol. 48, pp. 210–217. He followed the course of the river for 60 miles from Kila Panjah to Ishkashim, where turning northwards he followed the Oxus for nearly 100 miles further, passing successively through the districts of Gharan, Shighnan, and Roshan—countries which had hitherto only been known to us by name. He could not penetrate beyond Kila Wamar, the chief town of Roshan; but curiously enough another employé of the Survey, "The Havildar," who had been dispatched by the late General Walker from India in 1873 on an independent exploration, went from Kabul to Faizabad, the capital of Badakhshan, and thence started on a tour which combined with the Munshi's exploration to Kila Wamar entirely altered the map of that hitherto little-known portion of Central Asia. He visited the towns of Kolab, Khawaling, Sagri Dasht, Kila Khum (the capital of Darwaz), Kila Wanj, and Yaz-Ghulam. At Kila Khum the Havildar struck the Oxus (still called the Panjah), and his road for 40 miles lay on the right bank of the river—never previously mapped or, as far as I know, visited by any explorer. At Yaz-Ghulam, the eastern frontier village of Darwaz, he was unfortunately turned back—just as he had got within a long day's march of the Munshi's farthest point at Kila Wamar. The Havildar, who was ignorant of what the Munshi had done only a few weeks previously to his own arrival at Yaz-Ghulam, was most anxious to complete his own work. In order to do so he went back by Kolab to Ishkashim, and endeavoured to make a survey down the river to Yaz-Ghulam; but he was again stopped, this time at the southern frontier of Shighnan, and was prevented from carrying out his intentions. Thus there was a gap between the explorations of the Havildar and the Munshi, the existence of which was much regretted; fortunately the missing link was a short one—some 20 miles as the crow flies. A Russian scientific mission visited these parts ten years later, in 1883; but the map then compiled differs greatly from their latest published map of 1910, which again differs from an intermediate map published in 1900. I fancy that accurate surveys of these little-known countries have still to be made.

small parties in the summer, consisting of an experienced geologist, a topographer, a naturalist, and sufficient canoemen to man two or three canoes. Rapid reconnaissance surveys are made with boat log, Rochon micrometer, telemeter, or plane-table; astronomical observations are made for time, latitude, and compass variation; many photographs are taken, and observations made on geology, mineral deposits, natural history, ethnology, climatology, water power, volumes of streams, and other natural phenomena. Supplies are carried in the canoes to last two, three, or sometimes four months, depending on the extent of country to be covered, and expeditions are made into all parts of the country. Such parties are not expensive, and give the best results for the money expended, though the results depend very largely on the ability and experience of the leader of the expedition. These methods have been very successful in the past and will no doubt be continued in the future; for it is difficult to see how any radical change or improvement can be made in them, having regard to cost and the physical characteristics of the country to be explored.

Progress, however, is slow, and because of the distance to be travelled and the area to be explored it is hardly possible for one of these summer expeditions to spend more than three months in new territory; in the more northern areas, because of climate as well as distance, the limit is two months. Allowing for delays on account of storms and bad weather the average length of new routes surveyed by a single party, now that all the easier water routes have already been traversed, would be about 400 or 500 miles. This amount is bound to decrease as time goes on, and it becomes necessary to follow routes that are more and more difficult. To make up for loss of time exploratory parties will soon be compelled to winter in their fields, but even where this is resorted to it will take many years to cover the ground that remains for the Canadian explorer.

[Note by the Editors: In the paper on the same subject, read before the Ottawa Field-Naturalists' Club, and published with a map in the *Ottawa Naturalist*, May 1890, the late Dr. G. M. Dawson computed the then unexplored area as 954,000 square miles. (See *Proceedings R.G.S.*, New Series, vol. **12**, p. 555.) See also the paper by Professor W. L. Grant, *Geographical Journal*, vol. **38**, p. 362, October 1911.]

ON THE ACCURACY OF BASEVI'S DETERMINATIONS OF THE VALUE OF GRAVITY IN INDIA.

R. D. Oldham, F.R.S.

IN the years 1865–71 a very elaborate series of determinations of the value of gravity at a number of stations in India was carried out by Captain J. P. Basevi, who lost his life when trying to complete the series by observations in the centre of the Himalayan Range, but not before he

had completed a determination at Moré, at a height of 15,427 feet above the level of the sea. These observations were afterwards completed, tabulated, and published ('Account of the Operations of the Great Trigonometrical Survey of India,' vol. 5, 1879). They immediately attracted attention on account of some remarkable peculiarities revealed, and none more than the observation at Moré, which was of an especially remarkable character, and has been discussed from various points of view in connection with speculations on the origin of mountains and of the phenomenon known to geodesists as compensation.

The accuracy of these observations was unquestioned till in 1893–97 fresh observations were made at some of Basevi's stations by the Austrian Navy, which indicated that the earlier results were all in defect by about ·040 dyne. For this and other reasons it was decided to inaugurate a new series of gravity determinations, and the first result of these was to reveal a discrepancy of over ·100 dyne between the value adopted, as the result of prolonged and numerous observations, at Dehra Dun by Basevi and that obtained by Colonel G. P. Lenox Conyngham in 1904. As the new survey proceeded, observations at a half-dozen of Basevi's stations revealed defects of the value of the force of gravity varying from 0·026 to 0·110 dyne, distributed without any apparent reference to locality, and the conclusion appeared inevitable that the whole of the older observations were affected by an irregular source of error, the amount of which could not be estimated with any approach to accuracy in any individual instance. From this conclusion it seemed to result that the whole of Basevi's observations ceased to have any value, and would have to be ignored. A comparison of the old and the new observations has, however, convinced me that this conclusion goes too far, and that Basevi's results, if properly interpreted, have still a real value and importance where they have not been superseded by more modern observations.

In making a determination of the amount of the force of gravity at any place the first step is the measurement, with the utmost accuracy, of the period of a pendulum of known dimensions. To this measurement certain corrections have to be applied for the effect of temperature, of the pressure of the atmosphere, and of the flexure of the stand. The first two of these corrections were known and applied, so far as they had been determined, in Basevi's time; but the necessity of the last had not been recognized, and it was considered sufficient if the stand was sensibly rigid. It has however been found that even the most massive and solidly built masonry will yield more or less to the swing of the pendulum and so affect the period; and a method has been devised by which this effect can be measured and allowed for. Had Captain Basevi followed the usual course of having brick pillars built at each station for the support of his instrument, we should have had to do with a source of error of variable and undeterminable amount; but instead of adopting this procedure he

constructed a strongly braced wooden stand, which was carried from one station to another, and always erected on a platform constructed at ground-level. This procedure and apparatus were used at every station except three; at Mian Mir and Moré a tripod stand of lighter construction was used, and at Dehra Dun the heavier stand was mounted in a specially constructed room, in a manner which seriously modified the results. The observations may therefore be divided into three groups: (1) the standard stations, at which the heavy braced stand was mounted on a platform at ground-level; (2) the stations of Mian Mir and Moré, at which the lighter tripod stand was used; and (3) the station of Dehra Dun. In each of these groups the conditions of observation were so different that no comparison is possible, and each must be dealt with separately.

At six of the standard stations observations have been made in the newer series, and in every instance the older value is in defect, as compared with the newer, by amounts which are shown below:—

Mussooree	...	...	...	...	...	...	...	·042 dyne
Nojli ...	...	...	...	...	...	...	...	·027 ,,
Kaliana	...	...	...	...	...	...	...	·047 ,,
Colaba ...	...	...	...	...	...	...	...	·026 ,,
Madras ...	...	...	...	...	...	...	...	·042 ,,
Kalianpur	...	...	...	...	...	...	...	·052 ,,
			Mean	...	...	...	...	·039 ,,

This difference may be taken as representing, presumably, the correction for the effect of flexure of the stand, which should have been applied to Basevi's values. It will be seen that this correction varies between the values of $-·026$ and $-·052$, with a mean of $-·039$ dyne, so that, if Basevi's values are expressed in the metric system to the second decimal point and a correction of $-·04$ applied, the result will be correct within 01 dyne of the true value.

We now come to the stations of the second group, at which the lighter stand was used. This stand was not tried by Basevi at any of his standard stations, and so we have no basis for a direct comparison; but we have Colonel Lenox-Conyngham's observation at one of the stations, Mian Mir, at which it was used. Here the later observation gave a defect of ·109 dyne as compared with the earlier, a defect which may be attributed to the flexure of the stand. From this it seems that the use of the lighter stand introduces a correction of about twice as much as in the case of the heavier, and probably an uncertainty in the same proportion, so that the correction which must be applied to Basevi's determination at Moré will lie within the limits of $-·11 \pm ·02$ dyne.

At Dehra Dun the same stand was used as at the standard stations, but the observations were made in a room specially adapted for the purpose of determining the temperature correction; in this a set of flues

was built and a temporary wooden floor put in, at a level of 5 feet above the original concrete floor of the room, the wooden stand being supported on four brickwork pillars each 5 feet high by 1½ foot square at the base, tapering to only ½ foot square at the top. Seeing that Colonel Lenox-Conyngham, using pillars 1 foot 8 inches high by 2 feet 3 inches square at the bottom and 1 foot 6 inches at the top, and a much lighter apparatus, found it necessary to introduce corrections of from ·015 to ·020, and in one case as much as ·035 dyne, it is easy to understand how the taller and more slender pillars and heavier pendulum used by Captain Basevi might introduce an error, due to flexure of the support, of ·100 dyne. There is independent evidence that this is the correct explanation of the discrepancy in Basevi's preliminary observation at Dehra Dun, which was made in a simpler routine of observation, but agreed with the standard ones in being made with the same stand, supported on a solid platform at ground-level. The value obtained was equivalent to 979·036 dynes ('Account of the Operations,' etc., vol. 5, p. 118), or ·027 dyne less than that adopted by Colonel Lenox-Conyngham as the result of his observations.

CIVILIZATION AND CLIMATE.

Civilization and Climate.— Ellsworth Huntington, Ph.D. Yale University Press. (London: H. Mitiord.) 1915. Pp. 333 + xii. *Maps and Diagrams.* 10*s.* 6*d. net.*

PROF. HUNTINGTON has aimed in this work at constructing two maps of the world, the first to show the distribution of civilization and the second to show the distribution of those combined climatic effects which make for efficient human labour both mental and physical. Since civilization is an aspect of human efficiency, and since the two maps agree in their main outlines, it is urged that the climatic factors are partly responsible for the distribution of civilization as it occurs both in the past and in the present.

The measurement of civilization has already been described in these pages (*Geogr. Journ.*, vol. 47, p. 51, January 1916) in our review of a pamphlet which now forms part of the larger book. It will suffice here to recall the fact that the civilization map which Prof. Huntington has made differs little from a map of the world showing the density of population. The complete investigation into civilization was then considered, and the re-examination of that study in relation to the whole book does not lead the writer to change the views previously expressed.

The major portion of the complete work deals with climatic effects and consists of three sections. The first is introductory and discusses previous attempts, such as those of Ratzel, to demonstrate the importance of climate as a factor in the development of civilized life. The method

adequate basis for a complete explanation. Darwin's theory invokes widespread earth movements about which we still know very little. Daly's theory involves the Glacial period, as to the cause of which we are in total ignorance. Indeed, it is interesting to note that in a recent paper on the cause of the Ice Age (*Bull. Geol. Soc. Inst. Univ. Upsala*, vol. **13**, i. 1916) Enquist suggests that the great extension of glaciated areas in the Pleistocene was due to a tectonic sinking of the level of the sea to the extent of 600 metres, and the puzzling features of coral reefs are brought forward to support the theory. Daly's cart is Enquist's horse, but as we do not really know which *is* cart and which its horse, it is impossible to decide which should come first in the links of causation, the Glacial period or the sinking of the seas.

In the present stage of investigation the only theories that call for serious discussion are Darwin's and Daly's. Neither holds the field completely, nor is it likely that they ever will do so, for it would seem wisest to regard them as complementary, each supplying, in any particular case, the defects or inadequacies of its partner. One should not omit to mention that the Glacial-control theory, independently of its truth or otherwise, is worthy of a hearty welcome as a stimulus to further researches. From the causes of the Ice Age, to the habits of reef-building corals, it arouses interest in a wide variety of problems whose solutions, one and all, lie in the future.

ARTHUR HOLMES.

THE INDO-RUSSIAN TRIANGULATION CONNECTION.

WE have lately received an important volume, 'Records of the Survey of India,' Vol. **6**, prepared under the direction of Colonel Sir S. G. Burrard, Surveyor-General of India, and dealing with the completion of the link connecting the triangulations of India and Russia. The Indian Survey has done much splendid work, but none has been carried out under greater difficulties than this, and none is likely to be more valuable. It is the first step to the final solution of important geodetic problems.

During the International Geodetic Conference of 1909, which met in London, the question of a triangulation connection between India and Russia was discussed, and it was suggested that a link might be effected across the northern boundary ranges of India to the Chinese or Russian Pamirs. In the early part of the year 1911 the Surveyor-General of India received a proposal to this effect, and steps were at once taken to organize the work.

In 1909–1911 Gilgit had been connected with Rawul Pindi and the Indian system. In the mean time work on the Russian side, which had been initiated by Colonel Tcheikine, had reached the neighbourhood of

Pamirski port, about lat. 38° 13′, long. 75°. To the north-west of Kashmir, for a distance of about 160 miles between longitudes 72° and 75°, the British and Russian dominions are separated by a strip of Afghan territory not exceeding 40 miles in width. The connection of the Gilgit with the Russian survey, however, presented the most tremendous difficulties. The gigantic range of the Karakoram, with peaks ranging from 22,000–26,000 feet, with hardly any passes, and huge glaciers, filled nearly the whole of the ground that separated the Indian from the Russian survey. The difficulty of extending the Gilgit survey to the Afghan boundary was found to be insuperable. The only feasible route was from Gilgit up the Hunza valley to the Kilik Pass. This meant far more work, as the distance was greater; moreover, it meant surveying for over 100 miles up a narrow gorge such as can only be found in the Himalaya. The mountains on either side rise in precipices for thousands of feet. The bottom of the valley is seldom a mile wide, and in some places the path up the valley rests on pegs and props driven into the face of the cliff. The peaks on each side of the valley that had to be climbed in order to get stations were as a rule 6000–7000 feet above the valley, and were nearly all of them higher than Mont Blanc. The number of stations in the survey is thirty-three; their average height is 16,222 feet, the highest being 19,135 feet. Naturally such a survey entailed work of the most arduous kind, more often than not carried out under difficult conditions of wind and temperature.

A brief summary of the work has already been given by Lieut. Kenneth Mason, R.E., in the *Geographical Journal* (vol. 43, p. 664); this report of the Indian Survey gives the entire results of the expedition. During 1911 and 1912 Lieut. H. Bell, R.E., was in charge, and carried out all the reconnaissance. Only a few passes over the mountains were known, and some of these were inaccessible during the summer owing to rivers swollen with melted snow and unfordable; while beyond them ranges of peaks ("Glorified Matterhorns") entirely stopped further progress. According to Lieut. Bell they appeared inaccessible even to experienced climbers, and it was a physical impossibility to take an instrument up any one of them. It will be remembered that at the end of June 1912 Lieut. Bell was most unfortunately taken ill and died at Lup-Gaz, after having made his way to the termination of the Russian triangulation and met Colonel Tcheikine of the Russian Topographical Service. Early the next year 1913 Lieut. Mason took charge of the parties, and the connection of the English and Russian surveys was accomplished before the end of the year.

The report is full of interesting detail and makes excellent reading, especially the lively chapters contributed by Lieut. Mason, who went straight to the work from a holiday at Mürren, and tried his *ski* on the passes with some pleasure, but with "a fair number of tosses" and a descent of the Burzil which "left a lot to be desired." His chapter on Geographical Impressions of the Pamirs deserves careful study, and requires

for its full appreciation a better map than is contained in the report. His re-observation of marks placed by the Geological Survey on the snouts of certain glaciers shows the difficulties of satisfactory marking and the very valuable results to be obtained when these are overcome. He has also an interesting chapter on photographic surveying in the Pamirs. With Captain R. W. G. Hingston, I.M.S., he contributes a section on Geology and notes on the Climate and Snowfall. Messrs. V. D. B. Collins and C. S. McInnes describe the stretches of triangulation for which they were responsible.

Captain Hingston made a very complete zoological collection of the fauna of the Taghdumbash Pamir, and a series of observations of the cirrus clouds for the Meteorological Survey of India. A botanical collection was also made, but in such inhospitable wilds it necessarily was small and consisted of only forty-four species.

Captain Hingston's observations on the blood at high altitudes are particularly valuable, and the conclusions he draws from a large number of observations are given by quoting his words: "Increase in altitude means increase in the number of red blood-corpuscles. Normal blood at sea-level contains 5,000,000 red blood-corpuscles per cubic millimetre. During a gradual ascent the number increases until at an altitude of 18,203 feet, the highest point at which I was able to make an examination, the blood contains 8,320,000 corpuscles per cubic millimetre. The manufacture of these corpuscles takes time to develop, and failure in that development . . . means mountain sickness. The number of these red corpuscles in the blood of a dweller at low altitudes can increase until it reaches ultimately the number normal in the dwellers at high altitudes, and the converse is likewise true; and the method by which the body adapts itself to great heights is not by a greater energy on the part of the cardiac or respiratory mechanism, but by a slow and gradual manufacture of the red blood-cells which produce a greater richness of the blood stream and convey a normal supply of oxygen to all the tissues."

In the report are a number of excellent reproductions of photographs. They give a clear impression of the country, but they show it only in fine weather, and fine weather was the exception. Nearly half the days had seen snow falling to a greater or less extent. Naturally one of the greatest difficulties was the rationing the detachments. The Pamirs produce nothing except sheep and goats, and all the flour and other food had to be brought from Gilgit and Hunza; those only who have travelled in the desolate and rugged upper valleys of the Himalaya and Karakoram ranges will understand the immense amount of labour necessary. But in spite of this, in spite of the incessant climbing up and down the peaks from which the observations were to be made, waiting sometimes at the high camps on ice and snow for days till the weather was fine enough to allow angles to be taken, and in spite of numberless difficulties, the expedition was brought to a satisfactory end. Those who shared in the work are to

be congratulated, for not only have they completed a most important contribution to our knowledge of the mountain barrier that lies where "Three Empires meet," and connected two of these empires by survey, but they have also lived amongst some of the grandest scenery on the Earth's surface. In a letter from Captain Kingston to Lieut. Mason the former says, "I shall always look back on my experience on the Pamirs as one of the most fascinating of my life."

The report is dedicated by its authors to the memory of Lieut. Bell, who lies buried at Gilgit next to Hayward. His brother officers and his colleague Colonel Tcheikine bear touching reference to his high qualities of character and intellect. The Sarikolis at Lup Gaz, where he died, have named the valley Bell-Sahib-i-Jilga, and have built a shrine to the memory of the man they reverence for his just and kindly dealing.

J. N. C.

The technical results of the survey are described in three appendices, with a chart showing the figures of the triangulation, which has seven quadrilaterals, two tetragons with central points, and eleven single triangles, some of which can hardly be described as well conditioned, though they are far better than at one time seemed possible. Six-inch micrometer theodolites were used, generally with luminous signals. The mean triangular error of the whole series was $3''{\cdot}33$, and the mean error of an angle $\pm 2''{\cdot}79$. The Indian calculations are as usual based on the Everest spheroid.

It must be noticed that although a connection has now been made between Indian and Russian triangulation, the Russian work is at present not connected with the general triangulation of the Russian Empire. In an Appendix by General Pomerantsev it is explained that the Russian work starts from the town of Osh, where a base is measured, and proceeds by Lake Kara-Kul and the valley of the Aksu to the junction with India on the side Kukhtek–Sarblok, near which the chain is adjusted to a second base at Kisil-Rabat, where latitudes and azimuths were observed. The mean error of an angle of the Russian triangulation is $\pm 2''{\cdot}89$, and it is calculated upon the spheroid of Bessel. The side common to the Indian and Russian triangulations has a length of 7134 metres, and the discordance between the two values for this side is 1·52 metres. These results must be considered preliminary, and the whole will be recalculated when the Russian triangulation is joined to that of Tashkent.

Three peaks intersected from the new triangulation had been previously fixed by the Pamir Boundary Commission of 1895, and the agreement between the two sets of values is very striking. Commenting upon this in the Preface, Colonel Lenox-Conyngham remarks that the work of the Boundary Commission in 1895 was carried on by the approximate methods and expedients which rapidity of movement dictates, but that in skilled hands even these are capable of producing results of surprising accuracy,

so surprising as to have the appearance of lucky accidents were it not that the luck always seems to accompany those who know their art. It is possible that Colonel Wauhope and his colleagues on the Boundary Commission will be less surprised than Colonel Lenox-Conyngham at the excellence of this accordance, which suggests in fact that in course of time a connection will ultimately be established between the Indian and Russian Surveys by the method of re-section from visible but inaccessible peaks, stronger than is possible by the necessarily somewhat weak chain carried on stations which can be occupied in canonical form. It will be remembered also that in the recent work of the Peru–Bolivia Boundary Commission the triangulations north and south of the Cordillera were connected by re-sections with very satisfactory results.

A. R. H.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

THE meeting of the British Association at Newcastle-on-Tyne was again held under war conditions, and, as was to be expected, the attendance was small. But it is questionable whether the quality of the work done in the various sections suffered much thereby. In Section E, at least, many interesting papers were read, and there were several good discussions. The Presidential chair was filled by Mr. E. A. Reeves. Sir Thomas Holdich, Dr. W. S. Bruce, Mr. Chisholm, and Prof. J. W. Gregory were Vice-presidents. Mr. J. McFarlane acted as Recorder, and Dr. R. N. Rudmose Brown, Mr. B. C. Wallis, and Mr. N. Shaw as Secretaries.

The President's address on "The Mapping of the Earth, Past, Present, and Future" was read at the opening meeting of the Section in the Friends' Meeting House on September 6. It is reported in full in the October number of the *Geographical Journal.*

Prof. H. J. Fleure followed with a paper entitled "France—a Regional Interpretation," in which he dealt with the wealth of the contributions made by France and her people to the heritage of civilization, and endeavoured to interpret this, not as the result of any presumed race-superiority, but as due to much more serious and substantial factors. France is in a sense a goal of many east to west routes in Europe. Across her also run almost the only practicable ways from north to south. These ways are fairly easily graded, and have time after time allowed waves of Mediterranean civilization to adjust themselves gradually to the conditions of the forest and corn lands further north. It has thus come to pass that Northern France has always had a good deal to link it with North Central Europe in peace and in war, while the south has remained essentially Roman in the foundation of its life. Burgundy and Aquitaine are, as it were, go-betweens, and their cities and traditions suggest this. But Aquitaine and Brittany make another contribution to civilization, for they with Ireland and the west of Britain retained the old Celtic-Ægean life of the Bronze Age for centuries after iron had spread into Europe, and their life has much that will be found to have been inherited from that Age. The author then proceeded to discuss the relations of the Paris Basin, the Rhône Corridor, Burgundy, Aquitaine, and other regions to one another, and their reactions one upon another, as shown in their language, the history of their law, their town-places, their cathedral

traveller and a congenial companion, is given by his quondam associate Von Höhnel in *Petermanns Mitteilungen* for May last. He was born at Saromberke in Eastern Siebenbürgen—the ancestral home of his family—in 1845.

CORRESPONDENCE.

Glacial Phenomena on the Yun-nan–Tibet Frontier.

MAY I correct a misapprehension in the remarks of Dr. J. W. Evans and the President with reference to my paper, "Glacial Phenomena on the Yun-nan–Tibet Frontier," printed in the July number of the *Journal?* Both understood me to mean that I consider the western ranges to have risen appreciably during the last half-century, and that immediately prior to that the eastern ranges were glaciated.

This is, I imagine, owing to my ambiguous quoting of the Tibetans, who said that fifty years ago the Ka-gur-pu glacier extended further down the valley. Personally I attach little importance to that evidence, though it may perhaps show that this glacier has retreated appreciably during that period. In another paper, to be published at Edinburgh, I have endeavoured to show that the marked differences between the flora of the Mekong–Yangtze divide and that of the Salween–Irrawaddy divide are due to the retreat of the ice from the former range; but such differences could not have been brought about in a few years. Moreover, the glaciers of the Mekong–Yangtze divide are so reduced, and the records of them have been so far demolished and masked, that they must have disappeared long ago. Prof. Gregory states my case when he suggests that I mean that there has been a slow retreat, at least on the Mekong–Yangtze divide, since prehistoric times. Undoubtedly the glaciers are retreating now, but a temporary advance might set in again if for any reason the rainfall temporarily increased. While believing that the western range may still be rising, I have no reason to believe that the rise is appreciable in fifty years; the effect of a slight elevation might not be appreciable for some time.

F. KINGDON WARD, 2nd Lieut., R.O.I.A.

Bhamo, Upper Burma,
9 September 1916.

GEOGRAPHICAL LITERATURE: ADDITIONS TO THE LIBRARY. Edward Heawood, Librarian, R.G.S.

For list of abbreviations see January number.

EUROPE.

Alps. **Durham.**

Summer holidays in the Alps, 1898–1914. By W. E. Durham. London: T. Fisher Unwin, [1916]. Size 10½ × 7, pp. 208. *Illustrations. Price* 15*s. net. Presented.*

Eastern Europe—Slavs.

The Southern Slav Library: V. Idea of Southern Slav Unity. Published on behalf of the Jugoslav Committee in London, 1916. Size 7½ × 5, pp. 36. *Price* 3*d. Presented.*

Europe—Political. **Seton-Watson.**

German, Slav, and Magyar. A study in the origins of the great war. By Dr. R. W. Seton-Watson. London: Williams & Norgate, 1916. Size 7½ × 5, pp. 198. *Sketch-maps. Price* 2*s.* 6*d. net. Presented.*

that account. The weather also favoured us; and I do not think that any season of the year is likely to be better suited for this expedition than the months of December and January. Unfortunately the journey is an expensive one; but that is a fault which will be cured as soon as this colony takes a practical interest in the development of the high-level savannahs of the interior. The heavy expenses are all incidental to the river journey up the Potaro. In the savannah country, the cost of transport is at the rate of one shilling a day for each drogher. A party such as ours, in order to travel rapidly, needs about twenty droghers, whose wages would therefore total £1 for each day's march. According to the custom of the country, days spent at rest in camp are not paid for.

ROUTES IN KAN-SU.

Eric Teichman, B.A.

Map, p. 520.

THE following notes accompany a route map of Kan-su Province which I have recently compiled during my spare time from full notes made during an extended tour in that province in connection with the investigation of opium cultivation and other matters. As the journey was made with the assistance of the Chinese officials I had quite exceptional opportunities of going wherever I pleased, and covered practically the whole province except the extreme west.

The map does not pretend to be geographically accurate, but was drawn up to accompany an official report on the journey. I found the existing foreign maps of Kan-su singularly unreliable away from the main Peking-Turkestan road. I have therefore compiled the accompanying map from my own notes and from Chinese maps, which I found more reliable than the foreign ones. The Kan-su sheet of the China Inland Mission atlas of 1906 was about the best of the latter, but even it is full of remarkable inaccuracies, such as the position of the two Tao Chous in the south-west, the Koko Nor border north of the Si-ning, and the rivers between Ping-liang and Ning-Hsia Fu.

The names given are all Chinese. Many places have Tibetan and Mongolian names also. The map was made as follows:—

I kept up a route survey with a prismatic compass all the way with the exception of a very few days when special circumstances did not permit of my doing so. I then fitted my routes into a map of the Province which I had compiled from Chinese maps. The Chinese information is more reliable than that on foreign maps, especially that obtained from the district magistrates. The existing foreign maps of Kan-su seem to be made up of a collection of the routes of the old Russian travellers with weird place-names which the local Chinese have never heard of.

The road from Sian in Shen-hsi to Lan-chou Fu, 470 miles—a portion of the great highway from China to Turkestan—is too well known to need description. After leaving the Shen-hsi frontier and crossing the Liu-pan-shan pass (about 9000 feet), it traverses the loess plateau of north-eastern Kan-su for the rest of the way to Lan-chou Fu, winding through a maze of loess hills, valleys, and ravines. It is not a very pleasant journey, as all this region suffers from deficient rainfall, and the inhabitants are miserably poor, supplies very scarce, and the drinking-water often brackish. The loess plateau of central and north-eastern Kan-su, here 5000 to 7000 feet above the sea, slopes northwards from the mountains buttressing the Koko Nor down to the deserts of Mongolia, becoming more and more arid as one proceeds north till it merges into the sands of the Ordos and the Alashan. It is composed of a covering of loess, in places hundreds of feet thick, lying on sandstone, shale, and limestone, of which there are various outcroppings in the form of mountain ranges trending in a south-easterly direction from the Huang Ho (Yellow River). Where water is available the loess is highly fertile, as in the green irrigated valleys near Lan-chou Fu and the Huang Ho. It is a treeless region, and it is doubtful whether it was ever forested to any great extent; in its present condition the loess seems incapable of producing trees. On the map this distance is less than 200 miles, but allowing for mountains and windings it may be much more.

From Lan-chou Fu we proceeded south-east to Ch'in Chou, 240 miles, which is also a well-known trade route. The road, a good cart track for Kan-su, crosses a small pass to gain the Tao River valley and Ti-tao Chou, traverses the watershed between the Tao and Wei River valleys, and descends the latter to Ch'in Chou. Here, where the loess meets and mingles with the red sandstone of the Tsin-ling Shan range, is a much more fertile and better-watered region; good crops are raised even on the hills, and the people are better off.

From Ch'in Chou we travelled west through Li Hsien and Min Chou to T'ao Chou and Labrang monastery on the Kan-su Koko Nor border, a distance of about 300 miles. Between Ch'in Chou and Li Hsien the path crosses the Tsin-ling Shan, and passes from the basin of the Huang Ho into that of the Yang-tse by an easy pass. The south-eastern corner of Kan-su, south of the Tsin-ling Shan range, differs greatly from the rest of the province. The bare loess hills of Central Kan-su with their waterless valleys give way to jungle-covered mountains with abundance of water, and coolie transport takes the place of camels, carts, and mules. The people are in close touch with Se-chuan, and there is a considerable element of the latter province in the population and a noticeable absence of Mahomedans, who are so strong and numerous in other parts of Kan-su.

From Li Hsien to Min Chou the path is a bad mule track along the Tsin-ling Shan, first on one and then on the other side of the watershed, winding

through narrow cultivated valleys hemmed in by wooded mountains where the cornfields swarm with pheasants. Gradually rising it emerges before reaching Min Chou on to a grassy plateau some 9000 feet high, the extreme western end of the Tsin-ling Shan, which here merges into the mountains of the Koko Nor border. From this plateau there is a steep descent to Min Chou in the valley of the T'ao River.

From Min Chou we ascended the T'ao River valley, a deep trough in the mountains, to T'ao Chou New City, Cho-ni, and T'ao Chou Old City. New and old T'ao Chou lie a little way north of the T'ao River in a region of bare hills of red clay and red sandstone which occur all along the border; the whole region is comparatively elevated, 8000 to 9000 feet above sea-level. New T'ao Chou (so called though it is some hundreds of years old) is the official city as opposed to Old T'ao Chou, the commercial city where the Chinese, mostly Mahomedans, are engaged in trade with the surrounding Tibetans. Cho-ni, a picturesque little place, lies right on the river, which is here crossed by a remarkably good cantilever bridge, and is little more than a walled village round the residence of the "tu-ssu" (native chief); there is also a lama monastery with some five hundred lamas. The T'ao River is in this neighbourhood the dividing line between Tibetan and Chinese populations; south of the river are forest-clad mountains with a Tibetan population; to the north are the red hills with cultivated valleys inhabited by Mahomedan Chinese. Some of the best big-game shooting in China (sheep, wapiti, serow, etc.) is to be had in the forests south of the T'ao River in this neighbourhood. From various points in the vicinity of T'ao Chou fine views are obtained over the rocky snow-patched Min Shan range to the south of the T'ao River on the Kan-su Se-chuan border, a forbidding-looking barrier with a singular square gap known as the "shihmen" (stone gate), through which lies the road to Sung-pan in Se-chuan, a difficult route to travel by owing to the turbulent nature of the intervening Tibetans.

Leaving T'ao Chou Old City on the Labrang road there is a gradual rise to the grass lands of the Koko Nor plateau 10,000 to 11,000 feet above sea-level, inhabited by nomad Tibetans (Drokba) living in black tents. The grass lands ("tsao-ti," as the Chinese call them) are dotted with herds of yak and ponies and flocks of sheep, and antelope are occasionally seen. The track passes from one shallow grassy valley to another, and then descends slightly to the large monastery of Hei-tso (one thousand lamas), where cultivation reappears. At Hei-tso the track leaves the grass lands and winds through picturesque forest-clad valleys, crossing and recrossing mountain torrents for two more days to Labrang, which like Hei-tso lies in a shallow cultivated valley (about 9000 feet) just below the level of the grass lands. Labrang (Chinese La-ba-lang-ssu) contains over three thousand regular lamas as well as a large floating population of visiting Tibetans, and is the most important religious centre of the Koko Nor, not excepting Kumbum. It is a regular town in itself, and the

solidly built barrack-like buildings and huge gilt-roofed temples present a most striking appearance in this land of tent-living nomads. Near by is a small Chinese trading village consisting of inns and bazaars kept by Mahomedans; for Labrang, like all big lama monasteries on the Chinese border, attracts trade. Labrang is nowadays comparatively well known to foreigners.

From Labrang to Ho Chou is three days' journey down the densely wooded gorge of the Ta-hsia River. The mule track is bad, and dangerous in places where it is ledged out of the cliff side or carried on plank stagings overhanging the torrent, but there is nevertheless a constant stream of mules carrying goods up and down for the Mahomedan merchants. Ho Chou is a pleasant little city lying in a fertile valley some 6000 feet high surrounded by rocky snow-sprinkled mountains. It is of interest as the home of the Sala Mahomedans, and many of the inhabitants show their Central Asian origin in their long narrow faces, large eyes, and strong and often curly beards. A knowledge of Turki survives in the neighbourhood. From Ho Chou it is three days' journey across two mountain ranges and the T'ao River (crossed by a ferry) to La Chou Fu.

Leaving the provincial capital for the second time we followed the great west road as far as Liang-chou Fu, whence we struck north to the small town of Chen-fan Hsien on the edge of the Alashan desert, a distance of about 250 miles. For the first few days out of Lan-chou Fu the road passes through a barren waterless region with rare and brackish streamlets, whence it emerges into the fertile valley of the P'ing-Fan River. This valley is followed for two and a half days, past the small city of P'ing-Fan Hsien to the Wu-shao Ling (about 10,000 feet). The flat marshy valley of the upper P'ing-Fan River, the ruins of the Great Wall and of Chinese forts and military posts, and the background of bare snow-capped mountains combine to make up a scene of peculiar desolation which has witnessed many struggles between Chinese, Mongols, and Mahomedans in the past. Crossing the Wu-shao Ling, where marmots chase one another over the grassy slopes, the road descends gradually to the Liang-chou Fu plain. This pass represents the watershed between the Huang Ho and the Central Asian basins, and the streams flowing north lose themselves in the sands of the desert and fail to reach the sea.

Liang-chou Fu is a large city in a fertile irrigated plain between the Nan Shan Mountains and the Alashan desert. Immediately to the west rises a gigantic snow-mass in the main range of the Nan Shan, which provides water for the innumerable streamlets and irrigation channels fertilizing the oases in the plain till they are used up and disappear in the desert. These oases, of which Chen-fan Hsien three days north of Liang-chou Fu is the most important, are regions of great fertility, where cloudless summers combined with a never-failing supply of snow water for irrigation purposes ensure full crops with machine-like regularity. A feature of these irrigated plains are the fortified farmhouses with which every oasis is thickly dotted;

villages, so prominent a feature of the country life of China, are conspicuously absent. These fortress farms, which are in a lesser degree characteristic of many parts of Shen-hsi and Kan-su, are the result of the feeling of insecurity engendered by the Mahomedan rebellions of the past. The population of these plains is entirely Chinese.

From Chen-fan Hsien to Si-ning Fu and the Koko Nor border there are two roads, to the south and north of the snow mountains behind Liang-chou Fu respectively. We took the latter, *viâ* Yung-ch'ang Hsien, Epo, and Ta-tung Hsien. From Chen-fan Hsien to Si-ning Fu by this route is about 330 miles.

The three and a half days' journey from Chen-fan Hsien west to the district city of Yung-ch'ang Hsien is a trying march through waterless desert, especially for the first 30 miles which lie across heavy sanddunes. The Alashan desert is a forbidding waste of sand, lifeless except for antelope, which are constantly in view; the wells are rare and very brackish, but sweet water can be carried. As Yung-ch'ang Hsien is approached the country improves, and west of that city we travelled for three days over a grassy plain below the main range of the Nan Shan till we struck the Si-ning Fu–Kan-chou Fu trail at the mouth of the gorge leading through the mountains up to the Koko Nor plateau. Here were fine pasture lands with grass up to the ponies' knees and many antelope (altitude 8000 to 9000 feet). This country is inhabited by Chinese, but the population is very scanty, and cultivation limited to a few stunted crops of huskless barley round the ruined Chinese military posts. From the mouth of the gorge (known as the Pien-tu-k'ou—"frontier crossing pass," as it leads over the Kan-su border to the Koko Nor) to the little trading station of Epo is a long day's journey, made the more difficult by the mountain torrent which is barely fordable for loaded mules. The track is a very rough one, though this gorge represents an important trade route, being one of the few trails from Mongolia to the Koko Nor through the Nan Shan passable for camels. As the head of the gorge is approached the steep rocky mountain sides give way to grassy downs, and the traveller finally emerges after crossing an easy pass into a flat grassy valley at a height of about 11,000 feet dotted with the black rectangular tents of the Koko Nor Tibetans and innumerable flocks of sheep; an occasional Mongol yurt is also to be seen, for these steppes are inhabited by Mongols as well as Tibetans. The walled village of Epo lies surrounded by a sea of grass on or just across the Kan-su–Koko Nor border; the garrison of Chinese braves has now been withdrawn, but a small Mahomedan community remains engaged in the Tibetan trade and more especially in the purchase of wool, for this is a great sheep country.

From Epo the track runs due south across another easy pass, whence there is a fine view over the reverse side of the snow giants behind Liang-chou Fu, and descends to Yung-an in the valley of the Ta-tung River; from here it continues down the valley over a grassy plain some miles across bounded on either side by mountain ranges to Pei-ta-tung, where a little

scanty cultivation makes its appearance again. Yung-an and Pei-ta-tung are replicas of Epo; each of these old military posts is a long day's journey from the next without habitation in between.

At Pei-ta-tung the Ta-tung River, a broad and very rapid stream, is crossed by the usual "pifatzu" (a raft composed of a light framework resting on inflated skins), the animals having to swim, and the road leaving the valley climbs abruptly up the formidable range known as the Ta-pan Shan. Both ascent and descent are very steep, and the path particularly bad and rocky. The summit of the pass (about 13,500 feet) is just below the snow-line in August. From the Ta-pan Shan the track descends through narrow valleys to the district city of Ta-tung Hsien (Maopeisheng), which lies at a much lower altitude in a grain-growing region of cultivated valleys inhabited by Mahomedans. From Ta-tung Hsien to Si-ning Fu is a day and a half's journey by a good road down the valley of the Pei Ch'uan.

Si-ning Fu, one of the principal cities of Kan-su, is too well known to need description. It lies surrounded by bare mountains in a small plain formed by the conjunction of three streams, the Pei Ch'uan (from Ta-tung), the Hsi Ch'uan (from Tan-ko Hsien), and the Nan Ch'uan (from Kumbum monastery). From Si-ning Fu to Lan-chou Fu by the short road down the Si-ning River is six days' march (148 miles). The path is a bad and in places rather dangerous mule track down the gorge of the Si-ning River; the hills are bare sandstone covered by a layer of loess, and the country becomes more and more arid as one proceeds east, until the desolate hills and irrigated valley of the Huang Ho are reached one day above Lan-chou Fu.

From Lan-chou Fu we returned to Peking by the Huang Ho route. Rafts or boats are obtainable at Lan-chou Fu, but both are scarce. The former are safer for the stretch of 200 miles or so as far as Chung-wei Hsien, as the Huang Ho here runs through mountain gorges rivalling those of the Upper Yang-tze, and is much obstructed by rock and rapids. We were fortunate in securing large rafts of piled-up lumber standing a foot out of the water, and with a good tent pitched on the top there are few pleasanter methods of travelling in China. Navigation is carried out by large sweeps at the bow and stern, and consists in keeping the raft in the centre of the stream and away from the cliffs and rocks in rounding the bends of the river. The worst rapids occur immediately below Lan-chou Fu, and this stretch of gorges come to an end at Po-wan, half a day above the district city of Ching-yuan. In this neighbourhood the red sandstone cliffs bounding the river are pocked with square caves resembling those on the Min River below Cheng-tu in Se-chuan. Some are inhabited and provided with ropes and ladders as a means of access, though it is strange that any one should want to live halfway up a perpendicular cliff overhanging the river. Between Ching-yuan Hsien and Chung-wei Hsien the river runs through a series of gloomy gorges in desolate mountains of sandstone and shale; rapids are numerous, some of them sufficiently

alarming. Goral (wild goat) are seen in quite extraordinary numbers in these gorges, especially in the evenings, clambering about the precipitous cliffs. The stretch from Lan-chou Fu to Chung-wei Hsien takes about five days, night travel not being possible.

At Chung-wei Hsien, a considerable city, where the Huang Ho emerges from its mountain gorges on to a broad alluvial plain, we abandoned our rafts for boats, since the river is here much obstructed by sandbanks, and the unwieldy rafts are constantly running aground. Passing through the famous Ning-hsia plain, a region of great agricultural wealth due to a complicated system of irrigation from the Huang Ho, the city of Ning-hsia is reached, and two days further on the Kansu border is crossed and the dreary wastes of the Ordos are entered, where for days one sees no signs of life save for the desert antelope and an occasional Mongol with his camels. In the neighbourhood of the San-ta-ho-tzu (where there is a Roman Catholic Mission) the country on the north bank improves, and a considerable Chinese population is found engaged in agriculture round the old branches of the Huang Ho; to the south the country remains desert. Millions of geese frequent this portion of the Huang Ho in September. The length of time taken over the journey through the Ordos depends very much on the wind, as with an adverse wind, or indeed any wind at all, the clumsy scows are constantly blown ashore. Strong winds are naturally frequent in these regions by day, but night travelling is often possible. Twenty-four hours (floating time) above Pao-t'ou the Wulashan Mountains are reached, a rocky range stretching along the north bank, and a prominent landmark from afar. From this point on the population increases until Pao-tou is reached, where the country is one vast cornfield.

From Pao-t'ou to Kuei-hua-ch'eng is four days by a good cart road across undulating grain-growing prairies just south of the Ta-ching Shan, a continuation of the Wu-la Shan. From Kuei-hua-ch'eng to Feng-chen, the present railhead of the Peking Kalgan Extension Railway, is also four long days' march by a good cart road through low mountains.

THE PHYSICAL CONDITIONS OF THE WEDDELL SEA.

R. G. Mossman, F.R.S.E.

Read at the Afternoon Meeting, 15 *June* 1916.

This paper was prepared originally for the guidance of the Committee appointed by the Admiralty to conduct the search for and relief of the Shackleton Expedition. overdue from the Weddell Sea. Before it was delivered Sir Ernest Shackleton reached the Falkland Islands, and the questions of immediate interest to the meeting were the hope of survival and

CHINA

KAN-SU PROVINCE

Showing route traversed and mapped by

ERIC TEICHMAN, B.A.

Scale, 1/2,000,000 or 1 Inch = 31·56 Statute Miles.

10 0 10 20 30 40 50 100 Stat. Miles.

Reference.

Author's routes ——

Other routes ——

□ ... *Walled city with magistrate*

○ ... *Small town, village, walled fort or monastery*

Heights, in feet, are from Mr. Clementi's barometer and boiling point observations; except those given in round numbers which are rough approximations only.

Note.

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Liang-chou Fu	37 55 35	102 33 44
Ching-pien-yi	37 40 51	102 45 9
Chen-chiang-yi	37 9 3	102 53 29
Wu sheng-yi	36 53 16	103 4 44
Nan-ta-tung	36 36 53	103 18 26
Lan-chou Fu	36 3 11	103 46 7
Kan-tsao-tien	35 48 41	104 16 54
Ma-ying	35 18 20	104 58 2
Ch'in Chou	34 35 35	105 33 46
Hui Hsien	33 45 30	105 53 42
Pai-shui-chiang	33 34 49	105 53 28
Lo-yang	33 19 53	106 3 31

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99
100
101
102
39
38
37
36
M O N
Hwei Ho
To Su Chow
Kao-t'ai Hsien
4369
Fu-yi Hsien
Kuang-p'ing-p'u
Sha-ching-tzu
4514
KAN-CHOU FU
4642
Kan-chou Ho
Tung-lo Hsien
Shan-tan Hsien
Hsin-ho
5892
Hsia-kou
Yung-ku
Ta-ma-ying
Kao-ku-cheng
Shui-chuan-tzu
6916
Ma-ying-tung
Yung-ch'ang Hsien
6071
Pa-pa
Snow
NAN SHAN Mountains
OR
18-19,000
Pass 12,000
Epo
Pass 12,000 ft
Ta-tung Ho
Yung-an
Grassy Valley
Pei-ta-tung
Pass 13,500
9000 ft.
TA-PAN SHAN
Ta-tung Hsien
Hsin ch'eng
Pei Chuan
KOKO NOR
(CHING HAI)
10,500
Tan-ko Hsien
(Dangar)
Wei-yuan-p'u
HSI CH'UAN HO
SI-NING FU
Nien-po Hsien
Kumbum
(Ta-erh-ssu)
To Lhasa
Kao-miao-tzu
Pa-yen-jung Hsien
Kuei-te Hsien
HUANG HO
CHING HAI
TIBET


102
103
104
105
106
N G O L I
ALASHAN OR HSI SHAN
Ting-yuan-ying
(Wang-yeh-fu)
NING-HSI
Yen-ho
Yeh-shih-p
Plain
Ta-pa
Chen-fan Hsien
Sheh-sia-kou
Tung-wan
Ning-yuan-pu
Hsiang-chia-wan
Hsien
6071
Pa-pa
Chung-chia-ta-men
Ssu-shih-li-p'u
LIANG-CHOU FU
4748
Flat plain
irrigated desert
Ching-p'ien-yi
5577
Ku-lang Hsien
Ta-ching-pu
Yung-pang-shui
Hung-shui
Ching-ai-tzu
Lung-Kou-pu
Wu shao Ling
10,000
Chen-chiang-yi
8584
Ch'a-kou-yi
Ping-fan Ho
Sha-ho-ching
7192
Wu-sheng-yi
Ping-fan Hsien
Nan-ta-tung
6196
Liu-tun-tzu
Hsia-tung
Hung-cheng
Lao-ya
Yu-chia-wan
Hsiang-tang
Ho-tsui-tzu
Hsin-ch'eng
Chiang-chia-p'ing
4807
Ak-an-chen
Man-ting
5928
Kan-tsao-tien
Chin-chia-yai
LAN-CHOU FU
Ch'ang-ch'uan-tzu
Tsu-li Ho
HUANG HO
Gorges
Hsi-kou
Sha-p'o-ho
I-tiao-shan
So-han-pu
Ta-lo-pu
I-wan-ch'uan
Sha-p'o
Chung-wei Hsien
Ch'ü-k'ou
Plain
Tsou-yuan
Shih-kung
Ning-an-
Ta-la-chi
Po-wan
Plain
Ching-yuan Hsien
Hai-ch'eng Hsien
Gorges

106 107 108 109

39 38 37 36

Teng-k'ou

To Pao-t'ou

To Pao-t'ou via Daba-sun Nor

I A

Shih-tzui-tzu (Shih-chu-shan)

Pao-feng

HUANG HO

ALASHAN OR HSI SHAN

Ping-lo Hsien

Plain

NING-HSIA FU

Yen-ho-p'u

Hung-ch'eng

Yeh-shih-p'u

Plain

Ling Chou (Ling-wu Hsien)

Ta-pa

Chin-chi Hsien (Ning-ling)

Kuang-wu

Chü-k'ou

Plain

Plain

Ning-an-p'u

-wei Hsien

O R D O S

Hua-ma-ch'ih Hsien

Ting-pien Hsien

To Suite Chou & Tai-yuan Fu

An-pien Hsien

S H E N - H S I

Ping-yuan-Hsien

Hsien

Huan Hsien

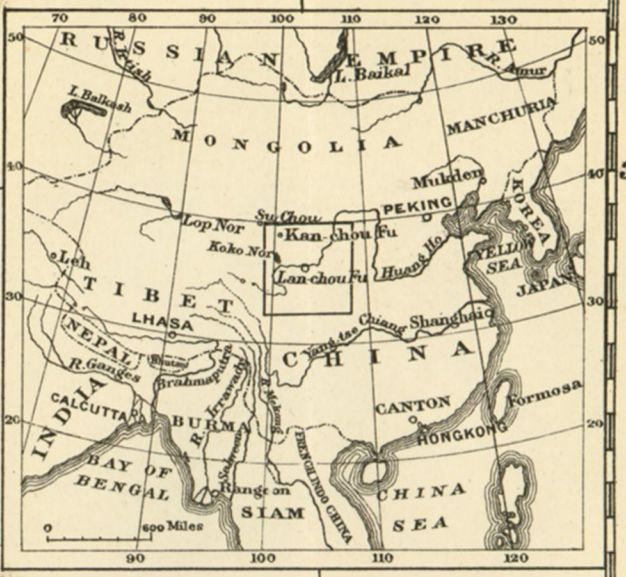
Huan Ho

Ho-shui Hsien

Ku-yuan Chou

Ch'ing-yang Fu

Hsiao-ho-ch'eng



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LAN-CHOU FU
Ho Chou
Ti-tao Chou
Tao Chou (New)
Tao Chou (old)
Min Chou
Chang Hsien
Wei-yuan Hsien
Kung-chang Fu
Ning-yuan Hsien
Li Hsien
Hsi-ho Hsien
Hsi-ku Hsien
Hui Hsien
Ch'eng Hsien
Chieh Chou (Kai Chou)
Nan-ping Hsien
Wen Hsien
An-ting Hsien
Hui-ning Hsien
Ching-ning Chou
Ch'in Chou
Fu-chiang Hsien
Tung-wei Hsien
Ch'in Hsien
Ch'in-shui
Ch'ao-kou
Sa-su-ma
Ka-chia-ssu
Hei-tso-ssu
Ch'ang-chuan-tzu
Chin-chia-yai
Kan-tsao-tien
Ch'eng-kou-yi
Hsi-kung-yi
Ch'ing-chia-yi
Yao-tien
Ma-ying
Ch'ing-ping
Shou-yang-cheng
Chao-chia-keng-tzu
Lo-men-chen
Wu-shih-li-pu
Kuan-tzu-chen
Kao-mo-chen
Lo-chia-p'u
Yen-kuan
Ma-wu-chen
Wu-chuan-ti
Su-tu-ko
Chen-chia-chi
Li-chuan
Hsi-ta-chai
Shan-ch'a
Cho-ni
Pai-ma-kuan
Pa-shui
Pi-k'ou
Hei-shui Ho
Ku Shui
Tao Ho
Ta Hsia Ho
Ho-tsui-t'zu
Hsin-ch'eng
Chiang-chia-p'ing
Ak-an-chen
Man-ping
Ta-wan-t'ou
T'ang-wang-chuan
So-nan-pa
Chung-pu
Sha-ni
Hsin-tien-tzu
Hsin-k'ai-p'u
Shuang-ch'eng-tzu
Tai-tzu-ssu
Sha-kou-ssu
Yu-chia-wan
Sha-p'o-ho
Hsiang-tang
Ho-miao-tza
Hsiao-ho
Liu-Shan
Lu-Hu
TAI TZU SHAN
LIEN-HUA SHAN
TSIN-LING SHAN
MIN SHAN
15000 - 16000
4807
5928
6716
4196
3708
Small Road
103
104
105
S E - C H U
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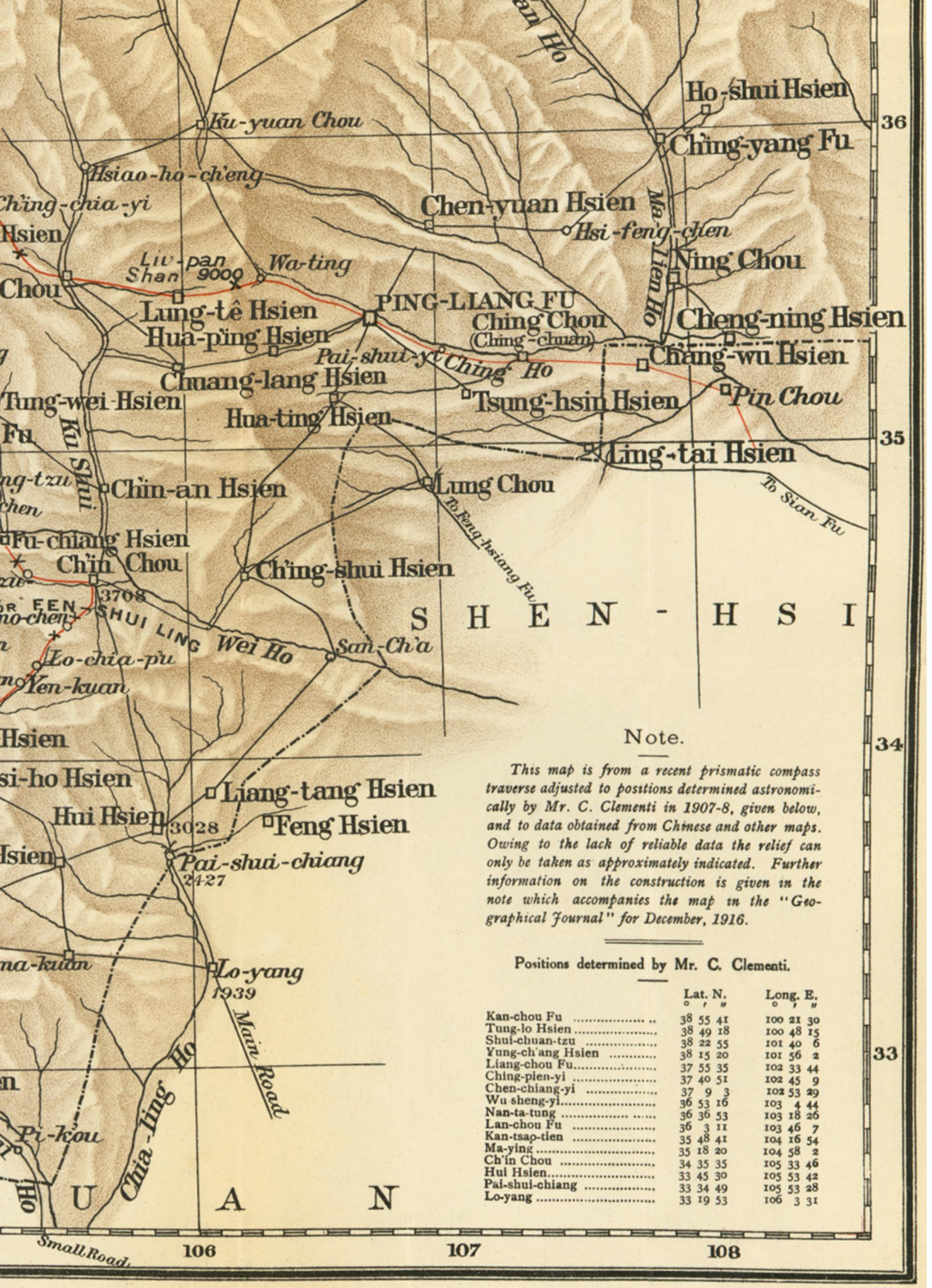

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KAN-SU.

Teichman.